# SHELF-STABLE ORIENTAL MEAT PRODUCTS

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## SUMMARY

Most shelf-stable meat products of the Orient are based on technologies developed in China in the course of centuries. Generally such meats are in the intermediate-moisture range and the reduction of water activity ($a_w$) is the major factor (hurdle) which secures stable and safe products, such as Rou Gan, La Chang, Ban Ya, La Rou, Ho Tui. The $a_w$ is adjusted by the addition of salt and sugar as well as a mild drying of meats. A heating step during processing or before consumption is important for the hygienic quality of the products. Today pork is the preferred meat in China, however, also beef, lamb and other species are used as raw material. Since traditional Chinese meats are widely appreciated in the Orient for their sensory and nutritional properties, they could become profitable export items for meat producing countries, and certainly are a source of unconventional ideas for Western food design.

## INTRODUCTION

The principal technologies for the transformation of meat into meat products have been developed in Germany, Italy and China. The traditional Chinese meat products have a history of more than a thousand years. Dried meats (Rou Gan) were already mentioned during the Chou Dynasty (1028-256 BC),and during the Sung Dynasty (960-1279 AD) already 200 types of dried meat products, based on red meat, poultry and fish, were known. Toward the end of the Sung Dynasty also the production of raw ham (Ho Tui) became popular, and Chinese sausage (La Chang) has been mentioned first during the Northern and Southern Dynasties (420-589 AD). Also pressed ducks (Ban Ya) have a history of at least 300 years, because production started toward the end of the Ming Dynasty (1368-1644 AD).

Still during the Yüan Dynasty (1260-1368 AD) the major meat processed was beef and lamb, but with the arrival of Buddhism in China pork was preferred. However, the Moslem population of China and other Oriental countries accepts only Chinese meat products made from beef, lamb or poultry. There are also meat products made from rabbit, horse, donkey and dog. The processing of rabbits has increased considerably in China during the last decade, and dry curing is the common process. Horse meat is imported from Europe and Latin America and is processed into smoked sausage or hams. The meat from donkeys is less liked, because it is often quite tough. Dog meat was held in high esteem in ancient times even more than today. Way back people in China would celebrate the birth of a male infant with 'one dog and two bottles of wine' and a female infant only with 'one pig and two bottles of wine' (Lü et al. 1985). Dog meat is also used for dry cured meat products, however, because of its special flavour and since it is not generally available it is eaten fresh and cooked most of the time.

For centuries the preparation of Chinese meat products was mainly done in the family, but today in China about 1200 processing plants for meat and eggs are in operation(Yang, 1988).

Traditional Chinese meat products are shelf-stable, i.e. storable for weeks and months without refrigeration, and their microbial stability is mainly based on the reduction of the water activity ($a_w$) of the meats, which is accomplished by the addition of salt and sugar and a mild drying process. Most traditional Chinese meats are in the intermediate-moisture range ($a_w$ 0.90 - 0.60), some are low-moisture foods ($a_w$ below 0.60). The Chinese call traditional and shelf-stable meats Yan La products (Lo et al. 1980). Yan means curing, i.e. the addition of humectant (sale and often also sugar) to meat or vegetables in order to preserve them; such products don't have to be dried, but they often are to foster their preservation. La is an ancient name for worship and offer. Because these ceremonies are generally conducted in the last month of the year, the 12th month is also call the 'La month', and the foods prepared for the Chinese New Year (end of February according to the Western calender) are called 'La foods'; a typical example is La Change (Chinese sausage). Such foods are cured as well as dried, and the cold season is favourable for their processing. The 'La foods' include many different kinds of meat products made from pork, beef, lamb, chicken, duck, rabbit and edible by-products, such as heart, tongue, liver, kidneys, pig heads (Lü et al. 1985).

Only about 10% of the pork available in China is processed into meat products, and with beef, lamb and poultry the percentage is even smaller. However, 10% of the available meat is still a large quantity, because China is next to the United States the largest producer and consumer of meat in the world, even the per capita consumption of meat due to the large population is still

Table 1: Population of China and consumption of meat (pork, beef, lamb) since 1949

| Year | Population millions | Consumption capita/year | Year | Population millions | Consumption capita/year |
|---|---|---|---|---|---|
| 1949 | 542 | 4.0 | 1977 | 950 | 8.2 |
| 1952 | 575 | 5.8 | 1978 | 963 | 8.8 |
| 1956 | 628 | 5.4 | 1979 | 976 | 10.8 |
| 1957 | 647 | 6.1 | 1980 | 987 | 12.2 |
| 1962 | 673 | 2.8 | 1981 | 1001 | 12.5 |
| 1965 | 725 | 7.5 | 1982 | 1015 | 13.3 |
| 1966 | 745 | 7.9 | 1983 | 1025 | 13.6 |
| 1970 | 830 | 7.1 | 1984 | 1035 | 14.8 |
| 1975 | 924 | 8.6 | 1985 | 1046 | 16.7 |
| 1976 | 937 | 8.3 | 1986 | 1060 | 18.0 |

relatively low; but has steadily increased during the last decades. The meat production (pork beef, lamb) increased in China from 1949 to 1986 from 2.2 to 19.2 million tons per year, and though during this time period there was also a considerable increase in the population from about 540 million to more than one billion, the meat consumption nevertheless increased from 4 kg per capita and year to 18 kg. The data in Table 1, which are taken from Yang (1988), illustrate this development. Today in China an extension of the meat production is emphasised, furthermore an increase of the transformation of meat into meat products is regarded as an important objective. The meat products envisaged are Western style sausages and cooked hams, but also a standardisation and improvement of traditional meats.

Traditional Chinese meat products have been introduced by overseas Chinese into other Asian countries, and have been adopted to the local taste in Japan, Philippines, Thailand, Malaysia, Singapore, etc. Therefore, an investigation of traditional Chinese meat products could elucidate the general principles of shelf-stable meat products common in the Orient.

In this contribution the technologies of some Chinese meats and the basis for their stability will be discussed.

## CHINESE DRIED MEATS (Rou Gan)

These meat products (called Rou Gan in Mandarin) are relatively simple to prepared, easy to store (no refrigeration) and to transport (light weight due to reduced water content). The total consumption of these foods throughout Asia is very large and their popularity is still increasing (Chen 1987). Most Chinese dried meats are intermediate = moisture foods ($a_w$ 0.90 -0.60), and some are in the low-moisture range ($a_w$ 0.6). Many different products are known, depending on the species of meat, the type of technology and the kind of spices used.

Our laboratories studied the physicochemical and microbiological properties of Chinese dried meats (Shin 1984), and we attempted to reproduce the standardise Rou Gan after visiting several manufacturers in Taiwan and Singapore. During these visits we learned that three different processes are distinguishable in the production of Chinese dried meats, which have been described briefly by Huang (1974) as well as Ho and Koh (1984) and were outlined by Leistner et al (1984) and Leistner (1985, 1987a).

### *Process I:*

Foods made according to this process are dried pork slices (also called dried sweet meat, barbecued dried pork) or dried beef slices (also called dried beef squares). In this process, lean meat (preferably from hams or loins) is cut along the grain into paper-thin (0.2 cm) slices, which are mixed with sugar, salt, soy sauce, monosodium glutamate, and 5 spices (anise, cinnamon, clove, fennel, watchau). The pickle is held for 24 h at room temperature or preferably, for 36 h at 4°C. Afterwards the meat slices are placed side by side and slightly overlapping on oiled bamboo baskets or wire racks and dried for several hours at 50 - 60°C, until they reach approximately 50% of their original weight or 35 5% moisture. The meat slices are removed from the trays and cut into squares, which are grilled over charcoal for a few minutes at 130 - 180°C, and should be finally dried at room temperature to $a_w$ <0.69. According to Ho and Koh (1984) about 5% maltose can keep the dried pork slices wet and bright in colour. Since the production of dried pork slices is time-consuming and labour-intensive, modified processes were suggested by Lin et al. (1981) as well as Ockerman and Kuo (1982). Lin et al. (1981) recommended the injection of pickle and tumbling of the meat to replace the soaking and hand-spreading of the slices. Ockerman and Kuo (1982) observed that an addition of nitrate/nitrite combined with vacuum packaging could be used to retard oxidative rancidity of dried pork slices. The vacuum packaging of products also improves tenderness, since it retards moisture loss during storage (Ockerman and Kuo, 1982). A product containing 30% sugar and 2.5% salt, compared with dried pork slices made with less sugar and salt, had the highest panel scores when evaluated by a group of Oriental panelists (Kuo and Ockerman, 1985). In a textbook from mainland China in which the other processes for dried meats are described (Lo et al. 1980), Process I is not mentioned, probably because the hygienic risks of this process are higher than in Processes II and III.

### *Process II*

Meats made according to this process are beef, pork, or chicken in pieces, cubes or strips. For flavouring, besides 5-spice-powder, other spices are sometimes added, such as curry, chilies, cayenne pepper, ginger, fruit juice, and wine. Many varieties are found in meats made with Process II; however, Lo et al (1980) pointed out that these products are mainly based on beef. In Process II the meat, after removal of the fat, is cut into fairly large chunks and is cooked with 10% water over medium heat until the meat is tender. Then the meat is cooled, drained (liquid retained) and cut into pieces, cubes or strips. To the liquid, sugar, salt, soy sauce, monosodium glutamate, and spices are added, and the mixture is again heated. The meat is placed in a pan with the liquid and stirred over low heat until the mixture is almost dry. Finally, the meat is spread flat on wire racks or plates and dried for several hours at 50 - 60°C or until it has lost about 50% of the original weight. The $a_w$ achieved should be < 0.69 (Shin 1984). According to Lo et al. (1980) such dried meats can be kept in glass jars or metal boxed (to exclude oxygen) for 3-5 months. These authors recommend that the meat be wrapped in paper and heated (inactivation of microorganisms before storing the product in clean containers.

### *Process III:*

Pork processed in this way is called pork floss, shredded pork, meat flakes, or Rou Song in Chinese. In this process lean pork is cut along the grain in pieces and cooked with equal amounts of water until very soft. The meat is drained and the liquid is evaporated to 10% of its volume. To this broth, sugar, salt, soy sauce, wine, monosodium glutamate, fennel, ginger, or other spices are added. The cooked meat is mashed, i.e., separated into fibres, and added to the liquid. The mixture is held at low heat until all the liquid has evaporated. Finally, the flakes are a cottonlike mass and are stirred for several hours at 80-90°C until very dry ($a_w$ < 0.6). To make the

flakes crispy, about 30% of hot vegetable oil is added, and the product is further stirred over low heat until dry and golden brown ($a_w$ < 0.4). Similar products are made from beef, chicken, or fish using the same technology. Singapore imports increasing amounts of pork floss from China, and the imported product is roasted again to make it crispy (ho and Koh, 1984). Pork floss tends to absorb moisture and, therefore, must be stored dry. According to Lo et al. (1980) pork floss, while it is still warm, should be placed into clean glass containers, and thus can be stored for six months without refrigeration.

Chinese dried meats are prepared preferably from hot-bones meat (but chilled meat is suitable too), requiring little energy and only simple equipment for processing. Such meats are storable without refrigeration. However, if not sufficiently dried, the products are spoiled by molds. For dry products, rancidity is the limiting shelf life factor which can be prolonged by vacuum packaging of the products. Our laboratory has published the formulas and processing techniques for six traditional dried meats of China (Shin et al., 1984). Improvements in processing and packaging of dried shredded and sliced pork were suggested by Lin et al. (1980).

To study the physicochemical and microbiological properties of Chinese dried meats we imported 42 commercial samples from Taiway, Singapore, and Hong Kong. At the time of arrival the $a_w$ of these samples was in the range of 0.78-0.20, and the pH-range was 6.2-5.3. We challenged the stability by inoculating portions of the samples with pools of xerotolerant molds of the *Aspergillus glaucus* group, and stored them for 3 months at 25°C. Of the 42 samples tested, 35 (83%) proved stable. These stable meats had an $a_w$ equal to or lower than 0.69, which therefore could be regarded as a critical $a_w$ for Chinese dried meats, which are stored unpackaged and without refrigeration (Shin, 1984). However, Ho and Koh (1984) are of the opinion that the $a_w$ of these products should be decreased to < 0.61 in order to avoid mold growth.

From our investigation of the 35 stable samples (Table 2), it was concluded that such meats, if prepared using Processes I and II, range in $a_w$ from 0.55-0.69, in pH from 5.8-6.0, and contain 20-35% sugar, 3-5% NaCl, and 10-15% moisture. If Process III was used, we observed an $a_w$-range of 0.20-0.59 and a moisture content of 2-12%. Therefore, these foods are in the low-moisture range. The same was true for some products prepared with Process I and II, if they were dried more than required for microbial stability (Leistner et al., 1984; Leistner 1985).

The microbial stability of Chinese dried meats depends primarily on the $a_w$ and the heat-treatment, while the pH is not so important. In Chinese dried meats only few microorganisms are present. This is due to the heating step. From stable imported products we rarely recovered more than $10^4$ microorganisms/g. Most samples were in the range $10^2$-$10^3$/g, which is impressive for uncanned meat products. Shin (1984) conducted inoculation studies using Chinese dried meats prepared in the laboratory and observed that salmonellae, pathogenic staphylococci, yeasts, and molds are eliminated during processing by the heat applied. Enterococci may survive, but die during storage of the products. Spores of bacilli and clostridia also decrease during processing and storage. However, most organisms encountered in imported Chinese meats were bacilli.

Recontamination of Chinese dried meats could easily occur after processing. Therefore Shin (1984) studied the survival of microorganisms inoculated onto imported and reproduced meats. He observed that during storage of stable products the number of organisms decreased, especially in meats close to the critical $a_w$ 0.69 Staphylococci and yeasts decreased rapidly, salmonellae more slowly, and enterococci and bacilli survived best. thus, Chinese dried meats are indeed safe products, because the heat treatment eliminates most organisms present in the raw material, and survivors as well as organisms which recontaminate the product are inhibited or inactivated by the $a_w$ and certain food components (e.g. Maillard products).

Chinese dried meats are easy to prepare and can be processed and stored without refrigeration. Therefore, they could be produced readily in developing countries, especially if Processes II or III are used. The traditional humectants employed, i.e. sugar and salt, are cheap and generally available. In addition, sugar has beneficial effects on the texture and plasticity of dried meats. However, in the Western world the sweet taste of Chinese dried meats, which is an advantage in the Orient, is not readily accepted by many consumers. Therefore, alternative humectants should be tested. From the microbiological point of view Chinese dried meats can be recommended without reservations.

Table 2: Average data of 35 commercial Chinese dried meat products, which proved microbiologically stable

| Product | Process | $a_w$ | pH | Sugar % | NaCL % | $H_2O$ % | $NO_2$ ppm | $NO_3$ ppm |
|---|---|---|---|---|---|---|---|---|
| Pork slices | I | 0.64 | 5.9 | 34 | 3.7 | 13 | 2 | 100 |
| Beef slices | I | 0.62 | 5.8 | 32 | 4.3 | 13 | 2 | 40 |
| Pork cubes | II | 0.66 | 5.9 | 25 | 3.6 | 15 | 3 | 50 |
| Beef cubes | II | 0.59 | 5.9 | 25 | 4.9 | 14 | 2 | 100 |
| Pork pieces | II | 0.57 | 6.0 | 34 | 3.9 | 14 | 1 | 1 |
| Beef pieces | II | 0.63 | 5.9 | 23 | 4.8 | 16 | 3 | 120 |
| Chicken pieces | II | 0.48 | 5.9 | 41 | 4.1 | 7 | 1 | 1 |
| Pork floss | III | 0.40 | 5.8 | 22 | 4.6 | 7 | 1 | 90 |
| Chicken floss | III | 0.48 | 5.9 | 32 | 5.1 | 8 | 1 | 60 |

## CHINESE SAUSAGE (La Chang)

About 1500 years ago Chinese sausage was made with minced goat or lamb meat, mixed with spring onion, salt, bean sauce, ginger, and pepper (Ho and Koh 1984). Today Chinese sausage is made of pork and sometimes heart, tongue or liver is added to special products. Various formulas for traditional Chinese

sausage (called La Chang in Mandarin or Lup Cheong in Cantonese) are found in different provinces of China (Lo et al. 1980), and differ with respect to the percentage of meat, fat sugar, salt soy sauce and wine used (Leistner and Fesel 1986) as well as to the favoured spices. In Canton more sugar, in Harbin more garlic, in Sichuan more watchau and in Taiwan a considerable amount of cinnamon is added to La Chang. Colouring agents (Angkak or Ponceau 4R) are sometimes used. The technology employed in the processing of traditional Chinese sausage is similar throughout all of China (Lo et al. 1980) and is also used by other Chinese communities of Asia, e.g. in Singapore (Ho and Koh 1984) and Malaysia (Savic 1985). La Chang may be prepared in the home or by small manufacturers, because only simple equipment and installations are needed. Traditional Chinese sausage is a raw but nonfermented product with an $a_w$ in the intermediate-moisture range; and therefore La Chang may be stored for 1-3 months without refrigeration.

La Chang is made from hot-boned, coarsely ground pork (preferably ham) and pork fat, mixed with sugar, salt, soy sauce, Chinese wine (Mei Luei Lu Chiew), saltpeter (Potassium nitrate), 5-spice-powder (anise, cinnamon, clove, fennel, watchau), and monosodium glutamate. Sometimes up to 25% water is added, so that after drying the sausage will have the desired wrinkled appearance (Ho and Koh, 1984). The batter is filled into small intestine hog casings; which are tied at about 15 cm intervals. the strings used are different colours, which indicate the quality of the product. The filled casings are punctured thoroughly to enable the escape of entrapped air and water vapour during the drying process. La Chang is dried for 1-2 days at 45-50°C over charcoal, and thereafter kept for 2-3 days at room temperature for equilibration of moisture. La Chang should look reddish-brown and fat-speckled; most famous is the Cantonese variety (Lup Cheong) with the wrinkled appearance nd sweet taste. Although processed and stored as a raw sausage, the product is always warmed before consumption and is eaten hot. It is often sliced and fried or steamed with rice, noodles or various vegetables. Due to the intense aroma of La Chang, which is also named Xiang Chang ('good smelling sausage'), a few slices are sufficient to flavour an entire dish.

The microbial stability of traditional Chinese sausage is due mainly to the rapid reduction of $a_w$ (Leistner and Dresel, 1986), and this is aided by the addition of salt (2.8-3.5%) and sugar (1-10%), the thin caliber of the casing (16-28 mm), and a high ripening temperature (45-50°C) at low relative humidity (65-75%). On the other hand, the pH is not important for stability, because it is relatively high (5.7-5.9).

We have investigated the traditional Chinese Sausage by visiting production facilities in Taiwan, Singapore and Malaysia and by importing 24 samples (each consisting of several sausages) of La Chang from different countries, including the Peoples Republic of China, Taiwan and Singapore. Furthermore, we reproduced the La Chang in our laboratories and challenged the stability of this product with food-poisoning and spoilage organisms (Leistner and Fesel 1986). Table 3 indicates the physicochemical data of the investigated samples. The usual $a_w$ and pH were 0.75 and 5.9, respectively. However, we observed considerable variation in physical properties among the samples. Variation was even greater for the chemical characteristics. Apparently the composition of La Chang made by different manufacturers varies widely, especially with respect to an unnecessary overdosing of saltpeter (nitrate), which occurs frequently. Ho and Koh (1984) observed similar pH values and levels of salt, nitrite, and nitrate in La Chang samples obtained in Singapore; however, they reported much lower $a_w$-values (0.6-0.7) than we found. This is probably due to the characteristics high sugar content (15-20%) in Chinese sausages from Singapore.

Table 3: Physicochemical properties of 24 commercial samples of La Chang, imported from different countries

| Criterion | Minimal | Maximal | Modal |
|---|---|---|---|
| pH | 5.6 | 6.3 | 5.9 |
| $a_w$ | 0.57 | 0.87 | 0.75 |
| NaCl (%) | 2.5 | 10.9 | 4.5 |
| Na-$NO_2$ (ppm) | 1 | 215 | 30 |
| K-$NO_3$ (ppm) | 16 | 11350 | 500 |

In spite of the wide variation in the physical and chemical characteristics, the microbiological properties of our 24 La Chang samples were favourable. In general, the total bacterial count (mainly *Micrococcaceae*) and the number of lactic acid bacteria were in the range $10^5$ - $10^6$ and $10^4$ - $10^5$ per gram, respectively. *Enterobacteriaceae* and *Staphylococcus aureus* were virtually absent in these samples. Therefore, the bacteriological status of La Chang is good and provides no risks. If traditional Chinese sausage spoils, it is due to an insufficient drying and is caused by a vigorous growth of Gram-positive bacteria, especially lactic acid bacteria, which lead to a sour product. Even though La Chang is a raw sausage, a fermentation is undesirable, because Chinese consumers object very much to a sour taste in sausages. Molds, which can grow on the surface, are another spoilage problem if La Chang is not vacuum packaged. Of the food-poisoning bacteria only *S. aureus* is of concern for traditional Chinese sausage (Leistner et al. 1984; Leistner and Dresel 1986). However, this risk can be avoided by properly drying the product.

The $a_w$ of La Chang must be decreased within 12 h to $<0.92$, and within 36 h to $<0.90$. This is achieved by drying the product for 36 h at 48°C and 65% relative humidity (Leistner and Dresel 1986). If the drying is not done over charcoal, then the product should be lightly smoked for several hours at 48°C and 65% relative humidity. Subsequently the product should go through an equalisation time of 3 days at 20-25°C and 75% relative humidity, until the $a_w$ is $<0.80$; the sausage is then ready for shipment. Vacuum packaging of the final product is recommended since it improves the flavour of the sausage

during storage and inhibits mould growth (Leistner 1987a).

Leistner and Dresel (1986) developed two standardised formulas for Chinese sausage by using the same technology but different ingredients for the products. Ho and Koh (1984) suggested a standardised formula for La Chang consumed in Singapore. Traditional Chinese sausage can generally be recommended for the preservation of meat in developing countries, because it is simple to prepare, stable and safe. The principle used in the preservation of La Chang, i.e., the quick decrease of $a_w$, is also of interest to industrialised countries, since this product demonstrates that raw sausage of small diameter may also be successfully processed at 48°C and 65-76% relative humidity.

### PRESSED DUCK (Ban Ya)

The making of Ban Ya has a history of several hundreds years. Already in the old days pressed ducks were given by high officials to the royal family as a gift during the Chinese New Year celebrations, and still today it is a precious present at this occasion (Lü et al. 1985). Most famous is the Nanking Ban Ya of Canton, but also the Nan An pressed ducks of the Jiangxi province are well known. Whereas the breeds of ducks used for Ban Ya differ, the technology of processing is similar throughout China.

In Jiangxi cross breed 'Big Gunny Ducks' are generally used for Na An pressed ducks. These birds are medium in size, the head is quite big and the neb bluish, which is important because neck and head are left on the product. This skin of these ducks is rather thin, white and has small follicles, which makes this breed suitable for Ban Ya. The 'Big Gunny Ducks' are fed 90-100 days and then are put on a rice diet for 28-30 days (Zhou et al. 1987). According to Lü et al. (1985) there are five grades of Ban Ya depending on the weight of the carcass; the special grade has more than 3.25 kg and lowest grade less than 2 kg.

The ducks are not fed 12-14 h before slaughter, the bleeding should be thorough and scalding is done immediately with 60-70°C hot water. The wings and the feed as well as the lower jaw with the tongue are removed. The ducks are cut open, the organs are taken out, and on both sides the rips are cut of the spine, without damaging the muscles, in order to get a circular shaped product (Zhou et al. 1987).

The carcasses are diligently cleaned and then rubbed with salt and spices. The dry curing procedure is repeated three times with intervals of 8-12 h; it is important that the skin is not damaged during this process. Thereafter, the birds are placed for 12 h in a cover brine with salt and spices. After salting the ducks are rinsed with water (40-50°C) in order to remove excess salt and dirt. Now the birds are shaped again and flattened up by dislocating the thigh and wing bones, because the appearance of a Ban Ya is very important and a flat product facilitates the drying process. After the carcasses have been dried for 4-6 h on a wooden board their shape is well fixed. Finally the ducks are hung up on strings and will be further dried for 5-7 days at 30°C and intermittently at 50°C. If the muscles appear light red, the skin yellowish and the Ban Ya has developed a pleasant aroma it is ready for shipping (Zhou et al. 1987).

Pressed ducks are only produced at certain times of the year. Lo et al. (1980) as well as Lü et al. (1985). makes a distinction between La Ban Ya (processed from November to February, i.e. from October to December according to the Chinese calender) and Spring Ban Ya (processed from February to the middle of April). The La Ban Ya has a shelf-life of 4-6 months without refrigeration, but the Spring Ban Ya only of 3-4 months.

The technology of Ban Ya has been described in detail (Zhou et al. 1987), and it is general knowledge that the shelf-life of this intermediate-moisture food is limited by mould growth and/or rancidity. However, little is known about the physicochemical and microbial data of this traditional Chinese meat product and the stability and ricks by using inoculation studies have not been determined either. Work in this direction is now in progress in our laboratories.

### CHINESE BACON (La Rou) AND HAM (Ho Tui)

Many Chinese have heard of bone-in hams (Ho Tui) made from the hind leg of hogs, but relatively few have eaten it, because Chinese ham is expensive and manufactured in specialised plants only. On the other hand Chinese 'bacon' (La Rou) is common and produced often in the home during the winter season. There are several types of La Rou, which are made from pork, but sometimes also from beef or lamb (Lü et al. 1985). For La Rou the meat is cured (dry or wet) and then dried by air, in an oven or by smoke. Most common is 'La Meat' which is dry cured with salt, sugar, spices (e.g. 5-spices-powder), wine and potassium nitrate. Pork is used with the rind and should contain about 50% fat. It is rubbed twice at intervals of 3-4 days with the salt mixture, which afterwards is washed off. Then 'La Meat' is dried in an oven at 40-55°C for 4-5 h and the further drying is done in the air or in light smoke. The finished product is wrapped with paper and may be stored in rice or big beans up to 2 years without refrigeration. Another variety is 'Soy Meat' typical for Pekin. This meat (preferably from the ham) is first covered with soy sauce, salt and 5-spice-powder, and after one day the product is pressed for 4-5 days. The 'Soy Meat' is dried on the air (Lü et al. 1984). Although all Chinese 'bacon' is produced and stored in the raw state, it is always eaten after heating; often cooked in a soup, e.g. together with radish.

Raw hams (Ho Tui) are produced in China for about 1000 years in different provinces, and they have been exported to Japan, India and other Asian countries since several hundred years. Most famous are th Jing Hua Ho Tui from Zhejiang province and the Ho Tui from Yunan province. These Chinese hams need at least 10 months to produce and have a shelf-life of about 3 years. The technology used and the quality obtained are similar to classical raw hams of Europe, e.g. Prosciutto di Parama, Prosciutto di San Daniele, Jamon Serrano, and America, e.g. Virginia Ham (Leistner, 1986). The processing of Jing Hua ham has been described by Lo et al. (1980) in detail and can be summarised as follows:

Hams should be used 24 h after slaughter and have a weight of about 607 kg, they should not be too fat, have a thin skin and a pleasant appearance, because the shape

is very important for Chinese Ho Tui, for which the entire ham including feed is used. The hams are dry cured in the cold season with salt and potassium nitrate, and these curing salts are applied 6-7 times on the meat side of the hams with intervals of about 7 days. During the curing process (35-40 days) the hams are piled up in 12-14 layers and are repacked at every salting interval. After curing the hams are soaked for 2 h in warm water, thereafter they are hung-up for 8 h in the sun for drying. Then the hams are carefully shaped, and it is considered important that the leg is straight and the hoof is sickle-shaped. The exposure to the sun and the shaping of the hams are continued for 4-5 days. Now a ripening and further during period starts which should lead to the desired aroma and texture of the product. Since the hams are already by a reduced aw he warm season of the year is suitable for the ripening process. The occurrence of green molds is considered desirable, whereas yellow molds would indicate an insufficient drying. The finished products should have lost 30% of their initial weight and they are graded according to appearance and saltiness. Ho Tui is eaten always cooked or steamed and never raw.

Apparently the Chinese hams have not yet been investigated from a scientific point of view, because information on their physicochemical and microbial data are not available.

## EDIBLE BY-PRODUCTS (miscellaneous Yan La products)

Tongue, heart, liver, kidneys pig heads or tails are considered in China even more precious than meat. Generally these items are made shelf-stable by curing and drying, and they are eaten at special festivals or ceremonies (Lo et al. 1980; Lü et al. 1985).

## CONCLUSIONS

Chinese meat products which are common in the Orient have a long tradition and apparently are shelf-stable and safe if properly processed. The huge practical knowledge about these foods has until now little back up by scientific investigations. However, a better understanding of the principles of the empiric processes used could lead to improved products in the Orient and new ideas for food design in the West. Thus a close cooperation in this area could be indeed a two-way street (Leistner 1987b).

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