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### **Safety level of Tangchay currently available on the market and development of Tangchay production from cabbage for enhancement of quality and safety**

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#### **Abstract**

Tangchay is a fermented vegetable product that is usually made from many kinds of vegetables that can be contaminated with pesticides. This study was divided into two parts. Part I was to determine the quality and safety of Tangchay available on the market by sampling nine brands. As for the contamination by pesticides residues, three brands had a level of inhibition higher than 50% which is considered very dangerous for consumer. The total plate count of *Staphylococcus aureus* was above the standard of fermented vegetables and some yeasts and molds, and *Escherichia coli* were found in the samples but the levels were lower than the standard. Part II of the study dealt with Tangchay production. It was found that it was possible to make Tangchay from cabbage. The quality of Tangchay depends on types and quantity of the ingredients and the process before fermentation. Drying in a hot air oven at 60 °C for 60 min. and adding 5% salt led to the best quality of Tangchay vs. other conditions, with a significant difference at  $P < 0.05$ . The suitable ratio of sugar, garlic and Chinese alcohol can improve flavour and taste of Tangchay. The fermentation period should be more than 15 days. Washing cabbage before drying and fermenting was recommended in Tangchay production to assure the safety of finished product.

**Keywords:** Tangchay; quality; safety

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#### **Introduction**

Tangchay is a type of seasoning agents produced by fermentation process and well-known in Thailand. Food usually serve with Tangchay are noodle, rice congee and mildly seasoned soup. With foods are habituated and usually eating for compare with another food. Recently, the production of Tangchay is still generally practiced as a household or small-level technology in

developing countries, with few operations carried out an industrial level (Rolle and Satin, 2002) and lack of Good Manufacturing Practices (GMP). Tangchay is produced by various processes, normally made from slicing cabbage and sun drying followed by mixing with additional ingredients and then fermentation. Excess vegetables, such as radish and papaya, during surplus vegetable industrial are also preserved as Tangchay.

Chiang Rai is a well-known agricultural land in Thailand. Cabbage (*Brassica oleracea* var. *capitata*) is one of the important vegetables cultivated in Chiang Rai with a total production of 5,891 tons in 2008 (Chiang Rai Agricultural Extension Office). Over production can cause lower cost of cabbage in the market and decomposition can result in economic losses. Fermentation is an alternative for solving these problems and adding value to cabbage.

Nowadays food safety is a major public concern worldwide for its direct bearing on human health. Pesticide residues in vegetables, poor hygienic practices, improper handling during post-fermentation and distribution, not only pose problems for international trade but also cause a risk to the health of consumers. Previous investigations of many fermented products such as tempe and kinema revealed the presence of considerable levels of food-borne pathogenic bacteria such as *Bacillus cereus*, *Staphylococcus aureus* and Enterobacteriaceae (Nout, Bakshi and Sarkar, 1998; Samson, Van Kooij and De Boer, 1987). The information about quality and safety of Tangchay in the market is not yet available. Moreover, the appropriate fermentation process for quality and safety of Tangchay product has not been studied.

The purpose of this study is to provide the information for safety consumption of Tangchay available on the market and to develop the fermentation process of Tangchay from cabbage for enhancement of quality and safety.

## Materials and Methods

### Experimental Design

This study was divided into two parts. Part I to determine, chemical, physical, microbiological and sensory quality of Tangchay product nine brands available in the market. Part II to develop the formula and the production of Tangchay and determine the qualities as in Part I.

### Collection of Samples

Nine samples of Tangchay (T1 – T9) were collected from different markets in Bangkok and Chiang Rai Province, Thailand. All samples were stored at room temperature as is usual in the retail shops.

### Sample Preparation and Fermentation

Heads of cabbage (*Brassica oleracea* var. *capitata*) purchased from The Public Relations Department Region 3, Chiang Rai Province, Thailand were used as raw material in this study. The cabbages were washed with tap water, discarded three layers of wrapper leaves and hand-cut into small pieces (2-5 mm). Fresh cut cabbage was dried by hot air oven in different conditions. Salt in various concentrations was added and left overnight at room temperature. The sample were drained, the water was squeezed out and then dried again. Finally, the ingredients (sugar, garlic, galangale, ginger and dark soy sauce in the ratio of 5.0:4.0:2.0:2.0:2.5%) and various alcohol types (2.2%) were added and then packed tightly in earthen or glass jars for fermentation at room temperature for 15 days. Many conditions for the fermentation process of Tangchay were studied as followed;

*Step 1:* The effect of drying condition on Tangchay quality by varying time (30, 60, or 90 min) and temperature (45, 50, or 60 °C). Salt used in this step was fixed at 3% and the ratio of sugar: garlic: galingale: ginger: alcohol: dark soy sauce was 2.5: 2.0: 2.0: 2.0: 2.2: 2.5.

*Step 2:* The effect of salt concentrations on Tangchay quality by varying salt (3% and 5% w/w). The moisture content of dried cabbage was set from the previous step and the ratio of ingredients also used as Step 1.

*Step 3:* The effect of alcohol type on Tangchay quality by using different commercial brands (Chinese alcohol, Seagram's, Sangsom, Red Label, Benmore and Arrack locally distilled). Other conditions were used based on the results of Step 1 and Step 2.

After fermentation, the chemical, physical, microbiological and sensory properties were also determined as in Part I.

### **Determination of Tangchay Quality**

All analyses were carried out in the Scientific and Technological Instruments Center of Mae Fah Luang University, Chiang Rai province. Chemical quality, moisture content, total acidity, pH and sodium chloride concentration were determined according to AOAC (2000). Pesticide residues was determined by using a GTtest kit (Department of Medical Sciences, Ministry of Public health, Thailand) and results were expressed in % of inhibition. Color of sample as physical quality was measured by Colorimeter (Color Quest XE, USA) in the value of L\*, a\* and b\*. For microbiological quality, Total Plate Count (TPC), *Staphylococcus aureus*, yeast and mold and *Escherichia coli* were determined following the Standard Operating Procedures for Microbiological Methods of Analysis (Department of Medical Sciences). The microbial populations were expressed in Colony Forming Units (CFU) per gram.

### **Sensory Evaluation**

Thirty-three panelists will be employed to identify the sensory acceptance of Tangchay product. The panelists will be selected on the basic of their color, texture, taste, flavor liking for Tangchay product and aptitude to describe the sensory characteristics of food product. Tangchay (30 g) was added into to soup and will be provided individually on dishes to the panelists. Ten different descriptions will be used to grade the overall quality in terms of color, texture, taste, flavor and general acceptability. Unacceptable corresponded to 1 and excellent to 10.

### **Statistical Analysis**

One-way analysis of variance (ANOVA) was used to determine the quality properties of Tangchay by Statistical Package for Social Sciences (SPSS, 11.5). Duncan's multiple range test was used to compare differences among means at  $P < 0.05$ .

### **Results and Discussion**

#### **Safety Level of Tangchay Consumption**

Chemical properties of nine brands are shown in Table 1. The moisture and % salt was between 50.73 to 58.51 and 9.07 to 23.69, respectively. These ranges were acceptable with the Thai Industrial Standard (TISs), that fermented vegetables moisture must be lower than 70% and salt more than 8%. Nine brands of surveyed Tangchay have pH between 3.38 to 5.01 and total acidity between 0.03 to 0.05%. Tangchay has light brown to dark brown color vary from the brand. These properties will have the effect to the sensory evaluation.

**Table 1** Chemical qualities of surveyed Tangchay

Brand	pH	TA	%salt	MC
T1	4.10±0.02* <sup>de</sup>	0.05±0.01 <sup>a</sup>	10.10±0.46 <sup>f</sup>	53.56±0.16 <sup>c</sup>
T2	5.01±0.01 <sup>a</sup>	0.05±0.01 <sup>a</sup>	13.33±0.34 <sup>e</sup>	55.20±0.30 <sup>b</sup>
T3	4.20±0.01 <sup>d</sup>	0.03±0.01 <sup>b</sup>	14.54±0.24 <sup>d</sup>	55.32±0.55 <sup>b</sup>
T4	4.19±0.01 <sup>e</sup>	0.05±0.01 <sup>a</sup>	19.85±0.38 <sup>b</sup>	51.01±0.20 <sup>d</sup>
T5	3.57±0.02 <sup>g</sup>	0.03±0.01 <sup>b</sup>	23.69±0.45 <sup>a</sup>	58.51±0.26 <sup>f</sup>
T6	3.38±0.01 <sup>f</sup>	0.03±0.01 <sup>b</sup>	12.85±0.34 <sup>e</sup>	57.33±0.08 <sup>g</sup>
T7	4.34±0.01 <sup>d</sup>	0.03±0.01 <sup>a</sup>	15.91±0.44 <sup>c</sup>	57.28±0.52 <sup>a</sup>
T8	4.40±0.01 <sup>c</sup>	0.05±0.01 <sup>a</sup>	9.07±0.27 <sup>g</sup>	51.38±0.31 <sup>h</sup>
T9	4.57±0.01 <sup>b</sup>	0.05±0.01 <sup>a</sup>	16.20±0.44 <sup>c</sup>	50.73±0.50 <sup>e</sup>

\* Results are mean ± SD ( $n = 5$ ). Values in the same column followed by different letters differ significantly ( $P < 0.05$ ).

number of TPC, *S. aureus*, yeast and mold, and *E. coli* were  $2.24 \times 10^7$  to  $4.63 \times 10^7$  CFU/g, 1.87 to 4.40 CFU/g, 33.68 to 98.11 CFU/g, and 1.52 to 4.46 MPN/g, respectively. From the Thai Industrial Standard (TISs) of fermented vegetable, the number of TPC, and *S. aureus* is over limit (total plate count  $1.0 \times 10^4$  CFU/g, and *S. aureus* not detect in 25 g). Whereas most Tangchay contains a high level of salt that could prevent the survival or growth of pathogen, the TPC needs to be clarified in future study. Although *S. aureus* is a salt tolerant microorganism, a large population may come from post-fermentation contamination such as lack of personal hygiene or during packaging.

**Table 2** Pesticide residues in surveyed Tangchay using GT Test kit

Brand	% of inhibition	Result
T1	0%	Not detect
T2	>50%	Detect and not safe
T3	< 50%	Detect but safe to be consumed
T4	0%	Not detect
T5	<50%	Detect but safe to be consumed
T6	<50%	Detect but safe to be consumed
T7	< 50%	Detect but safe to be consumed
T8	>50%	Detect and not safe
T9	>50%	Detect and not safe

The pesticide residues in surveyed Tangchay are shown in Table 2. If percentage of inhibition was more than 50%, pesticide residues are at unsafe levels that are very dangerous to the consumer. For this surveying, it was found that three out of the ninebrands (T2, T8, and T9) had >50% inhibition. The high level of contamination may be due to the high level of pesticide used in the field and unwashed raw materials used in fermentation. Washing and peeling are

the important steps in both household and commercial preparation of most fruits and vegetables. Residue of several pesticides can be removed in these steps (Kaushik, Satya and Naik, 2009).

The sensory evaluation was done using only six of the nine brands of Tangchay because of the the unsafe pesticide residues. Tangchay brand number 6 had the highest sensory evaluation score.

From this experiment, it was indicated that the safety of Tangchay consumption should be a concern. The next experiment in Part II was to develop the fermentation process for Tangchay production to obtain a high quality and safe product.

### Tangchay Production

The appropriate drying condition (data not shown) that provided product similar to the surveyed Tangchay is 60 °C for 60 min. which obtained pH, total acidity, salt concentration and moisture content for 4.05–4.57, 0.03–0.07, 7.13–10.77, and 51.48–58.56, respectively. The color of Tangchay was light brown. *S. aureus*, yeast and mold and *E. coli* were not detected. Salt concentration of 5% gave the most acceptable quality. The pH of Tangchay is about 3.48. The total acidity and moisture content are 0.14 and 57.32, respectively. The color of Tangchay was not significantly different. The principle function of salt is to withdraw juice from the cabbage (or other vegetables), thus making a more favorable environment for development of the desired bacteria. The spoilage organisms can tolerate salt concentrations up to between 5 and 7%, therefore it is the acidic environment created by the lactobacilli that keep the spoilage bacteria at bay, rather than the addition of salt (Mike and Sue, 1998).

The various alcohol sources resulted in significantly different ( $P < 0.05$ ) pH values, total acidity, moisture content, color and the amount of TPC of Tangchay (data not shown). From the sensory evaluation, Chinese alcohol provided the most acceptable in color, taste, flavor and overall quality.

**Table 3** Pesticide residues in fresh cabbage and Tangchay product

Treatment	% of inhibition	Result
Fresh cabbage (unwashed)	< 50	Detect but safe to be consumed
Fresh cabbage (washed)	0	Not detect
Tangchay product	0	Not detect

Fresh cabbage had some pesticide residues but was still within in the acceptable safety level (Table 3). Pesticide residues were not detected in the finished product after the cabbage was washed (before fermentation),. Vegetables from Good Agricultural Practice (GAP) farming or organic farming primarily ensure the low level or no pesticide residues in fresh produces. The good quality of raw material used in the fermentation process influence to the quality and safety of finished products. Washing cabbage before drying and fermenting is recommended to obtain Tangchay product (Figure 1) with quality, safety and good customer satisfaction.



**Figure 1** Tangchay product

## Conclusion

From the surveying, nine brands of Tangchay available on the market were not completely safe to consumers due to the presence of pesticide residues. Some brands also found *S. aureus* higher than acceptable standards indicating improper handling and poorly personal hygiene.

For the production of Tangchay from cabbage, the cabbage should be dried in a hot air oven at 60 °C for 60 min. before adding 5% salt and then left overnight. Then, sugar, garlic, galingale, ginger, alcohol, and dark soy sauce are added in the ratio of 5.0, 4.0, 2.0, 2.0, 2.2 and 2.5, respectively. Chinese alcohol is then used in fermentation for 15 days at room temperature to provide good quality Tangchay that is safe for human consumption. In addition, quality and safety control system during the production will enhance food security and also ensure the safety to consumers.

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