

## Processing and Improving Traditional Goat and Sheep Meat Products under Modern Technological Conditions

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## SUMMARY

During the last ten years meat production and processing have been developing rapidly in China. But in the processing of most meat products, especially of the local products, old methods are still used which do not go well with the modern meat-processing conditions.

After analysing the processing technology and the prescription and store characteristics of the traditional meat products, we have developed several new dried meat products, beginning with goat and sheep meat, that are suitable for the modern processing conditions. While they still have the sensory and nutritional properties of the traditional products, these new products are of better quality, and are well-received by consumers. This shows that it is possible to improve on traditional products using modern technology and equipment if the traditional features of the products are preserved and the local consuming habits are fully taken into consideration. Especially, the development of meat products from ruminants such as the goat and sheep is of great significance for developing countries, whose rapidly growing population is leading to an ever increasingly serious problem of protein deficiency.

## INTRODUCTION

During the last ten years, meat production in China has been increasing at an average rate of 10%. In 1990, the total production of meat reached 27.8 million tons. The annual meat consumption per capita increased from 12.2 kg. for 1980 to nearly 24 kg. for 1990. But the consumption level is still rather low compared with that of the industrialized nations, and the population growth also adds to the problem of deficiency in protein foods. Therefore, China places great importance on the exploration of the resources in its vast grasslands and on the development of meat production of ruminants. The Chinese government even lists goat-rearing as a means of promoting the economy of under-developed areas, increasing the production of meat, and opening up new sources of protein supply. As a result, the production of goat and sheep meat has been increasing at a rate far greater than the rate at which pork and beef production has been increasing. In the year 1990 goat and sheep meat production reached a total of more than 800 thousand tons, as compared with the total of 380 thousand tons for 1980, accounting for one tenth of the world's goat and sheep meat output.

Not only is China among the first countries where goat and sheep meat was consumed, but the habit is now widespread in the country. The early history of consumption is even reflected in the Chinese writing system: the Chinese character (meaning "delicious") is made up by 鱼 ("fish") and 羊 ("goat" or "sheep"), a fact indicating that in ancient China goat and sheep meat was already a delicacy. In his classic *Compendium of Materia Medica*, written in 1578, the Chinese scientist Li Shizhen gives a detailed account of the use of goat and sheep meat as a healthy food and as medicine for a number of diseases. Even today, the habit remains among the Chinese people to use goat and sheep soup in winter as a tonic. It has been established by research that compared with other kinds of meat, goat and sheep meat has a lower calorie and cholesterol content (Gall, 1981). Especially, compared with beef, goat meat is not only equally rich in its content of essential amino acids, but also has a greater content of arginine, leucine and isoleucine (Srinivasan and Moorjian, 1973). For these reasons, goat and sheep meat ranks very high among the delicacies in many countries (Devendra, 1988).

The main goat and sheep meat product in China is dried meat (Rou Gan); in some places, other products, such as goat ham (Pong Yangtui) are also made. As the making of dried meat from pork and beef, the making of dried goat and sheep meat can be traced back to the nomads. Written record about dried meat appeared more than 3000 years ago (Lü et al, 1985). The traditional methods for making dried meat have been used up to this day. In recent years, there has been rapid progress in China's meat-processing industry. Equipment and technology have been greatly improved; even small and medium-sized factories now possess modern equipment for refrigeration, high-temperature handling, constant temperature controlling, and vacuum packaging. A lot of technology, prescription and installations have been introduced for producing western-style meat products. But little change has been made in the production of traditional products. The same methods used in the old household workshops are still used; little change has occurred in the technology. This lack of improvement of the traditional products severely limits their market prospect.

Certainly, the traditional products have their advantages. Because of their special sensory and nutritional properties, these products have long been accepted by local communities. Their processing technology and prescription are the result of a long tradition among the people. As is summarized in the research of Leistner and others (1984, 1985, 1987, 1988), these products also have advantages in that they are relatively simple to prepare, easy to store and to transport. However, given the modern conditions of processing and consumption of meat products, it is necessary to improve these traditional products. For instance, in order to be stored for a long time without refrigeration, traditional Chinese meat products are usually made to contain a large amount of NaCl, other additives and little moisture, and are usually hard in texture and lack tenderness. As the living standard and nutritional conditions of the Chinese people improve, consumers begin to hope that while still keeping their special flavour, the traditional products contain less harmful additives and have better sensory qualities.

Under such circumstances, it has become a subject of great interest for meat researchers to find ways to improve on the traditional Chinese meat products such as dried goat and sheep meat, so that they will better suit the increased production and the improved living standards. We have done a lot of laboratory work, analysing the prescription, processing technology, and flavour of various types of traditional Chinese meat products and people's needs for them and, in collaboration with processing plants, improving the traditional meat products with modern technology. As an initial result of this effort, several new kinds of dried goat and sheep meat have been produced.

#### THE PROCESSING OF TRADITIONAL AND NEW GOAT AND SHEEP MEAT PRODUCTS

Traditional Chinese goat and sheep meat products consist mainly of dried meat and ham. The processing technology of these products is similar to that of these products is similar to that of pork and beef dried meats and ham. A lot has been published on the processing technology and prescription of these products (Lo et al, 1980, Lu et al, 1985, Leister et al, 1984, 1985, 1987, 1988, Li et al, 1980, 1981)

Dried goat and sheep meat products are intermediate-moisture, shelf-stable ripe meat products. The processing of these products is rather simple, and can be carried out round the year. The process consists mainly of the following steps: cut the meat into pieces weighing 250-500g, and boil it in water with some ginger; take the meat out, let it cool, and cut it into small pieces or cubes; put the small pieces or cubes back into the soup, add sugar, salt, soy sauce, saltpeter, and spices (anise, cinnamon, clove, fennel, watchau) and boil over low heat till the soup dries up; spread the meat on bamboo or iron wire rack and dry it over a heat of about 60°C till it reduces to 25-30% of the original weight. The dried meat can be stored for three to five months without refrigeration.

A lot has been done in the research of the physiochemical and microbiological properties of Chinese dried meat by Leistner and others (1984). We have also done laboratory analysis of dried goat and sheep meat bought from the market and processed by ourselves, with the following results:  $a_w$  0.55-0.63; PH 5.9-6.1; NaCl 4-5%; sugar 20-30%; sodium Nitrite 20-40 ppm; moisture 5-11%; total bacterial count  $10^2-10^4$ . This is very similar to the result published in Leistner et al. (1984), the only difference being that the dried meat products now generally contain Nitrate, and that dried goat and sheep products have a lower moisture content and lower  $a_w$ -value than pork or beef dried meat products.

The methods for making goat or sheep ham (Feng Yangtui) are the same as the methods for making Chinese ham, and are rather similar to the methods for making classical raw ham used in various parts of the world. As a natural fermentation raw meat product, the ham takes a long time to process, and can only be processed in winter. As a result, it is made in very few areas in China. The process for making goat or sheep ham contains the following major steps: wash the legs (preferably hindlegs) with water; apply evenly a mixture of salt, sodium Nitrate, sugar, Chinese liquor, watchau, and cassia bark; dry cure in a curing vat for four to seven days, inverting the top and bottom layers once in between; after seven days, wash the legs in lukewarm water, and hang them up in a sunny, well-ventilated place to dry, carefully adjusting the shape in the process so that they gradually become sickle-shaped; after seven days, when the shape becomes fixed, dry them under direct sunlight for a few days, and then continue drying by hanging them up in a dry, well-ventilated place. The character feng (风) in the name of the product (Feng Yangtui 风羊腿) means "to dry in the air". The whole process takes about two months; the hams weigh about 45% of their fresh weight. Goat or sheep hams can be stored for three to five months without refrigeration, and need to be steamed or boiled before being served.

Little has been published on the physiochemical and microbiological properties of Chinese hams. The results of our analysis of some samples acquired from the market are as follows:  $a_w$  0.65-0.7; PH 5.0-5.8; NaCl 5-7%; moisture 28-31%; sugar 8-15%; Nitrite (sodium nitrite) 30-50 ppm, total bacterial count  $10^6-10^7$ . No separate test has been done on the microbial flora, but it is obvious that the ham has microbiological stability, and the heating before consumption ensures its safety.

Besides analysing traditional goat and sheep meat products, we also made an investigation of the demands by consumers on these products. They consist mainly of the following: (1) these products keep their characteristic of being ready-to-serve and shelf-stable; (2) they keep their traditional types of flavour: five-spice, peppery, fruit, etc; (3) they have special curing colour and flavour; (4) the tenderness be improved and (5) the odour be removed that is unpleasant to most consumers.

On the other hand, the processing plants hope that the making of traditional products suit their present processing conditions, that the production become serialized and standardized, quality become more controllable, production cycle become shorter, comprehensive utilization rate improve, and that the production as a whole become more profitable. Taking these demands as a starting point, we have done a lot of laboratory work and, in collaboration with processing plants, have developed several new goat and sheep dried meat products that are popular among consumers. These include:

1. Peppery dried pieces (mala Gan): cut lean meat (preferably from the leg) into pieces weighing 200-250g, rinse to remove the remaining blood; wet cure with the curing mix under 4°C for 48 hours. The curing mix consists of the following: salt, glucose, sucrose, sodium nitrite, ascorbic acid, ginger juice, caoguo (Amomum tsao-ko) powder. After curing, steam the meat for 20 minutes, cool, and cut into small pieces. Dry the meat with a temperature of 80°C for 1.5 hours, till it has an  $a_w$  of 0.79 and a moisture of 24%. Mix thoroughly with a mixture of chilli, pepper, glutamate, watchau, and sesame oil. The finished product has a golden colour and a special peppery flavour. When vacuum-packed, it has a shelf-life of four months.

2. Golden filiform meats (Jin Si Rou): cut lean meat (preferably from the loin) into long pieces; boil for 15 minutes (meat: water = 1:1.5 w/w); remove the meat from the soup, cut it into long slices along the length of the fibres, and

manually or mechanically separate the slices into filaments; fry the filiform meat in hot vegetable oil till it turns into a golden colour; put the fried meat into a treating juice containing soy sauce, salt, glutamate, and sugar and boil over intense heat so that the juice quickly dries up. The finished product takes the form of golden filaments, and has a strong tasty flavour of fried food. The aw is 0.72, the moisture is about 15%, and the shelf-life is four months if the product is vacuum-packed.

3. Fruit flavour cubes; (Guowei Li); cut lean meat into pieces weighing 200–250g, rinse out the remaining blood and remove the water; dry cure for 24 hours under a temperature of 4°C with curing salt consisting of NaCl, Nitrite; boil for twenty minutes, and cut it into cubes; add ginger, anise, caoguo, green Chinese onion and other spices into the soup and boil for two hours; remove the undissolved spices from the soup, put the meat cubes back into it, add sugar, glutamate, liquor, orange juice, and some water to make up for the loss in boiling, and boil over 95–100°C for 1.5 hours, till most of the soup has dried up; dry the meat under a temperature of 80°C for 2.5 hours, till it has an aw of 0.76 and a moisture of 22%. The product is brown outside and red-brown inside, and has a strong fruit flavour. When vacuum-packed, it has a shelf life of over four months.

4. Five-spice dried slices (Wuxiang Pian); This is made from edible by-products such as the heart, liver, kidney, and tongue, with the fat and meat string removed. Wash and rinse these parts to remove the remaining blood; wet cure for 72 hours under a temperature of 4°C with curing salt consisting of water, NaCl, sodium Nitrite, ascorbic acid, sugar, and Chinese liquor; remove the cured parts from the curing vessel and stew for 2.5 hours with soy sauce, ginger, caoguo, “five spices” (anise, cinnamon, clove, fennel, and watchau), and water; remove the stewed parts from the sauce, and then into thin slices after they become cool; dry the slices for 2.0 hours under a temperature of 80°C, till the product has an aw of 0.75 and a moisture of 20%. The finished product is light brown, and has a strong spicy flavour. When vacuum-packed, its shelf life is over four months.

IMPROVEMENTS ON PROCESSING TECHNOLOGY AND DISCUSSION

The characteristics of the traditional Chinese dried meat products are that they are easy to prepare, to transport, (light-weighted) and to store (without refrigeration). Three basic methods are used in making these products (Leistner, 1985), but the most widely followed process now is to cut boiled meat into slices or cubes, boil these with spices, and then dry under a temperature of 50–60°C. The final products have an aw of 0.55–0.69 and a moisture of 10–15%. According to the research by Leistner and others (1984), these products generally contain 3–5% NaCl, 20–35% sugar, and PH 5.6–6.0. The new goat and sheep meat products we make retain the basic intermediate moisture food properties of the traditional dried meat. The table shows results obtained from market samples:

Table 1: Average data of new goat and sheep dried meat products

Product	aw	PH	NaCl(%)	Sugar(%)	H <sub>2</sub> O(%)	NO <sub>2</sub> (PPM)	Total count
Peppery dried pieces	0.79	5.8	4.0	15.5	25.0	15	3×10 <sup>4</sup>
Golden filiform meats	0.72	6.0	4.2	22.0	15.6	10	1×10 <sup>4</sup>
Fruit flavour cubes	0.76	5.9	4.5	26.0	22.2	13	1×10 <sup>4</sup>
5-spice dried slices	0.75	6.1	5.0	9.5	19.7	17	2×10 <sup>4</sup>

Compared with results obtained from traditional dried goat and sheep meat (aw 0.55–0.65, PH 5.9–6.1, NaCl 4–5%, sugar 20–30%, moisture 5–11%, sodium nitrite 20–40ppm, total bacterial count 10<sup>2</sup>–10<sup>4</sup>), the aw-value and moisture of the new products are slightly higher, and the sodium nitrite, NaCl and sugar content is reduced. In processing technology, a curing stage has been introduced which is necessary for most traditional Chinese meat products, and the drying temperature has been raised to 80°C. In addition, in the making of the “peppery dried pieces”, curing mix is introduced using ascorbic acid, glucose, and the original stage of boiling has been changed into steaming. In the case of the “golden filiform meats” and the “five-spice dried slices”, the new processes are the result of a summary of and improvement on traditional cooking. The new products still have the flavours popular among the Chinese people: the five-spice flavour (obtained from five-spice powder), the peppery flavour (obtained from chilli, watchau, and pepper and popular in the south), and the fruit flavour (obtained from sugar and fruit juice, popular in the north). In recent years many foreign products have appeared on the Chinese market, but these products only have a very moderate success with consumers, and one reason for this is that their flavour does not suit the taste of the majority of the Chinese people, which has been acquired over a long period and cannot be changed in a short time.

The improvements we have made in the making of a series of new goat and sheep meat products includes the following:

Making the most of the improved processing conditions. The use of modern processing equipment and technology will benefit the standardization and serialization of production, help improve the sensory quality and nutritional properties of the products, reduce microbial contamination caused by manual processing, increase the shelf life of the products, and improve productivity. Therefore we have designed the processing technology to make full use of the conditions available. The curing stage uses the refrigerated warehouse; the high-temperature treating stage uses the cooking tank with automatic temperature control; the drying stage uses the continuous infra-red drier. The centrifugal drier and the vacuum packaging machine are also used in the process. Most medium-sized plants in China now possess these means.

Improving the appeal to sight through curing. Curing is used in the making of most traditional Chinese meat products, but not in the making of dried meat. The Nitrate or Nitrite used in the making of dried meat now is used not to produce



colour but as a preservative. The products made with the traditional methods lack the bright colour that most Chinese consumers like. To produce an appealing colour, we introduced an additional procedure. While controlling the amount of nitrite used, we use ascorbic acid, glucose, (as in the making of the "peppery dried pieces"). As a result of the use of these additives and the modern equipment for cooking, drying and packaging, the products now have a much more appealing appearance, and are quite well-received by consumers. This is especially true with the "peppery dried pieces" and the "golden filiform meats".

**Removing the odour from goat and sheep meat.** Many Chinese consumers dislike the goaty odour in goat and sheep meat which, according to Wong and others (1978), is related to 4-methylthioacetic acid. The odour of goat meat is especially strong. Based on the popular practice of removing the odour by rinsing or by using spices (Lü et al. 1985), we developed a method of thoroughly removing the remaining blood by using the centrifugal drier while rinsing the meat, and then further removing the odour by applying spices such as ginger, caoguo (Amonum tsao-ko), and Chinese cinnamon. Consumers have found products thus treated to have no unpleasant smell.

**Improving the tenderness of dried meat.** Traditional dried meat products are stored without vacuum packaging or even without any packaging. Under such conditions, in order to have microbiological stability, these products need an  $a_w$ -value below 0.60 (Leistner, 1985). Therefore, these products have a low moisture and are hard in texture. Goat and sheep meat products especially lack tenderness (Morand-Fehr, 1977), for in China a large portion of the meat used is from old goats and sheep. To make up for this deficiency, we raise the moisture from 5-11% in the traditional products to more than 15% and even 26%; at the same time, we use the enzyme tenderizer (for instance, papain). As a result, the hardness is effectively reduced, and the products win more consumers, especially among old people and children.

**Ensuring the storage stability by applying the hurdle Technology.** One result of raising moisture in the new dried meat products to improve tenderness is that the microbiological stability of these products has declined. This in turn means a greater risk in food spoilage and food poisoning. To make the products more shelf-stable, we apply "hurdle technology" in the design of the "hurdle" factors of the products.

Leistner and Rödel (1976) and Leistner (1978) have put forward the theory of the "Hurdle effect" after studying the familiar methods to avoid food spoilage and the hurdle factors (such parameters as F, t,  $a_w$ , pH, Eh, and preservatives) that prevent food spoilage caused by microbial growth. After a lot of research, the theory has been put forward in the improved form of the hurdle concept. Brimmon (1985) and Leistner (1985, 1986) further developed the concept into hurdle technology, thus providing a way for the theory of hurdle effect to be applied in food testing and processing and in the development of new food products. According to the principles of the hurdle concept and the hurdle technology, the microbiological stability of traditional dried meat is a result of the interaction between preservatives (NaCl, nitrate and nitrite) and  $a_w$  (mild-heat treatment, the adding of NaCl, etc.). In the newly developed products, the increased moisture and the decreased amount of nitrate or nitrite affect the preservatives factor and the  $a_w$  factor. According to the balance mode by Leistner (1985), the stability of traditional dried meat products and the hurdle factors form a pair of even balances. In the new products, when the hurdle factors at one end become lighter, the stability of the products at the other end drop; the balance is broken. To maintain the balance, we increase the "weight" at the end of the hurdle factors, that is to say, raising the drying temperature from 60°C to 80°C; using vacuum packaging; increasing the pH and Eh factors; using safe additives allowed by health regulations, such as potassium sorbate, in such products as the peppery dried pieces to make up for the decline of the preservatives hurdle factor caused by the decrease of the amount of salt-peter. Product storage stability tests and results from the market show that the design has guaranteed the requirement in product stability and health safety under the condition of storage without refrigeration. It is a pity that circumstances have not allowed us to quantify the sequence of hurdle factors (Leistner, 1987) we have designed.

The progress in China's food-processing industry has not only made it necessary for the technology for making traditional meat products to improve, but has also made it possible for the technology to improve. In the improvement of the traditional dried goat and sheep meat products, the processing of dried meat has moved towards serialization of products; the prescription, technology, and product specification have moved towards standardization; in addition, inspection and control of the processing have become reliable. Through comprehensive utilization (using meat of different quality for different products and making by-products such as the heart, liver, tongue, and kidneys into intermediate moisture cooked foods) and quality improvement (improving the colour and the tenderness and reducing microbial contamination in manual processing so as to improve the products' shelf life), it has become possible to make the processing of goat and sheep meat economically more efficient, and to provide new protein foods for the market. Encouraged by these results, we are now engaged in the research on the improvement of other meat products.

## CONCLUSION

Developing goat and sheep meat production has great significance for solving the problem of protein deficiency in developing countries. In this respect, China has had some successful experience in recent years. The improvement of traditional meat products through the use of modern technology and equipment is of great help. Through the analysis of local products such as dried goat and sheep meat, we have developed a number of new dried-meat products, namely the "golden filiform meats" (Jing Si Rou), the "peppery dried pieces" (Ma La Gan), the "fruit flavour cubes" (Guo Wei Li), All Pian), and the "five-spice dried slices" (Wu Xiang). These products are popular among consumers. This shows that the improvement of traditional products is not only possible but also holds great promises. The following principles must be followed, however, in making the improvement:

1. Keeping the advantages of the traditional products in being simple to prepare and energy-efficient, being easy to transport and store, and being ready to be served.
2. Keeping the special form and flavour of the traditional products, especially the features that satisfy the long-established requirements in local communities.
3. Meeting the new requirements among consumers on the appearance and nutritional properties of the products arising from improved living standards.
4. Making improvements according to modern theories of processing technology and the local conditions in equipment and other means of processing.

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