

MICROBIOLOGICAL STABILITY IN THE MANUFACTURE OF CHINA BACON(LA ROU)

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ABSTRACT: China Bacon, so called La Rou, is one of the most traditional and well-known meat products in China. It sure has a history of more than one thousand years. Although there is a lot of information on the production of China Bacon, no reports on its microbiological stability have been found up to now. It is author's aim to examine the microbiological changes, including total bacterial count, *Pseudomonas*, *Micrococcus*, lactic acid bacteria, Enterobacteriaceae, *S. aureus*, *Salmonella* and yeasts molds during the processing of China Bacon in our laboratory.

The results show that the microflora of the raw material consists largely of bacteria. Most abundant are *Pseudomonas*, followed by lactic acid bacteria and *Micrococcus*. Enterobacteriaceae and yeasts and molds are few. In the finished product, however, all above organisms are almost undetectable, because of the heat treatment the product receives at the end of the curing phase(4-5 hours at 40°C and 43-44 hours at 55°C).

Samples of China Bacon were inoculated with *Salmonella* or yeasts and molds. Two other samples were separately inoculated with different counts of *S. aureus*. The experiments show that *Salmonella* and yeasts and molds can be inactivated in normally heated China Bacon, but *S. aureus* can grow and multiply. Nevertheless, when China Bacon was heated at 50°C for 4-5 hours, and then at 60°C for 43-44 hours, *S. aureus* counts were reduced to only 10⁷ cells/g.

The pH value, a_w value and NaCl content were also measured. The a_w value of the finished product is significantly lower(p<0.001) than that of fresh pork, and the concentration of NaCl in the finished product is as high as 9.2%. The pH value, on the other hand, didn't change significantly (P>0.05) during the manufacturing process.

All results suggest that the low a_w is essential for China Bacon as a microbiological stable meat product during storage without refrigeration. *S. aureus* can be the greatest microbiological risk under normal processing conditions, but it is possible to produce safe and stable China Bacon by traditional technology

SUMMARY: China Bacon is simple to produce by normal curing and heating enable it to a microbiological stable meat product even the raw material contains high bacterial count.

The stability of China Bacon is achieved mainly by lower a_w-value through curing, drying and heating (50-60°C for 2 days) at the end of curing time. Most undesirable microorganism including *Salmonella* are inactivated by this technology. However *S. aureus* can still be of problem if the product is not enough intensively heated at the end of curing (50-60°C for 2 days).

China Bacon contains much salt in its finished product(about 10%), but it is not considered unpleasant since China Bacon is always eaten with plain rice and vegetable. The high NaCl caused the low a_w-value in the finished product and is essential for China Bacon as a microbiological stable meat product during storage without refrigeration.

We can make the conclusion that it is possible to produce safe and stable meat product by traditional technology.

INTRODUCTION: China Bacon, so called La Rou, is one of the most traditional and well-known meat product in China. It sure has a history of more than one thousand years. The production of China Bacon is simple and cheap. It is generally produced at homes in the coldest season of every year(L.LEISNER, 1988). China Bacon is made from pork belly. The method of processing and the spices used are somewhat different in different provinces. But main procedure is the same, including curing, drying and heating (C.X.LU et al, 1980). The most popular ones are Guang, Chuan and Xiang types(M.L.LI et al, 1985).

MATERIAL AND METHODS:

technology of China Bacon: The pork belly (purchased from Kulmbach, Germany) is cut into rectangle strips (8cm X 40cm), dry cured with salt, nitrate, sugar and spices. Then it will be heated and hanged to dry (C.X.III et al, 1980). By the finished product, the lean meat should be bright red and golden brown in colour, and the fat appears milk-white and shining. China Bacon is always eaten cooked or steamed. It should be firm, smooth and a little elastic in texture, and has a typical La flavour (similar to wells ripened air dry ham).

For 100kg pork belly, one needs:

Salt	800g
Nitrate	50g
Spirit (clear)	150g
China pepper (Wachau)	100g
5 spice powder*	100g
Sugar	as desired

* 5 spices powder contains anise seed, fennel, clove, cinnamon and China pepper.

All ingredients well mixed, apply mixture on each pork strip, then put strips in a container in layers with the skin side down (top layer with the skin side up). Pour the rest of the seasoning mixture on the surface of the pork strips again. After a total curing time of 10 days, China Bacon is taken out of container and washed with warm water. Hang China Bacon in an airy room for some hours to dry, then hang them in a heating room with temperature of 40°C first for 4-5 hours, and gradually increased to 55°C. The total heating time needs about 48 hours. Then hang China Bacon in an airy place for further drying.

microbiological analysis:

We have made 5 production according to the above technology in our laboratory. Microbiological stability are investigated. The first production is finished in common processing condition. Other is inoculated with *Salmonella* or yeasts and molds. Another two production are inoculated with different count of *S. aureus*, respectively.

According to schedule, 20g sample is taken aseptically at random on 0, 1, 5, 6, 9, 10 and 12 days during the entire processing. Each sample is placed in a aseptical plastic bag containing 180ml of sterile 0.85% saline buffer and shaken for 10 minutes (Stomacher, Germany). Appropriate dilutions are made with sterile 0.85% saline buffer.

Total bacteria, as well as *Pseudomonas* counts are made on Standard I Agar (MERCK) with incubation at 30°C for 48 hours. For the enumeration of Lactic acid bacteria and *Micrococcus*, MRA Agar (MERCK) are used following incubation at 30°C for 48 hours. For the detection of *Salmonella* and Enterobacteriaceae, D11 Agar (MERCK) are used, and the plates are incubated at 30°C for 48 hours. *S. aureus* counts are made on MSEY Agar following incubation at 35°C for 48 hours. Molds and yeasts counts are made on Malt Extract Agar (MERCK) following incubation at 25°C for 5 days.

Meanwhile, the a_w -value is measured by ISO apparatus with NOVASINA sensors. The concentration of NaCl is determined by titration.

RESULTS AND DISCUSSION:

change of the a_w -value, pH-value and the concentration of NaCl during the processing:

The a_w -value, pH-value and the concentration of NaCl are measured on the scheduled days. Their results are shown in Table I.

Table I

The average a_w -value of fresh meat is 0.994, but the a_w -value has significantly lowered to 0.982 after the first day of dry curing ($P < 0.01$). The a_w -value is stabilized during the total curing period, except the first day. Even after washing at the end of curing period, the a_w -value doesn't apparently changed ($P > 0.05$), compared with the a_w -value during the curing period. After two days heating, the a_w -value

is remarkably lowered ($P < 0.01$), so that the a_w -value in the finished product reaches 0.703. However the pH-value doesn't change so much ($P > 0.05$) during the whole curing and heating period. The NaCl concentration is during curing from 6.5% increased to 8.4% and in the finished product even reaches 9.2% due to decreased water content.

Sensory evaluation has been done on two weeks ripened product:

- 1) Soak bacon in cold water for 2 hours, then sliced in thin slices and steamed.
- 2) Wash bacon with cold water, then cooked it in whole piece in water for 1 hour with small flame. Then sliced into small slices.

The taste and the flavour are satisfied in both cases. The relative high salt content isn't unwanted, because bacon is always eaten with much plain rice and vegetables. Vacuum packaged product hasn't much difference in taste when compared with the unpackaged product. Only the flavour is better and more typical in unpackaged product due to more fat oxidation. Probably, after longer storage, the vacuum packaged bacon will have better flavour than the unpackaged one.

microbiological stability of china Bacon:

From the beginning of the curing period and curing time and after heating stage and also in the finished product, we have done total bacterial count on all 5 production: *Pseudomonas*, *Micrococcus*, lactic acid bacteria, Enterobacteriaceae, yeasts and molds. We inoculate bacon in one production with *Salmonella* or with yeasts and molds. We inoculate bacon with *S. aureus* in two other production. Obviously, *S. aureus* is the most microbiological risk for China Bacon, since it can still grow and multiplied in a relative low a_w -value ($1.3 \times 10^3/g$) in the normally heated bacon (4-5 hours by $40^\circ C$, 43-44 hours by $55^\circ C$). However it only has $10^2/g$ after the improved heating condition ($50^\circ C$ for 4-5 hours, then $60^\circ C$ for 43-44 hours).

Our findings show that the total bacterial count on the fresh meat in all 5 production lay in 10^5 - $10^7/g$, and also not much have changed during the entire curing time. However, it has reduced tremendously after heating. The total bacterial count contained most *Pseudomonas*, then following by lactic acid bacteria and *Micrococcus*. Enterobacteriaceae, as well as yeasts and molds proved to be very few in the non-inoculated bacon (Figure I).

One production is inoculated with $8.9 \times 10^4/g$ *Salmonella*, the bacterial count is only slightly decreased during the curing time ($1.7 \times 10^4/g$). But after the normal heating processing, its count has decreased to $10^2/g$. Therefore, China Bacon is a safe meat product as far as *Salmonella* is concerned. In a further production, fresh bacon is inoculated with yeasts ($2.2 \times 10^4/g$) and molds ($2.1 \times 10^4/g$) and they also did not change much during the curing period, but they are rapidly decreased after normal heating (Figure II). Furthermore, the a_w -value of the finished is about 0.686 and molds will not likely to grow in this condition by China Bacon, just as by China dried meat (a_w under 0.690) (Shin, 1984). Therefore China Bacon is a safe meat product as far as molds is concerned.

Two production of are inoculated separately with two different count of *S. aureus*. The first with *S. aureus* $1.9 \times 10^3/g$, it has slightly increased during the curing time, even after normal heating, the bacterial count is still very high ($1.3 \times 10^3/g$). Obviously normal heating isn't sufficient to inactivate *S. aureus*. The second is inoculated with a higher number of *S. aureus* ($1.7 \times 10^3/g$). After by the improved heating condition (4-5 hours for $50^\circ C$, 43-44 hours for $60^\circ C$), *S. aureus* is rapidly decreased to $10^2/g$ (Figure III). The higher temperature of heating has proved no significantly change in neither taste nor flavour of the product.

REFERENCE

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TABLE I : Change of aw-value, pH-value in the manufacture of China Bacon

Days	0	1	5	6	9	10	12
pH	6.30±0.26a*	5.65±0.06a	5.66±0.19a	5.69±0.17a	5.70±0.24a	5.56±0.23a	5.75±0.19a
aw	0.994±0.0001a	0.892±0.019a**	0.887±0.032b	0.884±0.023b	0.886±0.028b	0.889±0.014b	0.703±0.010d

* Mean values in a line followed by different letters were significantly different ($P < 0.01$)

** Mean values in a line followed by same letter were no significantly different ($P > 0.05$)

