Risk Assessment Studies
Report No.8

Chemical Hazard Evaluation

Meat Curing in Chinese cuisine - A Risk Assessment on Lap-mei-

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Food and Environmental Hygiene Department
HKSAR

Correspondence:

Risk Assessment Section

Food and Environmental Hygiene Department

43/F, Queensway Government Offices,

66 Queensway, Hong Kong.

Email: enquiries@fehd.gov.hk

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Abstract

The addition of nitrate and/or nitrite to meats and poultry at low concentrations has been a common method of preservation for centuries. In curing of Lap-mei, referring to traditional Chinese preserved meat products, nitrate/nitrite is essential not only its provision of unique characteristic in colour and taste, but more important, is its anti-microbial properties against bacteria growth and spore formation especially *Clostridium botulinum.* However, nitrites may react with other substances found in meat forming nitrosamines, compounds that may cause human cancer. Thus, application of nitrate/ nitrite in curing is strictly controlled to the amount required to achieve the intended effect only. We reviewed the Lap-mei surveillance from 1999-2000 to examine this chemical hazard. Of the 130 samples collected throughout this period, there were 69 tested samples on nitrate and nitrite respectively. Three were found to exceed the permitted level of sodium nitrate, representing a non-compliance rate of 4.3%. These samples were all preserved sausages collected in 1999. There were another 168 tests conducted on non-permitted preservatives, all of them were proved satisfactory. Test results on the colouring matter were also reviewed in this report, one of the 62 tested samples was detected with non-permitted colouring matter, resulting in 1.6% non-compliance rate.

Meat Curing in Chinese cuisine

A Risk Assessment on Lap-mei

Introduction

1. Meat curing is a food technology widely employed to maintain the quality of meat for prolonged duration in the days without refrigeration. As a matter of fact, the use of salt, sodium chloride, to preserve meat is a practice with a long history. It was an incidental finding that the presence of sodium nitrate as an impurity in crude salt could give the treated meat an attractive red or pink colour. These lead to the later use of nitrate in meat preservation and subsequently led to the development of modern meat curing.[1]

2. There is also a type of traditional Chinese meat curing similarly using salt and sodium nitrate to a product called Lap-mei. Like the western meat curing, Lap-mei has lost its importance as meat preservation due to the availability of industrial and domestic refrigerators. Instead, it provides choices of wider varieties in distinct colour and flavour to the consumers nowadays.

Purpose

3. In this risk assessment study, we review the manufacturing process of Lap-mei to identify possible hazards, examine the surveillance results and assess the potential risks related to consumption of Lap-mei. Recommendations would be made to the trade and the consumers.

Lap-Mei – definition and characteristics

4. Historically, Lap means "ritual" in old Chinese, it was very often that surplus meat after the ritual would be cured for use in times of scarcity. In Chinese tradition, they are usually prepared around the time of December of lunar calendar (or in Chinese "Lap-Yue") as one of the delicacies to cerebrate the Spring Harvesting Festival, and therefore named as such.

5. There are three types of Lap-mei available on the local market. They are preserved Chinese sausages, preserved pork, and preserved ducks. These are characterized by their unique appearance, texture, and taste where are the results of the respective curing formulation.

6. The principal approach in producing Lap-mei is similar to the standard curing practice documented in the Western reference literatures. For instance, the meat or poultry are subject to the treatment of curing ingredients, which typically consist of salt, sugar, wine, and sodium nitrate/nitrite. The relative proportion of the curing ingredients may differ with the nature of meat and type of products involved. Food additives may be added to improve the quality of the final product.

7. The curing process of Lap-mei is summarized in a schematic diagram at Figure 1. The process involves five main steps. The raw materials, usually meat or duck, are cleaned and appropriately cut. They are then immersed in curing ingredients and mixed either manually or mechanically. The curing ingredients, that is, salt, sugar, wine, and nitrate diffuse into the meat and poultry. The mixture of meat and curing ingredients may be placed in chillers overnight to allow stabilization and thorough distribution. Some manufacturers may have cuisine with other flavouring agents such as spices or soya sauces. Furthermore, food additives such as colouring matter may be added to make the products better looking.

8. The meat, poultry, or sausages, after well soaked in the curing ingredients have to be dried such that the moisture content of finished products comes down to 25% or even lower. In the past, the meat or poultry are most often air-dried. The products would be hung to allow gradual reduction in the moisture. However, air-drying is seldom employed in the present days. Reasons are the space required for

loading, the unpredictable climates, and the process being relatively time-consuming.

9. In industrial setting, hot air-drying is the preferred method. The pieces of meat are placed in air-conditioned chamber at temperature range between 35°C-40°C. The choice of temperature and duration combination also depends on the characteristics of the meat or poultry pieces under processing. Usually three to four days of hot air-drying are sufficient for preserved sausages weighing about 500kg.

Functions of the Curing Ingredients used in Lap-mei

10. Typical curing ingredients in the preparation of Lap-mei include salt, nitrate and nitrite, sugar, and wine. Salt is known to have preservation effects and also serves flavouring purpose. The level of salt is usually less than 3%.

11. Sugar and wine both give special flavour to the finished products. Sugar has the effect of colour stabilization whereas wine has a mild preservative effect.

12. Nitrates and nitrites have a unique place in meat curing. They are important from a food safety perspective that they have anti-microbial functions especially on *Clostridium botulinum* and the inhibition of toxin production.

13. *Clostridium botulinum* is a gram-positive, spore-forming, anaerobic rod that can cause fatal infection. It is well known to exist in anaerobic conditions, thus, vacuum-packaged foods such as bacon and canned processed meat are capable of supporting growth and toxin production by *Clostridium botulinium* strains without causing noticeable off-odors. In preserved meat especially meat sausages, spores of the bacteria can germinate, grow and produce toxin under conditions of abused temperatures. *Clostridium botulinum* can grow at water activity of 0.94 and above.

14. Nitrates and nitrites have other important technical functions. First, they fix the colour of cured meat at red-pink by stabilizing the haem in myoglobin through the formation of nitrosomyoglobin. Second they can delay the process of oxidative rancidity and hence prevent the development of warmed-over flavour. This is an undesirable oxidized flavour that may gradually develop during prolonged storage of meat.

Health Implications of the Nitrate/nitrite

15. Nitrites are the compounds that are of more human health concern. Nitrates at the levels commonly present in food are not toxic to humans but serve as the reservoir for conversion to nitrite by the intestinal flora. Nitrate *per se* has a relatively low toxicity.

16. Accidental poisoning by significant amount of nitrite can cause methaemoglobinaemia when the iron in haemoglobin is oxidized from the ferrous Fe(II) to the ferric Fe(III) form. Methaemoglobin loses its ability to bind oxygen and causes hypoxia in the affected individuals. The condition is characterized by headache, weakness and breathlessness, and a bluish discolouration of the skin and mucous membranes called cyanosis. Methaemoglobinaemia resulting from exposure to food contaminated with nitrite has been extremely rare.

17. The development of methaemoglobinaemia is determined by the ingested dose and individual susceptibility. Infants are particularly susceptible to nitrite-induced methaemoglobinaemia because fetal haemoglobin converts to methemoglobin more easily. In addition, infants have a low concentration of the reducing enzyme such that methemoglobin is not converted back to hemoglobin as readily. For mild cases of methaemoglobinaemia, the patients usually recover without specific treatment.

18. At present, there is no evidence to show an association between nitrate and nitrite exposure and risk of cancer in humans. Nevertheless, they can combine with amines or amides in food to form N-nitrosocompounds, nitrosamines and some of these have been shown to be carcinogenic in experimental animals and epidemiologically implicated carcinogenicity.[2]

19. The matter has been reviewed by International Agency for Research on Cancer (IARC), which confirmed that these N-nitroso-compounds are reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity in experimental animals.[3,4,5]

20. In reviewing of the previous evaluations, toxicological and epidemiological data, Joint FAO/WHO Expert Committee on Food Additive (JECFA) in 1995, concluded that nitrate/nitrite as food additive, an acceptable daily Intake (ADI) of 0-3.7 mg/kg body weight per day[6] and 0-0.06 mg/kg body weight per day respectively[7] (as expressed in ion form) was allocated.

Local Situation

21. As listed under the Preservatives in Food Regulations in Hong Kong, made under section 55 of Public Health and Municipal Services Ordinance (Cap. 132), preservative means any substance, which is capable of inhibiting, retarding or arresting the process of fermentation, acidification or other deterioration of food or masking any of the evidence of putrefaction but this term does not include substances added to food for maintaining or improving nutritional qualities or any permitted antioxidant, permitted colouring matter, common salt (sodium chloride).

22. The permitted preservatives for use in foods are stipulated in the First Schedule to the Preservatives in Food Regulations, which specify the premitted preservatives for use in specified foods, as well as the respective maximum permitted levels.

Surveillance Findings of "Lap-mei" 1999-2000

23. The surveillance results from 1999-2000 were reviewed to examine the potential hazards related to preservatives and colouring matter in locally available Lap-mei.

Results

24. There were 130 Lap-mei samples sent to Government Laboratory for testing on preservatives and colouring matter. The methods used included High Performance Liquid Chromatography (HPLC) and Thin Layer Chromatography (TLC).

25. Of all these samples, 118, 5 and 7 was preserved sausage, preserved pork and preserved duck respectively. They were examined for sodium nitrate, sodium nitrite, non-permitted preservatives and colouring matter.

26. The results were compared against the statutory specifications stipulated in the Preservative in Food Regulations in Food Regulations and Colouring Matter in Food Regulations made under the Public Health and Municipal Services Ordinance (Cap.132).

Sodium nitrate/nitrite

27. Of 69 samples examined for nitrate and nitrite, three samples of preserved sausages taken in 1999 were found to exceed the permitted level of sodium nitrate, resulting in non-compliance rate of 4.3%. The levels reported were 990ppm, 1000ppm and 1100ppm.

Table 1- Results of sodium nitrate and nitrite obtained from Lap-mei samples.

Year	Sodium Nitrate		Sodium Nitrite	
	No. of Sample	No. of Unsatisfactory Samples (%)	No. of Sample	No. of Unsatisfactory Samples (%)
1999	42	3 (7.1%)	42	0% (0%)
2000	27	0 (0%)	27	0% (0%)
Total	69	3 (4.3%)	69	0% (0%)

Other Preservatives

28. We also conducted 168 tests on the non-permitted preservatives such as benzoic acid, sorbic acid, hydroxybenzoate, sulphur dioxide and boric acid. None of the samples were found to have used preservatives that were not appropriate for Lap-mei.

Colouring Matter

29. As for colouring matter, one out of 62 tested samples was detected with an industrial dye namely Crocein Scarlet 7B, resulting in 1.6% non-compliance rate. This incriminated samples was a preserved sausage that taken in 1999.

30. There were 26 samples containing permitted coloring matter. Of these detectable samples, the most commonly used permitted coloring matter was Ponceau 4R which gives a red colour.

Discussion and Conclusions

31. The above analyses revealed that the inappropriate use of non-permitted preservatives in Lap-mei has not been a practice. Nevertheless, excessive use of sodium nitrate and unlawful use of coloring matter are notable in the past three years. It is therefore the misuse of these substances remains a concern.

32. To prevent nitrite-induced intoxication and to minimize the extent of exogenous nitrosamines formation in cured meats such as Lap-mei, manufacturers are liable to assure their products contain no more than the permitted levels of sodium nitrate and /or nitrite in order to reduce the residual nitrites in food.

33. To this end, a standardized measurement is of importance. In a typical traditional Lap-mei production, nitrate/nitrite is added in a household utensil such that variation may occur according to the experience of personnel.

Recommendation

Advice To Trade

34. The use of preservatives should be appropriate in accordance with good manufacturing practice (GMP) such that they are of food grade and be prepared and handled as food ingredient. The amount added to food should be appropriate to fulfill their intended purposes.

35. To further enhance the safety of Lap-mei, the trade is recommended to adopt the following measures during preparation and storage:

(a) Mix the curing agents well and ensure they are evenly distributed;

(b) Lap-mei should be adequately dried under natural or artificial conditions; and

(c) Store finished products under cool and dry conditions.

Advice To Public

36. Lap-mei, despite its nitrate/nitrite level and potential risk of nitrosamine, its relatively high fat content is sufficient to call for a moderation in its intake for individuals especially for those with diabetes, heart disease and high cholesterol. They should choose sausages with low fat content. Nevertheless, the public is highly recommended to

maintain a balanced diet in order to safeguard their health.

37. Besides, infants are highly susceptible to the nitrite toxicity and should be avoided consuming Lap-mei. As for young children, their intake should also be restricted.

38. Practical advice to consumers in purchasing, cooking and storing are as follows.

Purchase

(a) Surface should be firm and dry

(b) Colour should be naturally pinkish (not bright red)

(c) Surface of cross section should be firm and shiny.

(d) Fat should be whitish without red specks.

Cooking

(a) Remove the part of meat connected to coloured threads; and

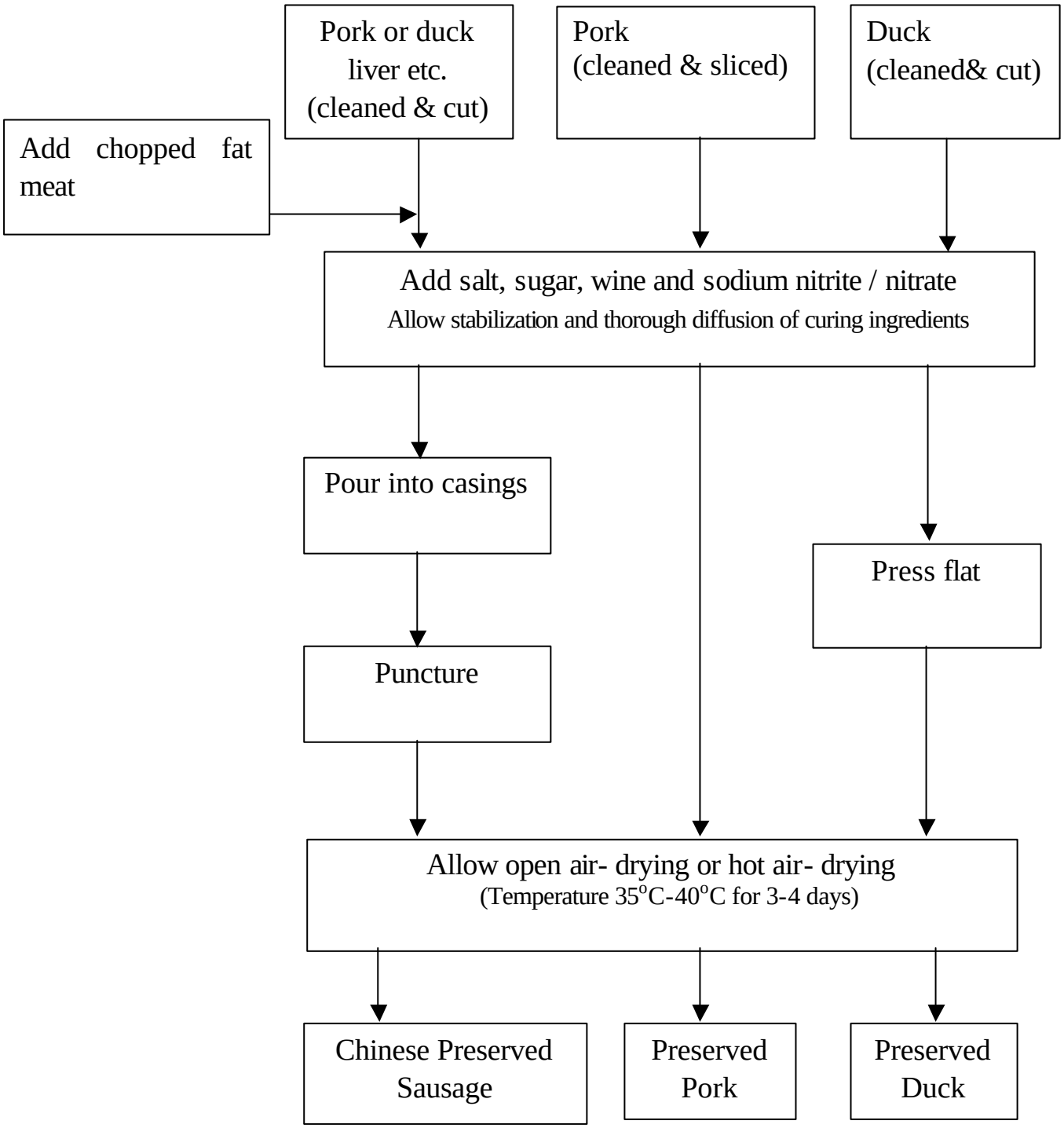
(b) Ensure thorough cooking (for at least 10 mins in boiling water).

Storage

Refrigerate unused and leftover Lap-mei.

Chart 1

Product of Preserved Pork, Sausage and Duck



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