DEVELOPMENT A METHOD TO MANUFACTURE FERMENTED BEEF JERKY AND COMPARISON THE QUALITY CHARACTERISTICS BETWEEN TRADITIONAL CHINESE AND FERMENTED BEEF JERKY

L. H. Yu*, M. Zhang, Z. W. Meng, R. H. Zhang, S. Q. He, Y. An

College of Food Science, Heilongjiang Bayi Agricultural University, Daqing, Heilongjiang, China

Abstract – The objective of this study was to investigate quality of fermented beef jerky produced by fermentation method, and compare the quality characteristics of fermented beef jerky with the traditional Chinese beef jerky. The fermentation parameters were determined through three sequential experiments monitoring the pH drop. The optimal fermentation process is as follows: fermentation temperature was 15 ^{o}C, the concentration of the glucose was 0.8%, the size of inoculums of start cultures were *Lactobacillus sakei* 10^7 CFU/g and *Staphylococcus caunosus* 10^6 CFU/g. In the drying condition, the water content of fermented beef jerky was lower than that of traditional Chinese beef jerky ($P < 0.05$). The results obtained from instrumental methods and sensory evaluation suggested that the color and tenderness of fermented beef jerky was better than that of traditional Chinese beef jerky. It is possible to manufacture of fermented beef jerky with minced beef by added start cultures.

Key Words – fermentation technology, minced beef, pH, start cultures

I. INTRODUCTION

Jerky is one of the oldest meat products. Today, some products are still produced according to the traditionally methods. For example, niuganba (a dry, cured beef) is produced in Yunnan Province of China, and 'Cecina' in Spain and Mexico; and 'Charqui' in Brazil. As a snack of food, jerky is highly accepted in different parts of the world.

Jerky has traditionally been made from sliced whole muscle of large animals (e.g. beef and pork) which have been marinated and dried. Artificial intervention is necessary in some procedures resulting in low production efficiency (Zhou, 2008). Recently, it was started using mechanized production to produced the jerky by re-structured and re-formed by minced beef.

Microbial succession of Spanish cecina (a salted dried and smoked beef meat product) during ripening was investigated, and the results indicated that *Micrococcaceae* constituted the predominant flora both on the surface and in the interior of the pieces throughout the curing period. (García, et al. 1995). Pinto (2002) examined the role of bacteria for some sensorial properties development in Charqui meats (Brazilian traditional salted and sun-dried beef products), and the results suggested that charqui meat is a fermented meat product. Sindelar (2010) applied vegetable juice/powder combined with a nitrate reducing starter culture to manufacture uncured, no-nitrate/nitrite-added whole muscle jerky. In china, there are many reports on fermented beef jerky, but the starter cultures used consisted lactic acid bacteria (LAB) only.

However, up to now, there is no report on applying bacterial pure cultures (*Lactobacilli* combined with *Staphylococcus*) to produce beef jerky. Therefore, the purpose of this study was to investigate the feasibility of using bacterial pure cultures in the production of fermented beef jerky, and compares physicochemical properties of fermented beef jerky with traditional Chinese beef jerky.

II. MATERIALS AND METHODS

2.1. Starter cultures

Lactobacillus sakei subsp. *sakei* (GIM 1.294) and *Staphylococcus. caunosus* (GIMT 1.044) were purchased from Guangdong culture collection center. Freeze-dried *L. sakei* was inoculated in MRS broth and *S. caunosus* in MSA broth, and incubated in static conditions for 24 h at 30 ^{o}C. The cultures were centrifuged twice (2000 × g for 10 min), with an intermittent washing step in sterile normal saline. They were then kept in phosphate buffer (pH 7.4) until they were used.

2.2 Fermentation parameters

In order to determine the optimal fermentation parameters, three sequential experiments were performed.

1) The glucose concentration was 1% (w/w, based on the initial weight of beef). The size of inoculum does for *L. sakei* was 10^7 CFU/g. The fermentations were preceded at three temperatures (15, 22.5, and 30 ^oC).
2) At the selected fermentation temperature, the size of inoculum does of *L. sakei* was 10^7 CFU/g. The fermentations were performed under various glucose concentrations (0.6, 0.8, 1.0, and 1.2%, w/w, based on the initial weight of beef).
3) Based on the above experimental results, the size of inoculum does of *L. sakei* was determined through observing the effect of different level (10^6, 10^7 and 10^8 CFU/g) on the pH.

2.3 Preparation of jerky

The raw material was beef bottom rounds obtained from a local supermarket. All external fat and visible connective tissue were removed. The pH of beef was 5.6–5.8. The nonmeat ingredients included 6% water, 1.6% salt, 0.8% sugar, 0.015% sodium nitrite , 0.03% sodium erythorbate, 0.12% onion powder, 0.16% garlic powder, 0.06% ginger powder, 0.2% five spices powder, 5% D-sorbitol, 0.1% potassium sorbate(based on raw meat weight; w/w).

The traditional Chinese-style beef jerky processing was carried out as follows: freezing → slicing (3 mm thick) → seasoning → curing (4 ^oC, 24 h) → drying. The fermented beef jerky was manufactured. The trimmed beef was comminuted using a meat grinder with a mesh size of 4 mm. Then seasoning, fermentation, reformed into 200 × 60 × 3 mm^3 schistic, then drying. All jerky were cooked in a thermal processing oven at 80 °C for 30 min, and then dried for 2 h at 60 °C.

2.4 Comparing the properties of the jerky

Processing yield was determined by calculating the weight differences of jerky before and after drying. Moisture content was determined according to GB/T 9695.15. Water activity was determined using a water activity meter. The color of jerky samples was measured with Chroma meter. The pH was measured according to Yang (2009). Shear force (N/cm^2) was determined using a texture analyzer with a V-shaped shear blade. Sensory evaluation was performed by a 12-member untrained panel according to a modified procedure of Choi (2008).

2.5 Statistical analyses

Statistical analysis was performed for all measurements using the Statistical Analysis System (SAS Institute, 1999). The Duncan's multiple range test ($P < 0.05$) was used to determine differences between means.

III. RESULTS AND DISCUSSION

Fermentation temperature significantly influences the pH value in the fermentation process. It is need 48 h to decrease pH value to 5.3 at 15 ^oC. At 22.5 ^oC, 24 h lower to 5.05, and 30 ^oC, the pH decreased to 5.15 in 12 h. In this study, the lactic acid bacteria was *L. sakei*, it can breeding under lower temperature. Additionally, rapid decrease in pH has a detrimental effect on *Staphylococcus.* Therefore, 15 ^oC was selected as the fermentation temperature.

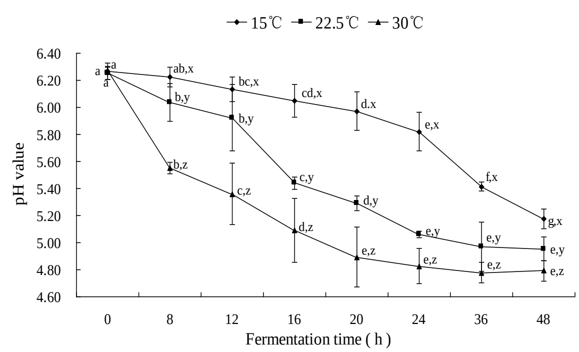

Figure 1. The effect of fermentation temperature on the pH value of beef mince

Fermentation temperatures were 15, 22.5 and 30 ^oC; the glucose concentration was 1%; the size of inoculum does for *L. sakei* was 10^7 CFU/g. $^{a-c}$ Means with different letters marked on the different fermentation time are significant difference ($P < 0.05$). $^{x-z}$ Means with different letters marked on the same time different fermentation temperature are significant difference ($P < 0.05$). Vertical lines represents standard deviations.

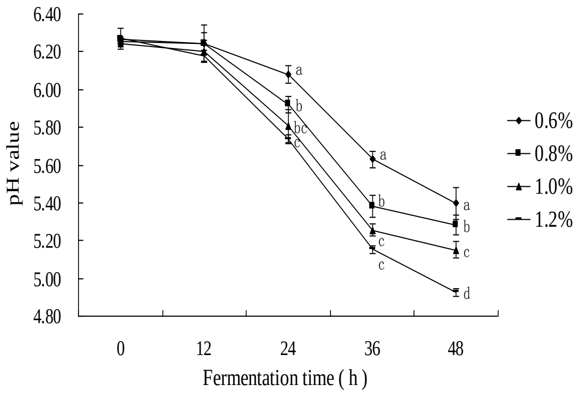

Figure 2. The effect of concentration of glucose on the pH value of beef mince
The glucose concentration were 0.6, 0.8, 1.0 and 1.2%; fermentation temperature was 15 ^{o}C; the size of inoculum does for *L. sakei* was 10^7CFU/g. $^{a\text{-}c}$ Means with different letters marked on the same time different glucose concentration are significant difference ($P < 0.05$). Vertical lines represents standard deviations.

Glucose is commonly added to sausage mince as fermentation substrates for the lactic acid bacteria because the natural content of glucose in the raw material is too low and variable to be reliable (Stahnke et al, 2007). Glucose is converted into lactic acid by lactic acid bacteria and the pH value of the mince drop. Added 0.8% glucose in the mince, the pH value decreased to 5.15. Therefore, 0.8% glucose was determined.

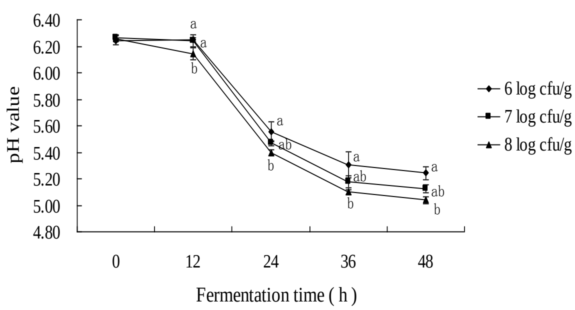

Figure 3. The effect of size of inoculum of *L. sakei* on the pH value of beef mince
The size of inoculum does for *L. sakei* were 6, 7, 8 log CFU/g; fermentation temperature was 15 ^{o}C; the glucose concentration was 0.8%. $^{a\text{-}c}$ Means with different letters marked on the same time different size of inoculum does are significant difference ($P < 0.05$). Vertical lines represents standard deviations.

In order to let the desired microorganism dominate the fermentation stage, appropriate amount of start cultures is necessary. The level to be added to meats depends on the growth potential of the organisms in the product (Lücke, 2000). During the whole course of fermentation, there is no significant difference between 10^6 and 10^7 CFU/g. At 12 h, the pH of 10^8 CFU/g is lower than 10^7 CFU/g ($P < 0.05$). But, there is no significant difference between 10^7 and 10^8 CFU/g. The results suggested that high level of inoculum affect the rate of the pH drop at the beginning fermentation, but have no effect on the final pH. After 12 h, the pH of 10^6 CFU/g is higher than 10^7 CFU/g ($P < 0.05$), it is seems like some glucose was consumed by natural flora producing other metabolic products than lactic acid. Thus, 10^7 CFU/g was selected.

Table 1 The cook yields, physicochemical characteristics, color, and sensory properties of traditional Chinese beef jerky and fermented beef jerky

Traits	T-1	T-2
Cook yields (%)	32.73 ± 0.57^a	30.07 ± 0.62^b
Physicochemical characteristics		
Water content (%)	17.07 ± 0.36 ^{a}	14.30 ± 0.14 ^{b}
Shear force (N/cm^2)	96.51 ± 2.21 ^{a}	75.04 ± 4.28 ^{b}
Water activity	0.67 ± 0.00 ^{a}	0.63 ± 0.00 ^{b}
pH	6.08 ± 0.04 ^{a}	5.29 ± 0.03 ^{b}
Color		
*L**	30.84 ± 0.35	30.97 ± 0.17
*a**	9.65 ± 0.11 ^{b}	12.42 ± 0.42 ^{a}
*b**	2.98 ± 0.16 ^{b}	4.21 ± 0.13 ^{a}
Sensory properties		
Color	7.6 ± 0.26 ^{b}	9.0 ± 0.39 ^{a}
Flavour	8.6 ± 0.76 ^{b}	9.0 ± 0.97 ^{a}
Tenderness	6.7 ± 0.34 ^{b}	8.2 ± 0.27 ^{a}
Chewiness	9.8 ± 0.22 ^{a}	7.2 ± 0.54 ^{b}

T-1: Traditional Chinese beef jerky; T-2: Fermented beef jerky; $^{a–c}$ Means with different superscript small letters in the same row differ significantly ($P < 0.05$).

Cook yields of traditional Chinese beef jerky (T-1) and fermented beef jerky (T-2) were 32.73% and 30.07% respectively. And the water content of T-1 was higher than that of T-2 ($P < 0.05$). These results indicated that under the same drying condition, T-2 is easier to dry than T-1. Maybe the reason is that the pH of T-2 dropped to close to the isoelectric point of myofibrillar proteins (Ammor et al. 2007), and the water holding capacity decreased simultaneously during the fermentation.

Commonly, the more water content makes the jerky softer. But in this work, we found that the shear force of T-2 was lower than that of T-1 ($P < 0.05$), while the water content of T-1 was higher than that of T-2. This result suggested that the tenderness of fermented beef jerky was improved.

The most important sensory attributes of jerky are colour, texture and flavour (Albright et al. 2000), which determine the consumer's choice. No significant differences was observed between T-1 and T-2 in L^* value. But T-2 have higher a^* value and b^* value, this means that the color of T-2 was more attractive to the consumer. And the sensory evaluations demonstrated that this suppose was true. The deficiency of fermented beef jerky was only the sensory evaluations score of chewiness was lower than that of traditional Chinese beef jerky. This result may be due to the beef which used to manufacture fermented beef jerky was minced.

IV. CONCLUSION

In this work, start cultures were added to minced beef to manufacture fermented beef jerky. And the optimum fermentation parameters were determined: fermentation temperature was 15 ^{o}C, the concentration of glucose was 0.8%, and the size of inoculums of starter cultures was *L. sakei* 10^7 CFU/g and *S. caunosus* 10^6 CFU/g respectively. Fermented beef jerky was easier dried than traditional Chinese beef jerky. And the lower of water activity and pH indicate that it has a long shelf-life. Additionally, the color of fermented beef jerky was more attractive. Except for the chewiness, the other sensory properties of fermented beef jerky were better than that of traditional Chinese beef jerky.

ACKNOWLEDGEMENTS

This research was supported by the bureau of technology (SCX2008-03-1), Daqing, Heilongjiang, China.

REFERENCES

1. Zhou, G. H. (2008). Meat Science and Technology. Beijing: China Agriculture Press. (*In Chinese*)
2. Sindelar, J. J., Terns, M. J., Meyn, E. & Boles J. A. (2010). Development of a method to manufacture uncured, no-nitrate/nitrite-added whole muscle jerky. Meat Science 86: 298–303.
3. Toldrá F., Hui, Y. H., Astiasarán I., Nip, W. K. (2007). Handbook of Fermented Meat and Poultry. Oxford: Blackwell.
4. García, I., Zumalacárregui, J. M. & Díez, V. (1995). Microbial succession and identification of Micrococcaceae in dried beef cecina, an intermediate moisture meat product. Food Microbiology 12: 309-315.
5. Pinto, M. F., Ponsano, E. H. G., Franco, B. D. G. M. & Shimokomaki, M. (2002). Charqui meats as fermented meat products: role of bacteria for some sensorial properties development. Meat Science 61: 187–191.
6. Yang, H. S., Hwang, Y. H., Joo, S. T., Park, G. B. (2009). The physicochemical and microbiological characteristics of pork jerky in comparison to beef jerky. Meat Science 82: 289–294.
7. Choi, J. H., Jeong, J. Y., Han, D. J., Choi, Y. S., Kim, H. Y., Lee, M. A., Lee, E. S., Paik, H. D. & Kim, C. J. (2008). Effects of pork/beef levels and various casings on quality properties of semi-dried jerky. Meat Science 80: 278–286.
8. SAS (1999). Applied statistics and the SAS programming language. Cary, NC, USA: SAS Institute INC.
9. Stahnke L. H. & Tjener K. (2007). Influence of Processing Parameters on Cultures Performance. In F. Toldrá, Handbook of fermented meat and poultry (pp 187–194). Iowa: Blackwell Publishing.
10. Lücke, F. K. (2000). Utilization of microbes to process and preserve meat. Meat Science 56: 105-115.
11. Ammor, M. S., & Mayo, B. (2007). Selection criteria for lactic acid bacteria to be used as functional starter cultures in dry sausage production: An update. Meat Science 76: 138−146.
12. Albright, S. N., Kendall, P. A., & Sofos, J. N. (2000). Sensory properties of beef jerky processed under various conditions. In Proceedings of IFT annual meeting, 10–14 June 2000, Texas, USA.