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Short Communication

Product development of canned Thai food by thermal processing

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Abstract

Thermal processing is the most widely used method for preserving food and extending its shelf-life. It would be possible to produce Thai food, containing sauce as well as pieces of meat and vegetables, with a long shelf-life at ambient temperatures. A traditional Thai food packed in 307 × 409 can was processed to commercial sterility in a still retort. Process lethality was determined by temperature measurements. The quality of the product was evaluated by microbiological tests and sensory assessment. This research consists of 2 parts. Firstly, to optimize the Thai food recipes before using thermal processing. The prototype of 4 types of Thai food recipes (Moo-kra-tium, Pa-nang, Gaeng-Phed, and Gaeng-jued) were evaluated using 9-point hedonic scale and just about right (JAR) 5-point scales. The appropriate formula was decided after the judge determined the optimum levels of attributes in each recipes (repeated until JAR > 70%) then evaluated the preference using hedonic scale. The result of 4 Thai food recipes showed the higher overall liking score compare to the recipes before adjust the seasoning levels and flavors. Secondly, all kinds of Thai food were subjected to commercial sterilizing conditions at 121°C (Pressure 15 psi) with a process lethality (F_0) of 5 minutes. Cold point of food products as affected by the formula of recipes was evaluated. The product with higher ratio of pork in their formula (The net weight was approximately 450 g/can) exhibited lower heat penetration rate. Approximately 120, 100, 75 and 15 minutes at 121°C was used as processing time for canned Moo-kra-tium, Pa-nang, Gaeng-Phed, and Gaeng-jued, respectively. The total plate count of all products was lower than the standard for canned food and no flat sour microorganism was found. The information obtained from this research could provide the guideline for the design of appropriate thermal process condition to extend the safety margin of the canned Thai food.

Introduction

Thai food is known for its unique combination of seasoning. Although it is hot and spiciness, Thai cooking is carefully balanced to bring out all the different flavors in a dish. Thai cuisines usually consist of pork, chicken, duck and beef. Common flavors in Thai food come from garlic, lemon grass, shallots, pepper, kaffir lime leaves, shrimp paste, fish sauce chilies. Thai food is an internationally famous dish such as Tom yam kung, Red curries, Green curries, Gang massaman, Gang jued, Pad thai etc. There must be a harmony of tasted and textures within individual dishes and the entire meal. For extension of the self life and preserve the quality of low acid canned food, "Thermal processing" is the most widely used for these objectives.

Designing a good thermal process is far from easy. It requires a lot of knowledge of processing methods, how the components of the food product respond to heat treatment and how the microorganisms are affected (Awuah *et al*., 2007). The outcome of the thermal process depends on physical properties of the product, the size and shape of the packaging, the type of microorganisms present and their heat resistance. The recommended conditions for effective sterilization of low acid food (pH > 4.6) in retort were 10 psi above atmospheric pressure for sterilization at 116°C, 15 psi at 121°C and 20 psi at 127°C (Potter and Hotchkiss, 1998). Seow and Gwee (1997) recommends a minimum F_0 value is 5 minutes for low acid canned food. Chiewchan *et al*. (2006) suggested that sterilizing at 121.1°C for 60 minutes with F_0 = 5 minutes could provide an acceptable color comparing to fresh coconut milk. In addition, Wasantiwong *et al.* (2010) studied the effects of different lethality of the thermal process

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levels (F_0 = 5, 10 and 15 minutes, respectively) on physical, chemical and microbiology characteristics of canned Num Phrik Kapi. They reported that the product with F_0 of 5 min, sterilized at 116°C for 13 min showed higher overall acceptability, which was significantly different at the .05 level ($p \leq 0.05$) in terms of physical and chemical characteristics from the product with F_0 of 10 minutes and 15 minutes, respectively.

Preference or affective tests are used to assess consumer response to products. They are concerned with acceptability of the product or whether one product is preferred over another. The 9-point hedonic scale is more useful for the preference testing (Stone and Sidel, 2004). It provides a measure of liking for each product, the magnitude of the difference in liking among the products and enables use of parametric statistics such as the analysis of variance to identify significant product difference (Meilgaard *et al*., 1999). Overall it is a more efficient methodology enabling one to test multiple product versus multiple paired comparison (Stone and Sidel, 2004). Just-About-Right (JAR) rating has been included in the questionnaire in sensory testing and marketing research (Gacula *et al*., 2007). These scales, categorical variables, are an approach to the measurement of the perceived attribute intensities that assess whether there is too little, too much or a JAR level of a particular attribute (Lawless and Heymann, 1999; Gacula *et al*., 2007). It is usually expressed as the percentage of respondents who consider the product according to those scales.

From literature described above, it would be possible to produce Thai food, containing sauce as well as pieces of pork and vegetables, with a long shelf-life at ambient temperatures. A traditional Thai food packed in 307 × 409 can was processed to commercial sterility in a still retort. Therefore the objective of this research was to study the effect of commercial sterilizing condition at 121°C (Pressure 15 psi) of four Thai food recipes (Moo-kra-tium, Pa-nang, Gaeng-Phed, and Gaeng-jued). The parameters considered after sterilization process were flat sour bacteria, total bacteria, yeast and mold.

Materials and Methods

Raw material

Pork loin (Prachinburi local market), sugar (Wangkanai Corp., Ltd, Thailand), fish sauce (Tiparos, Tang Sang Hah Co., Ltd, Thailand), palm oil (Morakot, Morakot Industries PCL, Thailand), red curry paste (Lobo, Thailand), pa-nang curry paste (Lobo, Thailand), coconut milk 100% (Aroy-D, Thai Agri-foods, Thailand), oyster sauce (Maekrua, Chew Huad Co., Ltd, Thailand), white pepper powder (Raitip, Thai Cereal World Co., Ltd, Thailand), dashi powder, soft tofu, dried seaweed (wakame), salted soya beans, sugar, green onion, red chili pepper, kaffir lime leaf, sweet basil, garlic (Prachinburi local market, Thailand).

Sample preparation

Firstly, Moo-Kra-tium preparation: The pork was sliced into ¼ inch thick pieces. The garlic was minced finely. The sliced pork, garlic, ground white pepper powder, oyster sauce and sugar were added in a bowl and marinade for 60 minutes. Deep-fried the pork into the palm oil for 10 minutes or until it was cooked through. It was soft on the inside and little crispy on the outside. Removed the pork from the hot oil and allowed the oil drained on a towel. The fried garlic was leftover the deep-fried pork. Secondly, Pa-nang preparation: The red curry paste was fried in the palm oil for 1 minute or until release the fragrance. Added the pork loin (sliced 1 x 1 inch) and stirred for 3 minutes. Fish sauce, sugar was added and mixed for 2 minutes or until pork is cooked through. The pieces of kaffir lime leaf and red chili pepper were leftover the curry. Thirdly, Gaeng-phed preparation: The red curry paste was fried in palm oil for 1 minute or until release the fragrance, then added the coconut milk and mixed well (for 2 minutes) to create the curry sauce. Pork loin (sliced 1 x 1 inch) was added and stirred for 3 minutes. Fish sauce, sugar was added and mixed for 2 minutes or until pork is cooked through. The pieces of kaffir lime leaf, red chili pepper and sweet basil was leftover the curry sauce. Finally, Gaeng-jued preparation: Dashi powder was boiled for 3 minutes or stirred thoroughly until the powder was dissolved. Soft tofu was cut into ½ inch and added to the boiled dashi. Salted soya beans and seaweed were also added into the boiled dashi, stirred for 1 minute. Finally, green onion was added and boiled for 30 seconds.

Sensory evaluation

Preference testing and just about right: The preference test of four Thai food recipes was carried out by 30 untrained panels at Faculty of agro-industry, KMUTNB Prachinburi campus. Each Thai food sample was served with fresh water for rinse after tested. The product characteristics such as color, sweetness, salinity, spiciness, red curry flavor, garlic flavor, pepper flavor, salted and soya bean flavor. The overall liking was also determined using the 9-point hedonic scale (1-dislike extremely, 5-neither like nor dislike and 9-like extremely). The just about

Table 1. The just about right consideration of Pa-nang

Product Attributes	JAR N : %	JAR≥70 Yes/No	Too little (n)	Too much (n)	Total (n)	Max value (n)	0.05 Critical value	Conclusion
Color	25(83%)	Yes	-	-	-	-	-	JAR
Sweetness	19(63%)	No	4	7	11	7	10	JAR
Salinity	19(63%)	No	2	9	11	9	10	JAR
Spiciness	13(43%)	No	14	3	17	14	13	Not enough
Red curry – flavor	9(30%)	No	19	2	21	19	17	Not enough

right scale (1-not enough, 3-just about right or JAR and 5-too much) was tested to evaluate the color, sweetness, salinity, spiciness, red curry flavor, garlic flavor, pepper flavor and softness of the product.

Retort processing

Approximately 450 g of sample was filled in a can of size 307 × 409. Headspace in the cans was controlled by filling hot water to obtain headspace sample. The cans were fixed with thermocouple glands (Ellab, Denmark), and the thermocouple probe (Ellab, Denmark). A typical temperature profile for canned food undergoing the heating process was obtained by placing a thermocouple at the cold point inside cans at the slowest heating point. The cans were exhausted in steam for 10 minutes to remove the residual air, and immediately double seamed. The sealed cans were loaded into the horizontal still retort (Patkol, Thailand) and processed at temperatures of 121 ± 1°C (pressure 15 psi) with F_0 value of 5 minutes. Time-temperature data were collected during heat processing using an Ellab data recorder (CTF 9008, Ellab, Denmark). The heat penetration characteristics were determined using a general method. After heating processing, the cans were cooled for 20 minutes in running cool water, and the data logger was used record the time-temperature relationship.

pH and microbiological analysis

The pH was determined using a Schott Grate pH meter (CG841, Germany). The viable microbial numbers were enumerated by pour plating onto Plate Count Agar (PCA, Difco, USA) incubated at 37°C for 48 h for total bacteria and onto Potato Dextrose Agar (PDA, Difco, USA) incubated at 30°C for 72 h for yeasts and molds. The finial products were sent to Institute of Food Research and Product Development (IFRPD) of Kasetsart University to investigate flat sour bacteria (mesophile and thermophile).

Statistical analysis

All experiments were conducted in three replications. The results of preference test were reported as the mean value with standard deviation. In addition, the just about right for the product was explored using binomial test.

Results and Discussion

Four Thai food recipes and sensory evaluation

Overall liking mean score of each Thai food was 5.32 ± 1.51 (Moo-kra-tium) 5.09 ± 1.15 (Pa-nang) 4.08 ± 1.04 (Gaeng-phed) and 6.07 ± 1.08 (Gaeng-jued) (data not shown), respectively. The mean score range 4.0 - 5.0 means dislike to neither like nor dislike, it can be noticed that the development of Thai food recipes were necessary to get the higher score of overall liking. Just about right rating scale was used to measure the perceived attribute intensities of four Thai food recipes that assess whatever there was too little, too much or just about right of a particular attributes. To investigate which product attributes should be improved, the JAR for the attributes of four Thai foods were explored in term of percentage. The product attributes with more than 70% of JAR means that they were accepted by panels and were not needed to be improved. For the product attributes with less than 70% of JAR they were analyzed further using binomial test in order to improve the product.

From Table 1, the results of Pa-nang consideration showed that the JAR percentage of color was more than 70% (83%) then they were not needed to be improved. While sweetness, salinity, spiciness and red curry flavor were less than 70%, so they were applied for binomial test. According to the results of the binomial test, the mean score of spiciness and red curry flavor were not enough, thus these attributes

should be improved to get higher score of preference. For the binomial test, the mean score of sweetness and salinity were JAR, so these attributes were accepted and not need to be improved. When considered Moo-kra-tium, sweetness, garlic flavor and pepper flavor were JAR, while color, salinity and softness were not enough, thus these attributes should be improved. For Geang-phed, color and red curry flavor were JAR, on the other hand sweetness and spiciness were not enough, thus these attributes should be improved. And Geamg-jued, the JAR percentage of color was more than 70% then these attribute was accepted, while the binomial test results of sweetness, salinity and salted and soya bean flavor were JAR so these attributes were accepted and not need to be improved. After improved the product attributes of four Thai foods according to JAR resulted. New four Thai food recipes were tested the preference by 30 panels using 9 point hedonic scale. The overall liking mean scores were higher as followed, 7.24 ± 1.13 (Moo-kra-tium) 6.90 ± 1.56 (Pa-nang) 6.80 ± 1.58 (Geang-phed) and 6.81 ± 1.68 (Geang-jued), respectively. Therefore the percentage of four Thai food recipes before using thermal processing reported as the Table 2.

Retort processing of Thai canned food

Figure 1 shows the heat penetration curve of samples during sterilization which could be divided into 3 steps, i.e., come up time, heating and cooling. A typical temperature profile for canned food undergoing the heating process was obtained by placing a thermocouple at the cold point inside cans at the slowest heating point (data not shown). The initial temperature of the samples prior to heating was approximately 60°C. The come-up time of the retort (the time from initiation of heating until the target retort temperature was reached) was 15 minutes. The results showed that all samples exhibited similar behavior, the sample temperature increased continuously as the heating time increased and approached the set target value (F_0 = 5 minutes) within 120, 90, 75 and 30 minutes in the cases of Moo-kra-tium, Pa-nang, Gaeng-Phed, and Gaeng-jued, respectively.

During heating process, the heat transfer mechanisms important for retort products were conduction and convection (Potter and Hotchkiss, 1998). In conduction, heat moves from one particle to another in more or less straight lines. This is the case in solid foods for example, Moo-kra-tium and Pa-nang, heat penetration exhibited slower rate in products than in the case of Gaeng-jued and Gaeng-Phed, respectively. This was because Moo-kra-tium and Pa-nang contain high ratio of pork as compared

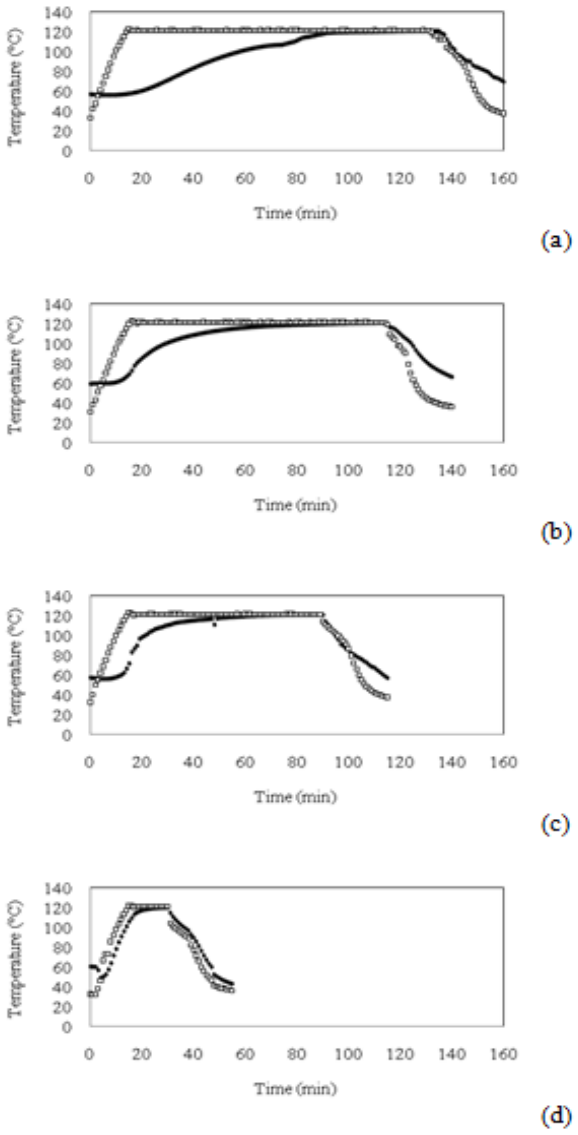

Figure 1. Temperature profile of samples (•) and retort (□) during sterilizing process at 121°C, pressure 15 psi (F_0 = 5 minutes): (a) Moo-kra-tium; (b) Pa-nang; (c) Gaeng-Phed; (d) Gaeng-jued

to other in recipes, the solid pieces of pork would be heated by conduction of heat received from the surroundings. However, convection heating is much more rapid, so the liquid is heated more quickly than the pieces (Awuah *et al.*, 2007). The water in Gaeng-jued and coconut milk in Gaeng-Phed occurred convection heating motion due to the heat received through the package wall. After heating process, the cans cooled with spray water making 20 minutes pass during cooling process from 121°C to a temperature below 40°C.

The lethal rate was also calculated and the F_0 value can be obtained from the area under the curve.

$$\text{Lethal rate} = 10^{(T-Tr)/z} \quad (1)$$

Table 2. Thai food recipes (product prototype)

Ingredients	Percentage			
	Moo-kra-tium	Pa-nang	Geang-phed	Geang-jued
Pork loin slice	80.5	46.3	69.5	
Palm oil	3.2	3.7	5.6	
Sugar	2.8	3.7	2.7	
Oyster sauce	5.3			
Garlic	7.0			
White pepper	1.2			
Red chili pepper		2.8	4.2	
Kaffir lime leaf		0.9	1.4	
Fish sauce		3.7	2.7	
Coconut milk		27.8		
Pa-nang curry paste		9.3		
Sweet basil		1.8		
Red curry paste			13.9	
Dashi powder				0.7
Soft tofu				8.9
Dried seaweed				1.4
Salted soya beans				4.1
Green onion				2.7
Water				82.2

Table 3. Processing time of canned food during sterilization at 121°C in retort

Processing time (minutes)	Moo-kra-tium	Pa-nang	Gaeng-phed	Gaeng-jued
Come up time	15	15	15	15
Heating time	120	100	75	15
Cooling	20	20	20	20
F_0	5	5	5	5

where T is the temperature in degree Celsius, at which the lethal rate is calculated and Tr is the reference temperature at which the equivalent lethal effect is compared. A Tr of 121.1°C is used in the determination of F_0. The z-value measured in °C is the reciprocal of the slope of the thermal death curve for the target microorganism or spore; 10°C is the value frequently used in F_0 calculations performed on low acid foods (Herson and Hulland, 1980). F_0 values were calculated from lethal rate in the heating process at 121°C, 5 minutes shown in Table 3. Approximately 120, 100, 75 and 15 minutes at 121°C which was used as processing time for canned Moo-kra-tium, Pa-nang, Gaeng-Phed, and Gaeng-jued, respectively.

pH and microbiological study of Thai canned food

Table 4 shows the pH and microbiological of canned food. For all canned food products, net weight was approximately 450 g. The pH values of the samples were varied in the range of 5.85 - 6.14. All products were classified as low acid food. According to the Japan National Standard (2004), the ready to eat food should contain the numbers of total bacteria, yeasts and molds less than 100 CFU/g. The results showed that all microbiology tested were less than standard and no indicated flat sour bacteria could be detected after sterilization. The results were in agreement with the findings of other researchers, for example, Rajan *et al.* (2014) could not detect any *E. coli, Salmonella* spp., *Staphylococci* spp., yeast or mold during their 180 day storage at 35 ±

Table 4. Properties of canned food after sterilization at 121°C

Properties	Moo-kra-tium	Pa-nang	Gaeng-phed	Gaeng-jued
Weight	450 g	450 g	450 g	450 g
pH	6.04	5.89	5.85	6.14
Bacteria	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g
Yeast	<1 CFU/g	<1 CFU/g	<1 CFU/g	<1 CFU/g
Mold	<1 CFU/g	<1 CFU/g	<1 CFU/g	<1 CFU/g
Flat sour bacteria	NF	NF	NF	NF

NF = not found

2°C of Chettinad chicken, which was processed in retort pouches to an F_0 value of 5.2. It should be remembered that the microbiological test described only proves the microbial quality after a short time of storage. Before commercialization of any food product, longer storage studies should be conducted.

Conclusion

Development of Thai food recipes and the possibility for producing canned food were investigated in this study. Four Thai food recipes were improved and measured by just about right and preference test. The appropriate formulas before using thermal processing were decided and processed in coated tin-free steel cans to a lethality value (F_0) of 5 minutes at 121°C (pressure 15 psi). The total process time taken to attain the targeted lethality increased with increasing weight of pork in each product. The targeted lethality value could be attained in 120, 100, 75 and 15 minutes for Moo-kra-tium, Pa-nang, Gaeng-phed and Gaeng-jued, respectively. For microbiological properties, commercial sterilization process could increase the safety margin of canned food products. There was no flat sour bacteria that contaminate in all canned food product after sterilizing in retort. However, some theories about shelf-life testing and expected effects of storage are included as a foundation for further studies.

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References

Awuah, G., Ramaswamy, H. and Economides, A. 2007. Thermal processing and quality: Principles and overview. Chemical Engineering and Processing 46: 584-602.

Chiewchan, N., Phungamngoen, C. and Siriwattanayothin, S. 2006. Effect of homogenizing pressure and sterilizing condition on quality of canned high fat coconut milk. Journal of Food Engineering 73: 38–44.

Gacula, M., Rutenbeck, S., Pollack, L., Resurreccion, A.V.A. and Moskowitz, H.R. 2007. The just-about-right intensity scale: Functional analysis and relation to hedonics. Journal of Sensory Studies 22: 194-211.

Herson, A.C. and Hulland, E.D. 1980. Canned food. Iurchill livingstone. New York.

Holdsworth, S.D. 1997. Thermal processing of packed foods. Blackie Academic and Professional Co. Inc. New York.

Japan National Standard, 2004. Canned ready to eat food. Database of National Food Institute, Bangkok, Thailand.

Lawless, H.T. and Heymann, H. 1999. Sensory evaluation of food: Principles and practices. Aspen Publishers Inc. New York.

Meilgaard, M., Civille, G.V. and Carr, B.T. 1999. Sensory evaluation techniques. 3rd. CRC press. New York.

Mohan, C.O., Ravishankar, C.N., Srinivasa Gopal, T.K. and Bindu, J. 2008. Thermal processing of prawn 'kuruma' in retortable pouches and aluminium cans. International Journal of Food Science and Technology 43: 200-207.

Potter, N. and Hotchkiss, J.H. 1998. Food Science. 5th. Philadelphia: Aspen Publishers Inc.

Rajan, S., Kulkarni, V.V. and Chandirasekaran, V. 2014. Preparation and storage stability of retort processed Chettinad chicken. Journal of Food Science and Technology 51: 173-177.

Ravi Shankar, C.N., Srinivasa Gopal, T.K. and Vijayan, P.K. 2002. Studies on heat processing and storage of seer fish curry in retort pouches, Packaging Technology and Science 15: 3-7.

Seow, C.C. and Gwee, C.N. 1997. Review, coconut milk:

chemistry and technology. International Journal of Science and Technology 32: 189-201.

Stone, H. and Sidel, J.L. 2004. Sensory evaluation practices. 3rd. Elsevier Academic Press. San Diego, California.

Wasantiwong, K., Surarakdisai, K. and Bonchakul, S. 2010. Effect of lethalities of the thermal process (F_0) levels on Canned Num Phrik Kapi. SDU Research Journal 3: 75-85.