A Study on Productive Process and Quality of Fermented Soybean (Thua – Nao) in the Upper North of Thailand

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Abstract

The objective of this research was to study fermented soybean called Thua – Nao in terms of a production process and its problem including quality testing in the upper North of Thailand. The experiment was a purposive survey and conducted from May to July, 2004. Simple random sampling was used for the representative locations that were composed of Chiang Mai, Maehongson and Chiang Rai provinces.

The results showed that Thua – Nao productions were differed related to produced locations. Affected factors were variety, boiling time, ferment time, grinding method, product quantity, marketplace and marketing, and product types. The method of Thua – Nao production was started by boiling soybean 5 – 8 hours and then putting them in the basket until they were drained of water. After that they were fermented in the plastic bag about 2 – 4 days and then were ground in a grinder or mortar, molded in a ball shape and pressed in a thin plate. Lastly they were dried using sun light about 2 – 3 days and kept Thua – Nao in a plastic bag or other wares.

Their qualities were described in terms of nutrition values, types and quantity of microorganisms. It was found that nutrition values showed higher than other soybean products. They were 38.94 – 42.81 %, 3.15 – 9.33 %, 33.62 – 40.43 %, 5.31 – 7.86 %, 0.01 – 0.09 % and 7.30 – 12.02 % in protein, oil, carbohydrate, fiber, ash and moisture content, respectively. Thua – Nao had inconsistent of quality, because of seasoning effect. Not only that, there were advantage bacteria (*Bacillus* spp.) and fungi (*Rhizopus* spp.). Disadvantage fungi (*Aspergillus flavus* and *Aspergillus niger*) were caused by low quality. Total microorganisms were ranged from 1.56 x 10^7 to 4.93 x 10^7 CFU/g.

Keywords: fermented soybean, quality, nutrition value, microorganism

Introduction

A scientific name of soybean is called *Glycine Max* L. Merrill, in genus Leguminosae, subfamily Papilonoideae. It is an economic crop of Thailand because of its plenty advantages (Lumlertgul and Boonraeng, 2004). It has been called a marvelous plant (Suppadit and Sangla, 2003). The increased demand of consumption for soybean processed in the Thailand and world markets have encouraged rapidly (Sangla and Suppadit, 2005). There have been many researches trying to study the utilization of soybean including soybean processing. Samples of soybean products are cooked soybean, tofu, miso, soy milk, soy sauce, white soy sauce, bean cake, soft bean cake, bean cake scum, Thua – Nao and utility compound extraction such as isoflavone, jenistine, lecithin and phytoestrogen (Siriboriruk, 1999). Fukutake *et al.* (1996) reported that isflavone and jenistine are used to protect cancer disease. Moreover, Chiang Mai Field Crops

Research Center (1999) reported that lecithin is known as a controller of nervous system and phytoestrogen work as a hormone function, that control menopause symptom of older people.

Thua – Nao has been produced by the people in many provinces in the upper North of Thailand (Chiang Mai, Chiang Rai, Lumpang, Lumpoon, Maehongson, Phrae, Nan, and Phayao provinces). They have produced local soybean food including Thua – Nao for long – term storage. The products are composed of dried Thua – Nao, spicy Thua – Nao, and grilled Thua – Nao (Sangla and Suppadit, 2005). Pintasean *et al*. (2002) reported that they are known as popular food and cheaper protein source. The upper north people use Thua – Nao as seasoning for food or direct consumption (Sundhagul *et al*., 1972). But, in the soybean processing, its process is limited in the local scale. The methods always use old traditional technology style or indigenous knowledge. Their production and quality are varied related to productive locations. Production and quality always have been inconsistent (Sangla and Suppadit, 2005).

Thus, the objective of this study was to survey the preliminary data of production, processing, and quality of Thua – Nao for improving the production, quality, and make it more hygienic and safety for consumers.

Materials and Methods

This study was a purposive research survey (Chanthalukana, 1980). It was conducted at productive locations in the upper North of Thailand from May to July, 2004. The productive regions are Chiang Mai, Chiang Rai, Lumpang, Lumpoon, Maehongson, Phrae, Nan, and Phayao provinces. The experiment used simple random sampling for the representative locations (Chanthalukana, 1980). They were composed of 3 provinces and 7 districts, which were as follows:

1. Chiang Mai was composed of Maewang and Fang districts.
2. Maehongson was composed of Khunyaum, Maung, and Pangmapa districts.
3. Chiang Rai was composed of Maejun and Maesai districts.

Primary data were collected by interviewing 30 villagers per location. Data of Thua – Nao production method, its problem, product time, marketplace and marketing, and types of product were recorded. Thua – Nao were sampled for testing its quality. Each sample weight was 300 gram and kept in vacuum plastic bag to protect microorganism contamination. Nutrition values were composed of carbohydrate, protein, oil, fiber, ash, and moisture content. They were measured according to Association of Analytical Chemists (AOAC) Manual (AOAC, 1992). Quantity of microorganism was determined by Total Plate Counts Methods in Nutrient Agar (Sundhagul *et al*., 1972; Suwanpinij, 2001). Microorganism types were classified by Instant Bacteria Classification of API50 CHB (bioMerieux, France) (Sundhagul *et al*., 1972).

Results and Discussion

Thua – Nao Production

Thua – Nao was produced in an indigenous knowledge. First, soybeans were boiled in water about 5 – 8 hours. Then, they were put in the basket until they were drained. Next, they were fermented in the plastic bag about 2 – 4 days. After that, they were ground in the grinder or mortar, molded in a ball shape and pressed fermented soybean ball in a thin plate. Lastly, they were dried using sun light about 2 – 3 days and were kept in a plastic bag or other wares.

The Difference of Method (Table 1)

1. Variety

It depended on consumer. Villagers used variety namely Tadeang Maungpai and SJ. 5, those are the popular local varieties.

2. Boiling time

It depended on productive locations ranging from 5 – 8 hours.

3. Ferment time

Ferment time was differed related to productive locations and seasons (2 – 4 days). For example, it takes longer time to ferment Thua – Nao in the winter than in the summer or dry season.

4. Grinding method

Both of grinder and mortar were used.

5. Product type of Thua – Nao

There were dried Thua – Nao, spicy Thua – Nao, and fried Thua – Nao.

6. Quantity and time of production including marketplace and marketing.

They depended on productive locations. Chiang Rai province was capable of producing the highest quantity. Meahongson had more marketplaces than Chiang Mai and Chiang Rai, respectively. Marketplaces were in the village, district, province, and nearby province.

Productive Problems

1. Drying

Sunlight was used to dry Thua – Nao. In the rainy season, fungi were contaminated in Thua – Nao, because of the limitation of sunlight. This makes yield loss. Therefore, product quantities were less than in the dry season. In Pangmapa District, Maehongson, drying warehouse was constructed for solving this problem. Sometimes, Thua – Nao had bad smell. This is because fermented microorganisms could not grow. It can be said that it takes longer drying time in the rainy and winter seasons than in the summer or dry season.

A long – term storage was sometimes caused of fungi contamination, especially in moist condition. Lumlertgul and Boonreang (2004) reported that, spicy Thua – Nao could be kept for 2 – 3 days, but fried Thua – Nao could be kept for 4 – 5 days. Besides, dried Thua – Nao had storage age (2 weeks) longer than fried Thua – Nao and spicy Thua – Nao, respectively. The optimal storage condition was found when dry and moisture content must not exceed 14 %.

2. Low standard quality

Product quality had low standard in term of color, flavor, smell, and texture. The standard was differed related to time of production and productive locations.

3. Limitation of marketing

Production process was limited in the local scale and products were only known as a popular food in some districts and provinces in the upper North of Thailand.

Thua – Nao Quality

Nutrition Values

Table 2 showed protein, oil, carbohydrate, fiber, ash, and moisture content that were ranged from 38.94 to 42.81 %, 3.15 to 9.33 %, 33.62 to 40.43 %, 5.31 to 7.86 %, 0.01 to 0.09 %, and 7.30 to 12.02 %, respectively. Total nutrition values of Thua – Nao was found to be higher than other soybean products, when compared with in equal weight. The sample of other soybean products were cooked soybean, soy milk, soy sauce, white soy sauce (miso), bean cake, soft bean cake and bean cake scum. Products of Thua – Nao had many types, for example, dried Thua – Nao, spicy Thua – Nao, and fried Thua – Nao. Yoksan (2005) reported that, protein from meat (9 %) was less than that from soybean. Clinical results obtained by Kungsadalaumpai (2005), reported that protein from soybean reduced cholesterol and LD – cholesterol level and the body received enough of protein, if consumed high quantity. Besides, lipid from meat was higher than lipid from soybean, and saturated fatty acid were almost (13 %) (Yoksan, 2005). While soybean had low saturated fatty acid and a good source of essential fatty acid including linoleic and linolenic were found. Both of them came from food and can not be synthesized from body,

therefore, soybean products consumption did not gain weight (Kungsadalaumpai, 2005). Soybean products had also high of carbohydrate and fiber. Juntawankul (1995) reported that carbohydrate in soybean had much of water soluble carbohydrate and water insoluble carbohydrate. Water soluble carbohydrate were composed of much sugar, for example, disaccharide (sucrose : $C_{12}H_{22}O_{11}$), trisaccharide (raffinose : $C_{18}H_{32}O_{16}$), and tetrasaccharide (stachyose : $C_{24}H_{42}O_{21}$). High of fiber makes a good of incretion in intestine and reduces constipation (Suppadit, 2003). Beside, ash from soybean was a part of minerals, for example, potassium, phosphorus, magnesium, calcium, sodium and sulfur (Yoksan, 2005).

Microorganism Values

Type and quantity of microorganisms in Thua – Nao were differed related to productive locations, (Table 3). This research showed that *Bacillus* spp. was found (*Bacillus subtilis*, *Bacillus licheniformi*, *Bacillus thermocatenulatus*) and it was the same types being in Nutto (Krusong and Pongsawadmanit, 1985). Nutto is a soybean product from Japan. *Rhizopus* spp., *Aspergillus flavus* and *Aspergillus niger* were found on Thua – Nao at Maung district, Meahongson and Measai district, Chiang Rai. Long term storage resulted in fungi contamination, especially in moist condition.

Bacillus spp. was an aerobic opportunistic bacteria although they resulted in toxic food (Suwanpinij, 2001). Their important roles are to release proteolytic enzyme, that's so called protease for digesting protein to ammonium form. Protease digested compounds in soybean into good characteristics such as good taste and smell, digested complex structure, prolong storage, increased digestion ability and dissolubility for simple absorption (Hesseltine and Wang, 1980). *Bacillus* spp. is used as a starter inoculum for Thua – Nao fermentation. Lumlertgul and Boonraeng (2004) said that using *B. subtilis* as starter inoculum was better than using *B. licheniformi* and *B. thermocatenulatus*, respectively. Mixing 3 bacteria gave however the contrast results. This might be because a competition of each type in fermentation process. Their toxicity and optimal inoculums should be therefore tested (Juntawankul, 1995). Not only that, Lumtertgul and Boonraeng (2004) and Wood (1998) reported that fermented Thua – Nao at 35 ^{o}C was optimized for fermentation process as it produced the best soluble protein.

Fungi groups in Thua – Nao were natural fungi. They can cause fungi allergy (Poonwan, 2005). *Rhizopus* spp. is the fungi that produce amylase to digest carbohydrate into dextrin and sugar during fermentation process (Srinakarintarawirot, 2005). It also increased nutrition values. Besides, *A. flavus* and *A. niger* were fungi that might produced toxin. It's so called aflatoxin. It was a compound that affected to health. High quantity of this aflatoxin could destroy liver, blood and this aflatoxin is carcinogen (Suppadit, 2003). However, *A. flavus* and *A. niger* had more advantages than *Rhizopus* spp. in term of Thua – Nao fermentation (Lotong and Suwanarit, 2005). They could change sugar to steric acid and decreased acid – base until some toxic fungi could not be grown in Thua – Nao (Srinakarintarawirot, 2005).

Conclusions and Suggestions

Currently, Thua – Nao production process has used indigenous knowledge technology for developing soybean nutrition and long term storage condition. Thua – Nao had higher nutrition than other soybean products. But, they have had inconsistency of quality. In the winter, incomplete fermentation process was found because of cool condition affecting microorganism growth. Not only that, fungi were the main problem in the rainy season. Thus, optimum fermentation condition that can adjust temperature of 35 ^{o}C is the new method for developing fermentation quality. Bacteria in Thua – Nao had advantages to fermentation process. Although they caused diarrhea, they released protease enzyme to digest protein for digesting food compounds into good characteristics. However, this disease has not been reported from Thua – Nao consumption. Majority of fungi can produce aflatoxin. It is an inferior of this product. Thus,

there should have been a measurement to control and protect those fungi in Thua – Nao involving raw materials selection, production, packaging and marketing.

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Table 1 The difference of Thua – Nao production in various locations.

Location (Province)	Productive Input						
	Variety	**Boiling Time (Hour)**	**Ferment Time (Day)**	**Grinding Method**	**Quantity (Kilogram/ Villager)/Time of Production (Day)**	**Marketplace/ Marketing**	**Type of Products**
Chiang Mai	SJ. 5 or Others	5	3 – 4	Grinder	8/1	District and Provincial Market/ Direct – Sale and Sub – Dealer	Dried Thua – Nao
Maehongson	Tadeang Muangpai	8	2 – 4	Mortar/Grinder	20/1	District, Provincial and Other Provincial Market/Direct – Sale and Sub – Dealer	Dried Thua – Nao Spicy Thua – Nao Fried Thua – Nao
Chiang Rai	Non – Specific	6 – 8	2 – 3	Grinder	32/1	District and Provincial Market/ Sub – Dealer	Dried Thua – Nao

Table 2 Nutrition values of Thua – Nao in various productive locations.

Sampling Location		Nutrition Values (%)					
Province	**District**	**Protein**	**Oil**	**Carbohydrate**	**Fiber**	**Ash**	**Moisture Content**
Chiang Mai	Maewang	38.94	3.15	40.43	5.44	0.02	12.02
	Fang	42.81	3.59	38.86	6.03	0.02	8.69
Maehongson	Pangmapa	42.19	8.20	33.62	7.86	0.04	8.09
	Maung	42.38	7.23	36.08	5.89	0.06	8.36
	Khunyaum	42.12	4.63	38.45	5.31	0.09	9.40
Chiang Rai	Maejun	39.25	8.10	39.35	6.26	0.01	7.30
	Maesai	41.25	9.33	34.81	6.40	0.07	8.14
Mean							
Chiang Mai		40.88	3.37	39.65	5.74	0.02	10.36
Maehongson		42.23	6.69	36.05	6.35	0.06	8.62
Chiang Rai		40.25	8.72	37.08	6.33	0.04	7.72
3 Provinces		**41.12**	**6.26**	**37.59**	**6.14**	**0.04**	**8.90**
Other Soybean Products*							
Cooked Soybean		11.00	5.70	10.80	1.60	-	-
Soy Milk		2.80	1.50	3.60	0.10	-	-
Soy Sauce		5.20	0.50	8.10	0	-	-
White Soy Sauce		12.00	3.80	8.00	0	-	-
Bean Cake		12.50	8.10	6.00	-	-	-
Soft Bean Cake		7.90	4.10	0.40	0.10	-	-
Bean Cake Scum		47.00	28.40	14.90	0.10	-	-

Source: * Kungsadalaumpai (2005)

Table 3 Type and quantity of microorganisms of Thua – Nao in various productive locations.

Sampling Location		Type of Microorganisms	Quantity of Microorganisms (CFU/Gram)
Province	**District**		
Chiang Mai	Maewang	Bacteria*	$1.56x10^7$
	Fang	Bacteria*, *rhizopus* spp.	$1.55x10^7$
Maehongson	Pangmapa	Bacteria*, *rhizopus* spp.	$3.18x10^7$
	Maung	Bacteria*, *A. flavus*, *A. niger*	$5.37x10^6$
	Khunyaum	Bacteria*	$1.31x10^7$
Chiang Rai	Maejun	Bacteria*	$3.29x10^6$
	Maesai	Bacteria*, *rhizopus* spp., *A. flavus., A. niger*	$2.23x10^7$
Mean	Chiang Mai		$1.56x10^7$
	Maehongson		$4.93x10^7$
	Chiang Rai		$2.76x10^7$
	3 Provinces		**$2.64x10^7$**

Food Note: * Bacteria = *B. subtilis, B. licheniformis, B. thermocatenulatus*
CFU = Colony Forming Unit