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STUDIES ON CHARACTERISTICS OF RAW CURED MEAT PRODUCT(SI-RAW) FERMENTED WITH LACTIC ACID BACTERIA

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INTRODUCTION: SI-raw is a raw cured neat product fermented with steamed rice produced in Taiwan. The aborigines in Taiwan prefer this type of traditional food. Recently some people who consumed it were poisoned and three of them died of botulism. In order to prevent food poisoning from botulism, *Lactobacillus plantarum* was used as a starter for Si-raw fermentation. The characteristics of the product were studied.

MATERIAL AND METHODS:
Si-raw preparation: pork trimmed off surfice fat and cut into cubes, then precured with 10% salt to remove the moisture. The precured pork cubes were mixed with steamed rice by ratio of 2.4:1(pork/rice), then placed in a jar and sealed and incubated at 25°C for fermentation as the control. The starter culture of *L. plantarum* was prepared by the procedure modified from the method of Raccach(1984). Pork cubes were precured with 0, 3, 6, and 10% salt and added steamed rice by the ratio of 1.6:1(pork/rice), and inoculated 10^7 cfu/g of the starter culture and placed in the jar and fermented at 4°, 25°and 37°C, and periodically examined microbiologically and chemically. Proteolytic activity of *L. plantarum* was determined according to the method of Garcia de Fernando and Fox (1991) and Kato *et al.* (1990). Lipolytic activity was determined with the procedure described by Molina *et al.* (1991). Salt content was determined with Mohr method (AOAC, 1984). ATPase activity was determined according to the procedure of Sung *et al.* (1976) and ATP and related compounds were determined with the method of Ryder (1985) and Boyle *et al.* (1991). The organic acids were analyzed with HPLC by the method of Kazuno *et al.* (1987). SDS-polyacrylamide gel electrophoresis of muscle proteins was carried out according to the method of Laemmli (1970).

RESULTS AND DISCUSSION:
Salt content: Salt content of the precured meat with 0, 3, 6, and 10% salt were 0.4, 2.9, 6.5 and 10.1%, respectively. The salt content of the Si-raw from the precured meat were 0.8, 3.1, 4.8 and 6.6, respectively, while the control (without inoculating with *L. plantarum*) was 5.5%. No significant difference was detected among the samples from different fermentation temperature and time. The salt content was lowered in the sample from the precured meat with 6% and 10%, but not with 0% and 3%.
Change in pH value of Si-raw fermented under different temperature and salt concentration was shown in Fig. 1. pH values of the procured pork with 0, 3, 6, and 10% for two days were 6.4, 6.1, 6.0 and 6.2, respectively The pH of the product without salt fermented at 37°C dropped more rapidly than other conditions after 7 days. Although its pH value dropped to 3.9 undesirable and ammonial odor was detected. And the pH value of the product with 3% salt at 37°C fermentation dropped to 4.0. However, pH values of the products fermented at 37°C depleted more rapidly than the products at 4°& 25°C, and the products without inoculating the starter culture(naturally fermentation) depleted slowlier than others. It was found that the pH value of the products with 10% salt at 4°Cmight inhibit fermentation, the trends of pH changes were also found in the fermentation at 25°& 37°C. From this result we can find Si-raw is one kind of high acid food (pH<4.6), so this may suggest the aborigines follow to produce the fermented meat with steamed rice and salt. Lactic acid bacterial counts: The Lab counts of Si-raw at different fermenting time, temperature and salt concentrations were significantly different(-p<0.05) (Fig. 2). The Lab counts of the inoculated products reached the highest level at first week of fermentation, but the control (without inoculation) reached the highest level at the 2nd week of fermentation. The Lab counts were found in the products fermented at 4°C and lowest in the products fermented at 37°C. The reason for this phenomenon might be caused by rapid metabolic rate for the microorganisms growth at high temperature and accumulation of metabolites to retard their growth. It was also found the high salt concentration might inhibit the bacterial growth.
Proteolytic activity: Total free amino acid content of the sample was used to express the proteolytic activity of the starter culture on muscle proteins. The inoculted products with lower salt and fermented at higher temperature had higher total free amino acid content (Fig. 3), it meant *L. plantarum* had higher proteolytic activity. Total free amino acid content in the products from the precured meat with 0% and 3% salt fermented at 25° and 37°C increased markedly at the first week of fermentation. The result also indicated that the product from the precured meat with 10% salt and fermented at 4°C had no change in the total free amino acid content.
Lipolytic activity: Total volatile fatty acid and non volatile fatty acid were used as an indicator of lipolytic activity according to the method of Molina *et al.* (1991). The level of the total VFA in the precured meat was high, however, it had significant difference from the level in the fermented products (Fig. 4). There was significant difference in VFA between the precured meat and the inoculated products. There also was significant difference in VFA between the fermentation at 25°and 37°C, 37° and 4°C as well as 4°Cand the precured meat (p<0.05). Fig. 5 showed the product from 10% salt precured meat had highest NYFA, but 0% salt had lowest in it. No significant difference was found in the NVFA level in the products fermented between 25°and 37°C , but there was significant difference between the control and the product fermented at 4°C. The result indicated change in NVFA level was affected by the fermentation temperature, time and salt concentration.
ATP and its related compounds: ATP and its related compounds of the product fermented at 4°, 25°and 37°C were shown in Fig. 6 and 7. The precured meat for preparing Si-raw had a higher IMP level than the products, but it decreased after one week fermentation. IMP level of the Si-raw fermented at 4°C depleted slowlier, but it could not be detected at the Si-raw fermented at 25° and 37°C. The higher the fermentatation temperature and the lower the salt concentration, the higher the ATP content. However, ADP, AMP contents were minor, inosine level was higher at 4°C but minor in the products

fermented at 25° and 37°C. On the contrary, hypoxanthine was higher in the product fermented at 25° and 37°Cthan at 4°C. Hypoxanthine level in the product from the precured meat with 10% salt was lower than the other concentrations of salt. The result indicated that ATP and hypoxanthine were the major compounds of nucleotides in Si-raw. ATP in Si-raw may origin from the lactic acid bacteria or other organisms growth in the products. This needs to do more research to prove it. Organic acids: Lactic acid was detected higher in the product from the precured with low salt concentration and fermented at 37°C. The lactic acid level of the inoculated samples was higher than the control (without inoculation). The other organic acids in the sample fermented at 4°C decreased after 4 weeks of fermentation, however, it increased in the samples fermented at 25°and 37°C. The lactic acid and other organic acids level were not high, therefore the pH value of the product fermented at 4°C remined constantly.

SDS-PAGE patterns of muscle proteins: SDS-PAGE patterns of muscle proteins in the products fermented with 0% salt at 37°C degraded markedly with increasing fermenting time, and those of the product fermented with 10% salt at 4°C remined stably. This result is in agreement with the change of total free amino acids. In conclusion, Si-raw is not suitable to be fermented with 10% salt at 4°C. This result suggest that optimum processing conditions are precured with 3% salt and fermented at 25°C.

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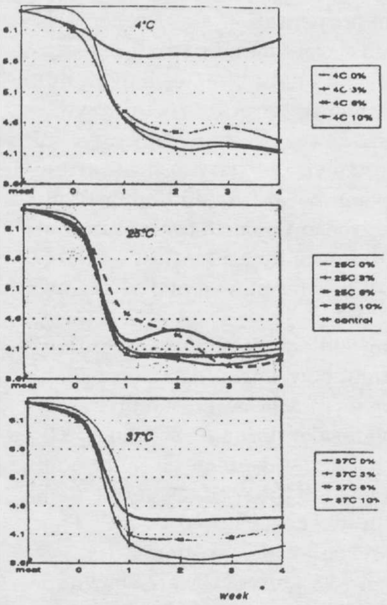

Fig.1 The changes of pH value in si-raw with different salt concentrations under different fermenting temperatures.

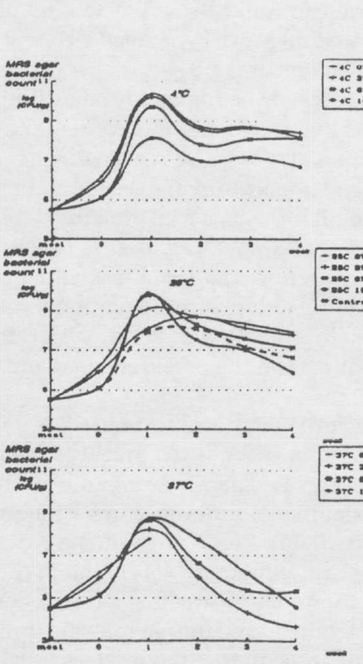

Fig.2 The changes of lactic acid bacteria count in si-raw with different salt concentrations under different fermenting temperatures.

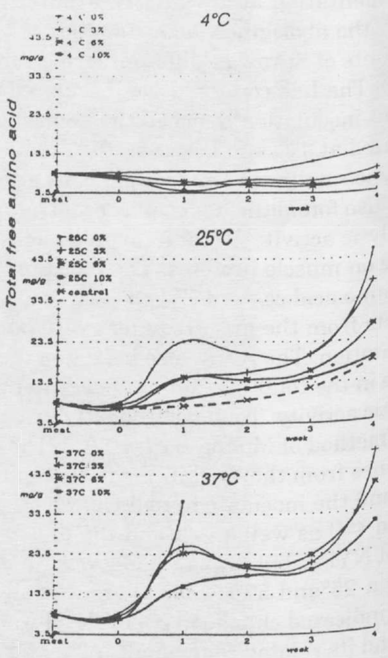

Fig. 3 Contents of total free amino acid of si-raw with different salt concentrations under different fermenting temperatures.

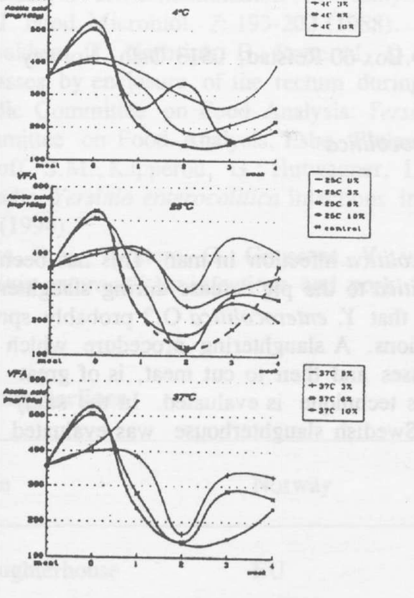

Fig. 4 The changes of volatile fatty acid (VFA) in si-raw with different salt concentrations under different fermenting temperatures.

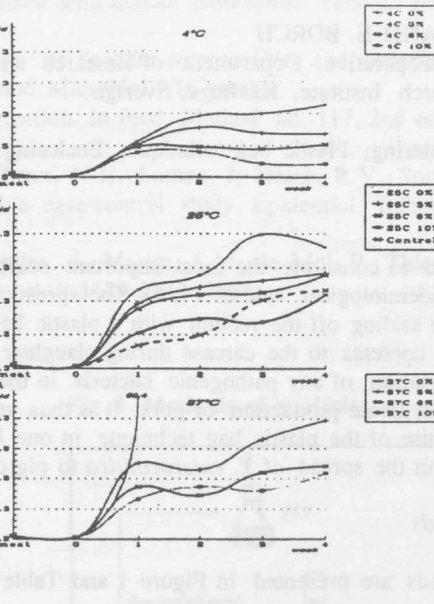

Fig. 5 The changes of non-volatile fatty acid(NVFA) in si-raw with different salt concentrations under different fermenting temperatures.

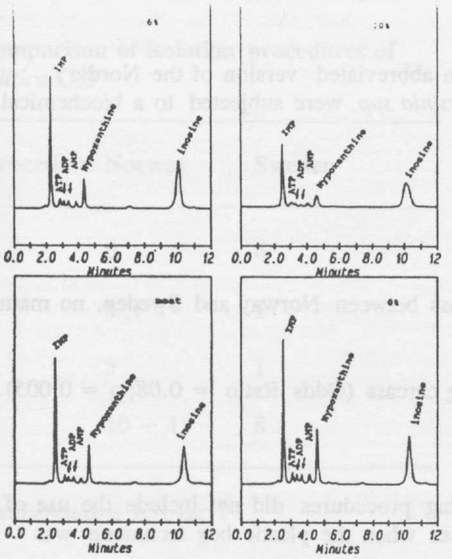

Fig.6 HPLC chromatograms of ATP related compounds in fresh meat and si-raw contained different usage of salt for 2 days

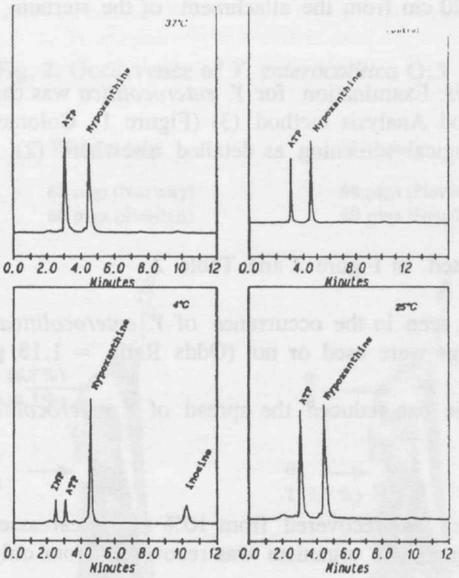

Fig.7 HPLC chromatograms of ATP related compounds in si-raw from different fermentation temperature and control (without starter culture).