BIBLIOGRAPHY

MABALO, MARY FE B. APRIL 2012. Microbiological and Economic Evaluation of Hot Smoked Pork Cured with White Sugar. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at the Animal Genetic Resources (TANGERE) Project Laboratory of Benguet State University in Bektey, Puguis, La Trinidad Benguet to determine the presence of pathogenic bacteria and return on investment of hot smoked pork cured with white sugar.

A total of 16 kg. of commercial pig and different level of white sugar were used in this study. Following are the different treatments:

T_0= 180 g of salt/kg of pork

T_1= 100 g of white sugar/ kg of pork

T_2= 150 g of white sugar/ kg of pork

T_3= 200 g of white sugar/ kg of pork

Result showed that all treatments were negative for pathogenic bacteria causing disease. However, treatment 1(100 grams of white sugar) was recommended due to high return on investment which is 16.29.

INTRODUCTION

Meat preservation is lengthening the storage life of meat. An effective preservation method must be practical, usable, and should not render the product unpalatable or destroy its appearance. It should be able to stop the action of forces of meat deterioration. Hence, the primary concern in meat preservation must be to make meat available and free from any microbiological organisms that make meat easily deteriorate and cause diseases such as food poisoning. It was argued by Ibarra (1983) that the physical appearance, the chemical composition and consistency of the product may change but as long as its fitness for human consumption is lengthened, preservation is achieved.

There are numerous approaches to prolonging the storage life of meat. The most common methods in meat preservation include cold storage, canning, drying, salting and smoking. Traditionally, smoking is used for preservation purposes. Smoking is the process of subjecting meat to the action of smoke and heat by produced burning woods. Salt is the primary ingredient used in meat curing. Many studies proved that using salt can lengthen the shelf life of meat. However, many curing ingredient are also used as a preservative for meat. One of these ingredients used to preserve meat is sugar.

Sugar is a secondary ingredient in meat curing. It counteracts the astringent quality of salt and enhances the flavour of the product. Furthermore, sugar aids in lowering of pH of the cure by providing food for some of the lactic acid-fermenting bacteria. However, sugar can reduce the shelf life of cured meats by providing food for spoilage bacteria, yeasts and moulds. It increases the browning effect of meat during subsequent cooking (Meat Processing Committee, 1991).

In this study, instead of using salt as a curing ingredient for meat, sugar will be used to enhance the flavour of the product and avoid salty taste. In addition, white sugar is preferred as it does not caramelize easily.

Therefore, the study was conducted to provide some information about meat preservation and some microbiological organisms present in meat. Furthermore, the study was proposed as a means of preserving pork by curing with sugar and hot smoking. It is hoped that the hot-smoked pork using this process will have a longer shelf life.

Generally, the study aimed to determine the presence of pathogenic bacteria in the smoked pork cured with white sugar and make a cost and return analysis of producing smoked pork cured with sugar.

Hot smoking was carried out in January 2012 at the Meat Preservation Laboratory of the Animal Genetic Resources (TANGERE) project of the Benguet State University in Bektey, Puguis, La Trinidad Benguet . Microbiological testing of smoke pork sample was done at the DOST-CAR Regional Standards and Testing Laboratory in La Trinidad, Benguet.

REVIEW OF LITERATURE

Originally, curing treatment were practiced as a means of preserving meat before the days of refrigeration and curing goes back at least 1,500 B.C. In less developed areas without modern preservation facilities, the prime objective of curing is still preservation. But where more effective preservation facilities, the prime objective of curing is to produce unique – flavored meat product; a secondary purpose is to preserve the red color of the meat after cooking (Desrosier, 1970).

One of the principal ingredients used for curing or pickling meat is sugar. Sugar helps stabilize color and also adds flavor. It helps also to overcome the saltines and counteracts the toughing effect of salt. In long cures, the sugar provides nutrients for bacteria which reduce nitrate to nitrite. Sugar also provides food for some of the lactic acid fermenting bacteria that develops the characteristic flavor of some dried cured products.

According to the Food and Agriculture Organization, fructose and sucrose are very effective for preserving food while glucose is not. Sugar may also encourage the growth of healthy bacteria that prevent bacteria that will make you sick from growing. High concentrations of sugar also exert osmotic pressure that will draw water out of bacteria, preventing them from growing. The preservative action of sugar, in the concentrations in which it is normally used in meat products, is of minor importance. Sugar is now used mostly for its organoleptic value. Sugar aids in improving the color, flavor, taste, and appearance of meats. Meat cured with sugar will not be as hard, and sugar also aids in acid production, which helps to retard spoilage.

According to Forrest *et al* (1975), the used of sugar as a preservative agent would require levels well above those normally used in cured meat or other processed meat

products. However, the sugar that is added to fermented sausage as a preservative because of lactic acid that is formed in addition to their lowered pH. All these factor adds up to high degree of stability and a longer shelf life.

There are several causes of meat spoilage. These can be grouped into three main categories: the biological factor, physical and chemical forces. Among these forces of deterioration, the biological force is the most prevalent, and the most destructive biological force is the microbiological action. Meat contains abundant nutrients required for the growth of bacteria, yeast and molds. Thus, microorganisms flourish luxuriantly in meat. Most preservation methods must therefore be counter cures for microbial growth. Controlling microbial spoilage involves minimization of contamination and application of procedures to inhibit or prevent the growth of organisms that can produce undesirable changes in meat (Ibarra, 1983).

Curing, as a method of preservation centres on one basic principle, the curing ingredients inhibit the growth of microorganisms. If the ingredients are absorbed by the meat ahead of the penetration of destructive microorganisms, curing is a success. On the other hand, if the microorganisms enter the meat faster than the curing ingredients penetrate it, curing is a failure.

Following curing, processed meats are often smoked. Smoking also was originally employed as a mild preservative, but today smoking is used mostly for its flavour contribution. As with most preservative methods, smoke was used long before the reasons for its effectiveness were understood (Potter and Hotchkiss, 1995).

In preserving foods such as meats and fish with smoke, the preservative action generally comes from a combination of factors. According to Pearson and Dutson (1986),

smoking is subjecting the meat to smoke produced by burning woods or saw dust. In the process, moisture evaporates and some phenolic pyroligneous compounds are attached to the meat surface. The reduced moisture moisture and the action of the above compounds inhibit the growth of microorganisms.

According to Potter and Hotchkiss (1995), smoke contains preservative chemicals Such as formaldehydes and other materials from the burning of woods. In addition, smoke is generally associated with heat which helps kill microorganisms.

The common microorganisms found in meat are bacteria, yeast and moulds that can attach virtually all food constituents. Another special kind of food deterioration that may or may not alter a foods organoleptic property has to do with food born- diseases. The most common bacteria are Staphylococcus, Salmonella and E.coli.

Staphylococcus typically occurs in grape like cluster. The most important specie is *Staphylococcus aureus*, named for its yellow – pigmented colonies. They grow comparatively well under condition of high osmotic pressure and low moisture.

S. aureues is the agent of toxic shock syndrome, a severe infection causing high fever and vomiting and sometimes death. *S. aureus* also produces an entotixin that causes vomiting and nausea when ingested (Tortora, 1992).

Escherichia coli O157:H7 is important not only in connection with water analysis, but medically also, as a cause of several common forms of human infection. *E. coli* O157:H7 can be transferred from contaminated hides or the intestines of infected animals during the slaughter process. Although not a good competitor, *E. coli* O157:H7 can survive under refrigerated and frozen conditions. It is acid resistant, and thus it presents a potential problem by its survival in fermented meats. Even very low numbers of *E coli* O157:H7 are

capable of causing infection, thus the microorganism must be completely destroyed during the process. Control principles for *E. coli* O157:H7 include minimizing the presence of the organism in the raw meats and proper fermentation and heating of final product (Burdon and Williams, 1968).

Salmonella sp. is an enteric microorganism associated with the intestinal tract of many animals and thus is potentially present in most raw meats. *Salmonella sp*. is recognized as a potential problem in salted, dried meats. Illness is usually caused by ingestion of sufficient microorganisms to survive digestion and reproduce in the human intestinal tract. Fortunately, salmonellae are heat sensitive and easily destroyed with the mild heat treatments for cooking meat. Also, salmonellae are acid sensitive, not surviving well in fermented meats, and are not good competitors, being inhibited by the lactic starter cultures. They are also sensitive to meat curing practices (Warris, 2000).

MATERIALS AND METHODS

Materials

The study made used of fresh meat obtained from the entire carcass of a commercial pig. Other materials needed include white sugar, stainless pans, meat knives, measuring cup, chopping boards, weighing scale and alnus firewood (Fig. 1).

Figure 1. Materials used

Methods

Preparation of meat. A total of 16kg of pork was obtained from the warm carcass of a commercial pig. Meat pieces were cut into 1-inch thick strips containing the skin, fat and lean meat. The strips was washed and drained. After draining, the meat strips was placed in a stainless pan for curing.

Curing. White sugar was used as a curing ingredient at the rate of 100, 150 and 200 grams per kilogram of pork. Salt was served as the control treatment at 180g per kg of pork.

The curing ingredients were rubbed on both sides of the meat following the dry curing method (Fig. 2). Then the pork pieces was packed in stainless pans and allowed to cure for 7 days. The pork was placed in a separate pan under different treatment.

Hot smoking. To start the combustion, pieces of dried alnus wood (about 1kg) was lighted inside the fire pit of the smoking house. When the wood was burning and the fire emitted was already stable, air-dried alnus firewood was placed over it to produce the smoke. Initially, ¼ kg of alnus firewood was spread over the burning wood to produce the smoke and to heat the smoking chamber. Then ¼ kg of the firewood was placed inside the fire pit every 20 minutes thereafter until the end of hot smoking period.

Before hanging inside the smoking chamber (Fig.2), each meat slice was weighed and labeled for identification. The pork slices were suspended in the hangers following the experimental layout as indicated in Appendix A. All treatments have undergone 16 hours of hot smoking at 8 hours of smoking per day.

Experimental design and treatments. The pork slices were subjected to the following levels of curing ingredients as treatments:

T_0= 180 grams of rock salt (control) / kg of pork

T_1= 100 grams of white sugar/ kg of pork

T_2= 150 grams of white sugar/ kg of pork

T_3= 200 grams of white sugar/ kg of pork

Microbial analysis. Samples of the smoked product, weighing approximately 250 grams each, was wrapped in aluminum foil and placed in labeled plastic bags. The samples were brought to the DOST-CAR Regional Standards and Testing Laboratory in Poblacion, La Trinidad, Benguet for microbial isolation and identification.

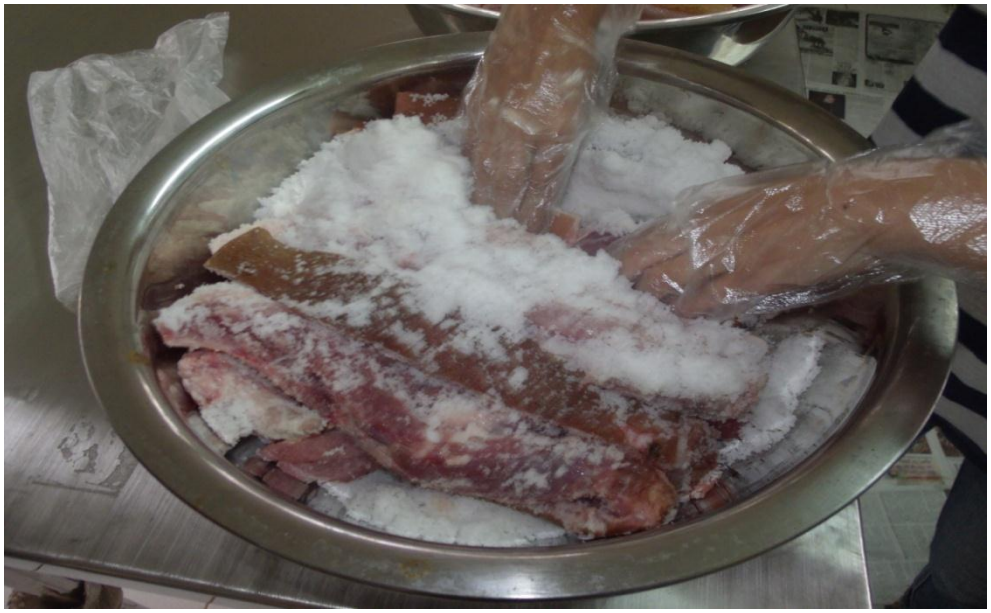

Figure 2. Meat cured with white sugar

Figure 3. Smoking chamber

Sanitation and Hygiene

To prevent or minimize microbial contamination, good hygienic practices (DOH, 2004) in meat processing and handling of smoked products were observed as follows:

1. Maintaining adequate personal cleanliness

2. Wearing adequate garments, and hand gloves.

3. Washing hands before starting work and repeatedly during work.

4. No rings, watches and bracelets shall be worn during work.

5. Cleaning/Disinfection of tools, knives, chopping boards, utensils, and other materials for meat handling.

6. Taking any other necessary precautions to protect against contamination of meat and finished product.

Data Gathered

The following data were gathered:

1. Microbial count. The number of microorganisms such as:

1.1 Coliform,

1.2Staphylococcus

1.3Salmonella

2. Production Costs. The costs of pork, curing ingredients, firewood and labor were determined.

3. Sales. All the smoked products were considered sold at PhP350/kg.

Data Computed

The following data were computed:

1. Total cost of production (TCP). Computed using the formula:

   TCP = Cost of Pork + Cost of Ingredients + Cost of Firewood + Cost of Labor

2. Net income (NI). Calculated as:

   NI = Total Sales – Total Cost of Production

3. Return on investment (ROI). Computed using the formula:

   ROI = NI/TCP x 100

Statistical Analysis.

The Statistical Package for Social Sciences (SPSS) was used to analyze the data. Significant differences between treatment means was determined by the Duncan's Multiple Test (DMRT).

RESULT AND DISCUSSION

Total Coliform Count and Fecal Coliform

Table 1 below shows the Total Coliform Count (TCC) and Fecal Coliform (FC) of the hot smoked pork. The table shows that the presence of microorganisms on the hot smoked pork were in the standard limit set for food which is <3.0.

Coliform bacteria may not cause disease, but can be indicators of pathogenic organisms that cause diseases. The latter could cause intestinal infections, dysentery, hepatitis, typhoid fever, cholera and other illnesses. However, these illnesses are not limited to disease-causing organisms in drinking water. Other factors not associated with drinking water may be the cause (DOH,2004).

Table 1. Mean number of microorganisms present in the smoked pork

TREATMENT	TCC (MPN/g)	FC (MPN/g)
T_0 (180 g of salt)	<3.0	<3.0
T_1 (100 g of sugar)	<3.0	<3.0
T_2 (150 g of sugar)	<3.0	<3.0
T_3 (200 g of sugar)	<3.0	<3.0

Bacterial Analysis

Table 2 shows the result of bacterial analysis which are Salmonella spp. and *Staphylococcus aureus*.

The report analysis (Appendix B) indicates that To (180 grams of salt) is negative for Salmonella spp. and Staphylococcus colony is within the standard limit set of food by the Bureau of Food and Drugs.

In T_1 (100 grams of sugar), the sample is negative for Salmonella spp. and *Staphylococcus aureus.* Total coliform count and Fecal coliform is within the standard limit set of food (Appendix C).

T_2 (150 grams of sugar) and T_3 (200 grams of sugar) are both negative to all pathogenic bacteria as reported by DOST-CAR Regional Standards and Testing Laboratory (Appendix D and E).

Microorganisms of relevance with regard to meat hygiene include parasites, molds, bacteria and viruses. Within these group bacteria plays an important role and depending on the slaughter hygiene, these bacteria find their way to the carcass or contaminate the meat during slaughterhouse operation (Heinz and Hautzinger, 2007).

In addition, the wood smoke contains a large number of volatile compounds that may have bacteriostatic or bactericidal effect and the residual effect of the smoke in the food has been reported to be greater against bacteria (Frazier and Westhoff, 1998).

Table 2. Salmonella and Staphylococcus spp.

TREATMENT	SALMONELLA	STAPHYLOCOCCUS
T_0 (180 g of salt)	negative	coagulase negative
T_1 (100 g of sugar)	negative	0 CFU/g
T_2 (150 g of sugar)	negative	0 CFU/g
T_3 (200 g of sugar)	negative	0 CFU/g

Return on Investment

The Table below shows the sales, expenses, net income and ROI of the treatments. The smoked pork from T_1(100 g of sugar) had the highest mean (16.29) in ROI. T_3 (200 g of sugar) resulted in -1.78 is because the treatment has low total sales, and also low in total income. The table also reveals that T_1(100 g of sugar) has the highest in terms of sales, thus realizing a higher income and ROI. This is because of the higher weight produced, and lesser level of ingredient used in the study.

Table 3. Return on Investment

TREATMENT	SALES(Php)	EXPENSES(Php)	NET INCOME(Php)	ROI(%)
T_0	896.00	794.4	101.6	12.79
T_1	927.50	798.00	129.5	16.29
T_2	836.50	807.00	29.5	3.66
T_3	801.50	816.00	-14.5	-1.78

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The study was conducted at TANGERE Project Laboratory of Benguet State University in Bektey, Puguis La Trinidad Benguet to determine the microbiological and economic evaluation of hot smoked pork using white sugar.

A total of 16 kilograms of pork from slaughter hog was equally divided into four to make up the four treatments. Each treatment has four replications with 1 kilogram of pork per replication following the completely randomized design. For every kilogram of pork, 180 grams of salt, 100 grams,150 grams and 200 grams of sugar was used for curing. The treatments were placed in a clean stainless pans covered with foil and cured in room temperature for 7 days.

After 7 days, the different treatments were exposed on the hot smoking chamber for 2 days (8 hours per day). After smoking the hot smoked pork was placed in a zip locked.

Based on the result of microbiological analysis by the DOST-CAR Regional Standards and Testing Laboratory the hot smoked pork was negative Salmonella spp. and *Staphylococcus aureus.* Total Coliform Count and Fecal Coliform are within the standard limit set for food.

In terms of ROI, T_1 (100grams of sugar) compared to the control which is 180 grams of salt has the highest mean (16.29).T_3 got negative result which is -1.78 due to high cost of production than the sales.

Conclusion

The use of sugar as curing agent in hot smoking was effective for controlling microbial pathogens, since all the treatments using different amount of white sugar were negative for Salmonella and Staphylococcus spp. Coliform count was within the standard limit set for food. In terms of economic value, treatment 1 which is 100 grams of white sugar has the highest return on investment due to the high production weight where in this treatment has the lower shrinkage percentage, and less production cost that is100 grams of white sugar.

Recommendation

Since all the treatments are negative for Salmonella and Staphylococcus spp., all treatments are recommended for preserving meat. However, for higher profit, treatment 1 or 100 grams of white sugar should be used for curing the pork before smoking.

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