

A Case Study: Detection of Nitrate Meat Products Sold Convenient Store and Supermarket in Bangkok, Thailand.

Sornusa Vichaidit¹, Pasinee Puhoy², Punnatorn kitkancharoensin³, Kornsuparnut Chotthanapaisan⁴, Warintorn Prapaiwankun⁵, Watcharawat Singsowan⁶, Phongphawit Lorchatnoppakun⁷

¹ Rajini School, Bangkok, ²Rajavinit Matthayom School, Bangkok, ³Bangkok Christian College, Bangkok, ⁴Tawornnukul School, Samutsongkram, ⁵Triamudom Suksa School, ⁶St. Gabriel's College, ⁷Mahidol Wittayanusorn School

Contact Address: 99/9 Charansanitwong 25 Road, Bangkhunsri, Bangkoknoi, Bangkok 10700

Abstract

Nowadays, Nitrate is a food preservative, which is used in traditional processed meat products to extend its shelf life, and transform to preferable colour, and odour. The objective of this study is to investigate the contamination of Nitrate in food that exceeds standards in the traditional processed meat products from convenience stores and supermarkets. The study collected 6 types of the traditional processed meat product in June 2022 from a convenience store and supermarket in Bangkok, Thailand. Then, detection of Nitrate in the samples by GT-Nitrate test kit. The results showed that, there was 27.78% sample that was not met Nitrate that exceeded standard value according to the regulations on the usage of food additives, Notification of Ministry of Public Health number 389 in B.E. 2561 (2018), Re: food additives (Number 5) determine to use of Nitrate exceed than 500 mg. per kg. 2 samples of steamed pork sausage products (50%) were the highest of Nitrate contamination that were over the standards, followed by fermented pork, sour sausage, and sun-dried pork products of 1 sample (33.33%), respectively. Moreover, the Chinese sausage and sun-dried beef products were not found that there was the Nitrate contamination in products over the standard value. It has been found that there are a few of traditional processed meat products in convenience stores and supermarkets contaminated with Nitrate. This phenomenon demonstrated that some producers still use Nitrate exceeding the standards. Hence, the processed meat products workshop for entrepreneurs should be conducted by the related sectors to stimulate them to be aware and follow the regulations strictly. In addition, they should monitor the safety of processed meat products before distribution to avoid the hazard to the consumers' health that may cause.

Keyword: Nitrate, Nitrite, native processed meat products

Introduction

According to the processed meat products industries, most of them have added Nitrates and Nitrites to prevent the growth of Clostridium Botulinum bacteria which can produce a toxin that is highly toxic to humans¹⁻². Besides, it also prevents an unpleasant odour such as rancidity and helps to cause a pinkish red colour in marinated meat products. Nitrates can be converted to Nitrites by both internal reactions or during improper storage. This produces nitrous acid when Nitrite reacts with stomach acid. In 1954, 2 British scientists, John Barnes and Peter Magee, discovered Dimethyl Nitrosamine: NDMA is a carcinogen in rats. This has led many scientists to study other nitrosamines, finding that 90% of them are diverse and organ-specific carcinogens, such as Nitrosamines in tobacco leaves cause lung cancer³. In addition, Nitrosamines can be formed by Nitrate compounds in the form of salt, which are commonly used as food additives in processed meat products such as ham, bacon, sausages, fermented pork, and Chinese sausage. The growth of the pathogenic bacterium Clostridium botulinum can produce Botulinum toxin, which is quite potent and easily fatal. It also contributes to the stable red colour of the product. Due to the combination of Nitrite and the red pigment in animal muscle (Myoglobin), it forms bright red Nitrosyl myoglobin. When cooked by heat, the red substance is converted to Nitrosyl Hemochrome which looks appetizing, pink, unique smell and tasty. Nitrates can be converted to Nitrites by reactions that occur in the body when it is absorbed. It is converted to Nitrites by bacteria in the mouth and stomach. Moreover, storing food at improper temperatures can also contribute to the conversion of Nitrates to

Nitrites. Besides, Nitrites may react with compounds such as Amines and Amides and transform to be Nitrosamine³. However; the number of Nitrosamines may vary depending on factors such as dietary fat content. Nitrate and Nitrite content method and temperature used for cooking as well as methods of food storage. Joint FAO/WHO Expert Committee on Food Additives (JECFA) The recommended daily intake for Nitrates and Nitrites without causing a lifelong health hazard (Acceptable Daily Intake: ADI) were 0-3.7 mg./kg. and 0-0.07 of the body's weight per day⁵. From the Notification of the Ministry of Public Health No. 389 B.E. 2561; Use Potassium Nitrate or Sodium Nitrate in marinated meat products, including sausages, not more than 500 mg./kg.⁶ Currently, Nitrates and other food additives have been added at a level that exceeds the standard specified by law. It was found in case of children suffering from Methemoglobin at the same time from consumption of unbranded and undocumented sausages in 5 provinces at the end of January 2022. Furthermore, according to a report from the Smart Buy Testing Center Foundation for Consumers (M.P.) and Consumer Organizations in the Central Region and the Project to Strengthen the Surveillance System of Goods and Services for Consumer Protection, Thai Health Promotion Foundation. Nitrate was detected in 17 samples of sausage products in Ayutthaya province. The amount ranges from 20.67-112.61 mg./kg. According to the Notification of the Ministry of Public Health (No. 418) B.E. 2563 (2020), the use of Nitrates in meat products that have been processed by heat is prohibited Therefore, the objective of this study is to detect Nitrate contamination in traditional processed meat products sold at flea markets and shopping malls.

Objectives

1. Study on Nitrate contamination in traditional processed meat products sold in department stores and flea markets in Bangkok.
2. Compare Nitrate contamination in each type of traditional processed meat products to provide information to the authorities who are in charge of regulating the production and distribution of food due to the specified laws.

Method

Sample group

A total of 18 samples and 6 types of traditional processed meat products, including Vietnamese sausage, fermented pork, Chinese sausage, Sour sausage, seasoned mash pork, and sun-dried beef, were randomly collected from a selling place of processed meat products in a department store and a flea market in Bangkok.

Tools and equipment

GT-Nitrate test kit in food was used for preliminary analysis for Nitrate contamination of food additives and used in a test paper (2 in 1 test paper; Quantofix brand) for preliminary analysis for Nitrite food additive contamination.

Data analysis

Analysis of the test results from the GT-Nitrate test kit in food analysis the test should be noticed from the vitro colour. When the sample tube is lighter than the B reagent tube of the test kit, the content of Nitrate is less than 500 mg./kg. When the test tube sample is equal to or darker than the standard reagent ampoules of test kit B, indicating Nitrate contents equal to or greater than 500 mg./kg. Analysis of the test paper results (2 in 1 test paper; Quantofix brand) by observing the colour on the paper strips and comparing the colour with the standard colour bar on the product label.

Result

1. The result of analysis of Nitrate contamination above the standard in all 18 samples of processed meat products 5 samples, representing 27.78%, found the contamination of Nitrates exceeded the standard of 500 mg./kg. When categorising the sample analysis results according to the type of traditional processed meat products, it found that Vietnamese Pork had the highest Nitrate content at 50%, followed by fermented pork, Sour sausage, and seasoned mash pork at 33.33%. No Nitrate content above was found in Chinese sausage and sun-dried beef as shown in Table 1.

Table 1 The number of samples of Nitrate salt analysis results in Vietnamese Pork, Sour Sausage, Chinese Sausage, Sour Sausage, Seasoned Mash Pork and Sun-Dried Beef sold in department stores and flea markets in Bangkok.

Types of Products	Number of Samples (a)	Number of Samples that found Nitrate Salt (b)	Percentage (b/a)*100
Vietnamese Pork	4	2	50.00
Fermented Pork	3	1	33.33
Chinese Sausage	3	-	00.00
Sour Sausage	3	1	33.33
Seasoned Mash Pork	3	1	33.33
Sun-Dried Beef	2	-	00.00
Total	18	5	27.78

2. From the result of analysis of Nitrate and Nitrite contamination in 18 samples of traditional processed meat products. There was found excess Nitrate contamination of 5 samples of Vietnamese sausage, fermented pork, Sour sausage and seasoned mash pork (the standard value was 500 mg./kg.), and showed the sample colour was darker than the B standard reagent tube of the test kit. When Nitrite contamination was analysed with a test

paper (2 in 1 test paper; Quantofix brand). The use of Nitrite salt was not found in samples of traditional processed meat products.

Table 2 The quantity of Nitrate and Nitrite salts in 18 samples of Vietnamese sausage, fermented pork, Chinese sausage, sour sausage, seasoned mash pork and sun-dried beef sold in department stores and flea markets in Bangkok

Types of Products	Number of Samples	The quantity of Nitrate and Nitrite salts (ml./kg.)			
		Nitrate		Nitrite	
		Color	Don't meet standard	Quantity	Don't meet standard
Vietnamese Pork	4	Darker	2	None	0
ermented Pork	3	Darker	1	None	0
hinese Sausage	3	Lighter	0	None	0
our Sausage	3	Darker	1	None	0
asoned ash Pork	3	Darker	1	None	0
in-Dried Beef	2	Lighter	0	None	0
Total	18		5		0

Discussion

Nitrate and Nitrite may be added to the products in the processed meat production industries. It is intended to be used as a preservative to prevent the growth of *Clostridium Botulinum* bacteria. In addition, it helps to prevent unpleasant odour and it also gives products a stable red colour with a distinctive aroma and flavour, such as sausages and hams. Nitrate can be converted to Nitrite by both internal reactions or during improper storage. If humans consume food that contains too much Nitrate into the body, it may cause health hazards. Nitrates are converted to Nitrite by bacteria in the mouth and stomach. Nitrite changes Haemoglobin. (Haemoglobin; Hb) to Methemoglobin and causes hypoxia in cell until cyanosis, fatigue, gasp, headache, heart pounding especially in young children which are more toxic than adults⁸. In addition, in the metabolic process of the body within the gastrointestinal tract. Nitrite and Nitrate may produce Endogenous N-nitroso Compounds (ENOCs), such as Nitrosamine which is classified as a carcinogen (carcinogenic). Food additives permitted for using in meat products must be based on the type of food additives. The type of food and the maximum amount to be used must be in accordance with the Notification of the Ministry of Public Health (No. 389) B.E. or commonly called "saltpetre". It is widely used in processed meat products to prevent food spoilage. From sampling locally processed meat products Including of Vietnamese pork, Chinese sausage, fermented pork, sour sausage, seasoned mash pork and sun-dried beef have found that the Nitrate values exceeded the standard value. The legal limit is not more than 500 mg/kg. The results of the analysis revealed that there were 4 types of traditional processed meat products, Vietnamese pork, fermented pork, seasoned mash pork, that contained Nitrate impurities that exceeded the standard. It was found that the samples with the highest Nitrate contamination exceeded the standard 50.0% is Vietnamese pork, followed by fermented pork, sour sausage and seasoned mash pork representing 33.33%. If there is a chain reaction with amines in meat, it can cause carcinogens. The manufacturer may intentionally use or may be the manufacturer has not adjusted the production formula that is found in small quantities due to contamination from raw materials or other food additives used in production. For Chinese sausage and sun-dried beef, No Nitrate contamination exceeded the standard. In addition, from the sampling of fermented pork, Chinese sausage, sour sausage, seasoned mash pork and sun-dried beef. It was found that there was no nitrite value that exceeded the standard required by law to be used at no more than 125 mg/kg.

The results of this study are consistent with a study by Wenika Benjapong and colleagues that analysed Nitrate and Nitrite contamination in processed meat products sold in Bangkok and 5 other provinces in the provincial part in from 1,024 samples. The Nitrate exceeded the standard in Chinese pork and fermented pork by 6.6% and 4.3%, respectively. The highest Nitrate contamination was found in the samples as high as 2,764 and 86.10 mg/kg, respectively⁵. From Boonsong Lee Suraplanon's research that study on the use of food additives in meat products in Nakhon Ratchasima Province in 2017 found that 19 samples of sausages contained Nitrate in 2 samples, fermented pork 14 samples found 2 samples of Nitrate and 3 Nitrites. 28 samples of Chinese sausages were contaminated with Nitrates 11 samples⁴ and according to Kittima's latest research report, Sonamit and Exit Dechanuwat assessed the situation of Nitrate and Nitrite residues in processed meat products. Residual Nitrites found in chicken sausage, pork sausage, fermented pork, pork chops, sun-dried beef, Vietnamese pork and meatball, accounted for 1.6, 3.4, 5.7, 11.1, 40.0, 1.4, and 1.3% of samples respectively that exceeded standard. Nitrates were found in all products⁹. In addition, an excess of Nitrate consumption (500 mg/kg) was reported in 4 samples of fermented pork by 8.88% and in 2 samples of ham at 4.44%. There are all processed meat products that are contaminated with Nitrates above the standard in 3 markets of Bangpra district, Chonburi¹⁰. However, from the result of this study, no excess nitrate contamination was found in local processed meat products such as Chinese sausage and sun-dried meat. This showed that the manufacturer of such products has adjusted the production formula in accordance with the Notification of the Ministry of Public Health to keep the product to be in the safe level to consume.

Conclusion

From a situation study on the use of Nitrate and Nitrite preservatives in local processed meat products comprising of Vietnamese pork, fermented pork, Chinese sausage, sour sausage, seasoned mash pork and sun-dried meat in Bangkok, it was found that Nitrate are still used that are not in accordance with the above-mentioned law. Therefore; measures should be taken as follows:

1. In the case of analysis findings that the use of Nitrates is not in accordance with the law, should inform the operators to improve the production formula to be in the standard specified by law and the relevant officials. The established guidelines should be followed to reduce and eliminate the problem of food additives overuse.
2. In case the use of Nitrate in the production process is found as required by law, should conduct advice to entrepreneurs in terms of knowledge and understanding to improve the production process or bring suitable tools and equipment to be used in the production process.
3. Advise entrepreneurs to have an analysis of the amount of Nitrate remaining in the product before selling it in order to prevent the residual Nitrate in the product exceeding the legal limit.

Recommendations

Studies have shown that Nitrates used in traditional processed meat products. Its purpose is to help extend the life of food, to keep longer and to colour food to make it more appetising. It was found that non-standard Nitrates were used exceed the specified standard which should be corrected as follows:

1. Competent staff in the responsible area of the production site should be continuously monitored.
2. Competent staff should provide knowledge to entrepreneurs in food production to make sure that food can be stored properly for consumption, make sure they have an understanding of the use of technology in production, packaging, storage or transportation which affects the quality or standard of food and to comply with the law on the use of food additives as specified in the Notification of the Ministry of Public Health.
3. Processed meat producers should have control and supervision from the beginning of the raw materials, ingredients, tools and other equipment related. There may be a quality analysis at least once a year in order to ensure that they are safe for consumers.

References

1. Siddiqui MR, Wabaidur SM, ALOthman ZA, Rafi quee MZA. Rapid and sensitive method for analysis of Nitrate in meat samples using ultra performance liquid chromatography-mass spectrometry. *Spectrochimica Acta A Mol Biomol Spectrosc* 2015;151:861-6.
2. Cammack R, Joannou CL, Cui XY, Torres Martinez C, Maraj SR, Hughes MN. Nitrite and nitrosyl compounds in food preservation. *Biochim Biophys Acta* 1999;1411:475-88.
3. Rath S., Reyes, FG, Ryes. Nitrosamines. In: Nolle LML, Toldra F, editors. *In the handbook of processed meats and poultry analysis*. Taylor & Francis Group; 2009. P. 687-705.
4. Leesuraplanon, B. (2017). A study of the situation of the use of food additives in meat products in Nakhon Ratchasima province. *Journal of Food and Drug Administration* 25(2): 58-66.
5. Benjapong V, Thesasil G, Likidrattanaporn J, Vistechat P, Muangsrichan N. (2554). Assessment of nitrate and nitrite intake from processed meat consumption of the Thai population. *Khon Kaen University Research Journal* 16(8):931-41.

6. Ministry of Health(2018). Notification of the Ministry of Health (No. 389) on Food Additives (No. 5).
7. Council of Consumer Organizations (2021). Contaminants banned by the FDA have been found in 17 samples of sausages [Internet]. Bangkok. [Accessed 1 July 2022]. <https://www.tcc.or.th/sausage-preservative/>
8. Fennema OR. Food Chemistry. 3rd ed. Taylor & Francis; 1996. pp:784-5.
9. Sonamit K, Dechanuwat A.(2021). Evaluation of nitrite and nitrate exposure from meat product consumption. Journal of the Department of Medical Sciences 63(1):160-72.
10. Choosaeng S, Wongsalee B, Meesuwan S, Sritha D, Chankhong D, SinghAsa K. (2021). Nitrates in processed meat products in flea markets in Bang Phra Subdistrict Municipality, Si Racha District, Chonburi Province. Journal of Food and Drug Administration 28(2):59-65.