BIBLIOGRAPHY

ASHRYL M. YUBOS APRIL 2012. Microbial and Sensory Properties of Hot-Smoked Pork from Native Pig As Affected By Duration of Hot Smoking with Oak Wood (*Quercus Spp.*). Benguet State University, La Trinidad, Benguet.

INTRODUCTION

"From the dawn of agriculture to the green revolution, food has been an essential ingredient in human history," thus wrote by Standage in 2009. But the ever growing human population and consumption will mean that the global demand for food will increase for at least another 40 years (Godfrey *et al*., 2010). There has been a dramatic shift in Asia and the Pacific region from diets that were formerly predominantly vegetable-based to the diets based on animal protein. Levels of livestock production and processing are increasing in response to technological development and market requirements, among other factors. Pork is the predominant meat consumed in East Asia at 30 kilograms per capita per annum, according to the Food and Agriculture Organization of the United Nations regional office for Asia and the Pacific (2008).

Humans are omnivorous and have consumed both animals and plants as food throughout recorded history (Potter *et al*., 1995). Meat comprises the basic part of the daily diet of every person. It is the flesh obtained from different farm animals and used as source as food. Meat contains primarily protein (50%), it also provide phosphorus (25%), iron (6%), zinc (20%), riboflavin (22%), thiamin (67%), cyanocobalamin (32%), niacin (30%), calories (8%), and fat (11%). According to Damron (2009), a meat protein has a high

digestibility and the amino acids contained in it are biologically complete. Therefore, it is natural that meat plays an important part in keeping the human body in order. Although meat is highly nutritious food products, it spoils rapidly due to microbial, chemical, and physical factors. Meat preservation in Prehistoric times is absolutely essential for prolonging shelf life, and for the storage of all fresh meat and most processed meat products (PCARRD, 1991). In general food preservation process is required to ensure food product safety. Most of the history associated with food processing is based on preservation of the food product, either to control or eliminate human health concerns to extend the product shelf-life (Heldman, 1997).

Salting has been practiced since the fifth century before Christ and possibly longer. Drying meat is reducing its available water content. Smoking of meats was known to the Egyptians as well as the Ancient Sumerians civilization which preceded it. Smoking as applied to cured products, is the process of subjecting the meat to the action of smoke and generated by burning hardwood or sawdust. Its purpose is to preserve these protein-rich foods, which would otherwise spoil quickly for long periods. These are two mechanisms for this preservation: dehydration and the anti bacterial properties of absorbed smoke. During hot smoking food is smoked at medium-high temperature of 200ºF to 300ºF or 90ºC to 150ºC for a period of typically 2 to 24 hours. During the hot smoking process the food is cooked by the heat of the gasses of the fire, while the smoke adds extra flavor (Anonymous, 2006).

Meat smoking is one of indigenous technology of meat preservation. A delicacy in the Cordilleras that is now undergoing into value adding interventions to enhance its unique

taste and flavor. It is dubbed by the foreigners as the “Igorot smoked meat” or “Igorot ham”, it is known locally as “etag”, “inasin”, or “kinuday” (Didican, 1995).

Because of its high demand in the market, meat smoking helps as livelihood and promotes conservation and profitable use of a threatened local genetic resource. It is then important to determine the best smoking materials and method of smoking to serve as a reference to other researchers and students who wish to conduct further researchers and students who wish to conduct further researches on meat smoking. It is to ensure food safety, quality, and high market acceptability of smoked meat; and also to promote its commercialization.

This study aimed to:

1. evaluate the general acceptability and quality attributes of smoked-meat produced through the process of hot-smoking method by using oak wood;
2. to determine the presence of pathogenic bacteria in the smoked products; and
3. to make cost and return analysis of smoked-meat production using this method.

The study was conducted at the Animal Genetic Resources (TANGERE) Project Laboratory of the Benguet State University in Bektey, Puguis, La Trinidad, Benguet from March 2011.

REVIEW OF LITERATURE

Igorots are known be meat-eaters. Smoked meat is very much a part of the Igorot's culture and age-old traditions. During the festive occasions, they prepare their favorite dishes, often pork-based, making "Igorot smoked meat" a regular ingredient. Every part of the pork carcass is used in preparing the various local dishes. Smoked meat dishes are consumed with much delight along with rice wine and other locally brewed alcoholic beverages (Coplas, 2010).

Preservation is by some means is absolutely essential for prolonging shelf life and for the storage of all fresh meats and most processed meat products. The preservative action of each of the preservation methods is accomplished by restricting, or in some instances completely inhibiting, microbial activity, as well as the enzymatic, chemical, physical reactions that would otherwise cause deteriorative changes and spoilage (Aberle *et al*., 1975).

According to PCARRD (1991), to be able to intelligently handle and preserve meat, one must know the causes of meat deterioration. Major factor affecting food deterioration include the following: (1) Growth and activities of microorganisms, principally bacteria, yeast and molds; (2) activities of enzymes and other chemical reactions within food itself; (3) infestations by insects, parasites and rodents; (4) inappropriate temperature for a given food; (5) either gain or loss of moisture; (6) reaction with oxygen; (7) light; (8) physical stress or abuse; (9) time. This factor can be divided into biological, chemical and physical factors (Potter *et al*., 1995). And among the biological forces, microbiological spoilages are the most severe account for almost 99.9% of all biological deteriorations. The method

of preservation must be practical, usable, and should not render the product unpalatable or destroy its appearance.

According to Damron (2009), smoking is the most commonly meat preservation techniques prevent spoilage by altering or eliminating one or more of the environmental factors of spoilage organisms need- water, air, warm temperature or other factors. Smoking is the processing step used in by the food industry centuries ago. It is originate from the practice of suspending meat, fish and fowl. Smoking was done primarily by hanging the meat over burning wood logs or wood chips (Potter *et al*., 1995).

There are two methods in smoking: cold smoking and hot smoking. During "cold smoking" meat is placed or hung in the smoke of a smoldering fire. The food is smoked at a temperature of around 85ºF (30ºC) for a period of typically a day or a couple of days, or even longer. The primary goal of cold smoking is to conserve the food by drying, most often after brining, while that delicious smoke flavor is thrown in as a bonus. After cold smoking the food in essence is still raw, while that beautiful dark-red color developed by the smoking process runs deep into the food- or all through the food. During cold smoking, the texture of the food will remain dense, or will become even denser. The cold smoking process is mainly used for "fatty" food (Anonymous, 2006).

During "hot smoking" food is smoked at a medium-high temperature of, say, 200ºF to 300ºF (90ºC to 150ºC) for a period of typically 2 to 24 hours. During the hot smoking process the food is cooked by the heat of the gasses of the fire, while the smoke adds extra flavor. After hot smoking the food is done or even well done, while the dark-red color caused by the smoking process does not run deep under the surface. During hot smoking,

the texture of the food will be become softer and less dense, like during any cooking process (Anonymous, 2006).

In smoking, smoke has high antimicrobial properties. The drying effect of the heat produced during smoking also aids in inhibiting and killing the microorganisms in the products (PCARRD, 1991). During smoking, a coat of creosote at the surface of the meat is formed. This film at the outer portion of the meat acts as a barrier against the evaporation of moisture and entry of insects and microorganisms to the products (Ibarra, 1983).

According to Barbour (1978), smoking can influence the taste, smell, texture and appearance of food to produce a wide variety of flavors. The chemicals from the smoke condense on the food which gives the food its coloration and smoky flavor.

Composition of wood smoke is numerous. More than two- hundred compounds of smoke have been isolate and identified. The complexity of smoke composition is partly influenced by the amount of oxygen available during combustion. When oxygen is limited, the resulting smoke is dark and contains the large amount of carboxylic acid. This type of smoke is avoided. As available oxygen increase, the production of the acids and phenols is at its maximum when approximately eight times the amount of oxygen required for complete oxidation. Phenols are found in the smoke in the form of vanillin, 4-methylquaiacol phenol, o-cresol, m-cresol, and p-cresol which acts as antioxidant, flavor compound and bacteriostatic agent. Alcohols are also found in wood smoke in the form of methanol or wood alcohol. It acts as a carrier for volatile components of smoke and imparts minor bacteriostatic effect. And these may have very minimal influence on the flavor and color development of meat. Wood smoke also contains organic acids which is important in the coagulation of the proteins at the surface of frankfurters and other sausage since they

give the skin like texture of the pieces; carbonyls in the form of aldehydes, ketones, and their derivatives that have been found to impart the typical smoke flavor in meat; and hydrocarbons that are present in smoke mostly as polycyclic types such as the pyrene and benzapyrenes. But these compounds do not add any preservative effects to smoked meat products (Ibarra, 1983).

The composition of smoke is highly affected by the material burned. The best materials used for smoking meat in the Philippines are hardwood trees made up mostly: cellulose, hemicelluloses, and lignin. Cellulose and hemicelluloses are the basic structural material of the wood cells; lignin acts as kind of cell-bonding glue which included Acacia, Oak, and Hickory. Oak is available all over the world, is probably the most commonly used wood for meat smoking. Strong but not overpowering, well good for sausages, beefs of lamb. Smoked products develop light brown to brown color, depending on the length of smoking (Anonymous, 2006). According to David (1992), oak tree are paradox under many conditions they reproduce themselves naturally in profusion. The genus has also been widely planted as an ornamental great success.

Since different of tree have different ratios of components, various types of wood do impart a different flavor to food. Another important factor is the temperature at which the wood burns. High- temperature fires see the flavor molecules broken down further into unpleasant or flavorless compounds. The optimal conditions for smoke flavor are low, smoldering temperatures between 570ºF to 750ºF (299ºC to 399ºC). This is the temperature of the burning wood itself, not of the smoking environment, which sees much lower temperatures. Woods that are high in lignin content tend to burn hot; to keep them smoldering requires restricted oxygen supplies or a high moisture content. During smoking

using wood chips or chunks, the combustion temperature is often raised by soaking the pieces in water before placing them on a fire (Wikipedia, 2010).

According to Whitney and Radyrolfes (2002) that this food can be associated food borne illness. These may caused by the consumption of food contaminated with bacteria, viruses, molds or parasites or with toxins produced by these organisms. Among illness attributed to food borne pathogens, almost 67% are caused by viruses, 30% are by bacteria and 3% are from the parasites. Bacterial food borne infection is caused when a food containing pathogenic bacteria is ingested and the bacteria take up residence and reproduce into the gastro intestinal tract. These bacteria may also grow in other tissues or produce toxins within the body. Some common causes bacterial infections which includes *Escherichia coli, Staphylococcus aureus* and *Salmonella spp*.

Food borne diseases have also been recognizing throughout the ages. The historical laws of the Israelites contain detailed information on foods to be eaten and those to be abhorred, as well as methods of preparation and cleanliness of hands. The growth of science of microbiology in 19th century allowed identification of the agents of some other major food borne diseases. In 1880's, *Escherichia coli* was discovered by a German pediatrician and named after Theodore Escherich. *Salmonella* was named after the American microbiologist Dr. E. Salmon in 1888. *Staphylococcus aureus* was then discovered by Dr. Dennison on 1885 in the United States of America (Little and McLauchlin, 2007).

MATERIALS AND METHODS

The study made use of fresh meat obtained from the entire carcass of a one-year old native pig. The other materials included the following: chopping board, dry salt, meat knives, meat smoker, raw trunks and leaves of oak wood (*Quercuss* spp.), salinometer, scraper, stainless pans and weighing scale.

Methods

A. Preparation of meat. A native pig was slaughtered following prescribed procedures (Figure 1). From the entire carcass, a total of 30 kilograms of pork was taken as raw material for smoking. The meat was chopped into 1-inch thick pieces containing the skin, fat and lean, then washed and drained. After draining, the meat pieces were placed in a stainless pan for curing.

Figure 1. The one-year old native pig during its preparation for slaughtering and evisceration

B. Salting or curing. For every one kilogram of meat, 180 grams of dry salt which contained 15% salinity was rubbed in all sides both of the meat (Figure 2). Undissolved salt was scraped off to prevent the appearance of the very objectionable white crust on the surface of the meat. After rubbing, the meat was placed in a clean plastic container and kept at 10ºC inside the refrigerator for 24 hours. The curing period allows the salt to penetrate into the meat.

Figure 2. Pork strips placed in stainless pan for curing

C. Hot smoking. The meat pieces were suspended above the safety baffle in the smoker with a dimension of 31.5" wide x 27.5" height and 31.5" long (Figure3). Meat strips were not allowed to come in contact with one another in the smoke chamber to enable the uniform penetration of smoke and even color development. The smoker was prepared by placing oak wood inside the fire pit in which they are subjected to air dry to produce smoke. A total of 10 kg (9 kg trunks plus 1 kg leaves) of raw oak was placed in the fire pit for every 8 hours. A temperature ranging from 70ºC to 80ºC was maintained inside the smoke chamber. The temperature was monitored by using thermometer four times a day during 10:00 AM, 12:00 NOON, 2:00 PM and 4:00 PM. Air intake was adjusted to regulate the fire and burning woods.

The duration of smoking served as experimental treatments and was replicated four times. Two and a half kilograms of previously cured pork was considered as a replicate. The experimental treatments were as follows:

T_1 = 8 Hours (8:00 AM to 4:00 PM for one day only)

T_2 = 16 Hours (8:00 AM to 4:00 PM for two days)

T_3 = 24 Hours (8:00 AM to 4:00 PM for three days)

Figure 3. The cured meat strips (left) hanged inside the smoking chamber (right)

E. Sensory evaluation. Smoked-pork from each treatment was cut into bite size and cooked by boiling into plain water. At least two pieces were placed in a bowl with sufficient amount of soup. The samples were evaluated by ten traditional smoked-meat consumers who had been consuming smoked meat for at least ten years and another team of ten non-traditional smoked pork consumers.

An appropriate testing room with adequate light and seating arrangement with individual testing compartments was used for the sensory evaluation. Samples were coded and presented to the panelist. Each panelist was given relevant instructions and a score sheet (Appendix A) to mark their own ratings (Figure 4). A 9- point hedonic scale rating test was adopted from Heinz and Hautzinger (2007).

Figure 4. The panelists having their evaluation on the different sample

E. Microbial analysis. Each sample weighing approximately 250 grams obtained equally at the bottom in each replication which contains the skin, fat, and lean; and was wrapped in aluminum foil and placed in a plastic bag. The samples were labeled accordingly and brought to the DOST-CAR Regional Standards and Testing Laboratory for microbial

isolation and identification. Each sample was tested for the presence of pathogenic bacteria such as *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus* using destructive methods.

The various tests for microbial analysis were as follows:

1. Total Coliform Count- Presumptive test. The most probable number (MPN)} of coliform organisms present in 100 grams of sample, Lauryl Sulfate Broth, 48 hours incubation at 35ºC.

2. Total Coliform Count- Confirmed test. The most probable number (MPN)} of coliform organisms present in 100 grams of sample, Brilliant Green Bile Broth, 48 hours incubation at 35ºC.

3. Fecal Coliform. The most probable number (MPN)} of coliform organisms present in 100 grams of sample, *Escherichia coli* medium, 24 hours incubation at 45ºC.

4. *Escherichia coli* Confirmation. Streaked in EMB 48 hours incubation at 35ºC.

5. Indole Production. Tryptone Broth, 24 hours incubation at 35ºC addition with 0.5 milligrams of Kovac's reagent.

6. Methyl Red Test. MR-VP Tube, 24 hours incubation at 35ºC addition with 5 drops of Methyl Red Solution.

7. Citrate Utilization Test. Streak and stab inoculation, Simmons citrate agar slants, 24-48 hour incubation at 35ºC.

8. *Staphylococcus aureus* Enumeration. Colony Forming Units (CFU) in 100 ml sample, spread plate method, Baird- Parker Agar, 48 hours incubation at 35ºC.

9. Salmonella Detection. Lactose Broth (LB), 24 hours incubation at 35ºC; Tetr-

athionate Broth Base, 24 hours incubation at 35ºC. Streaked in Bismuth Sulfite (BS) Agar, Xylose Lysine Deoxycholate Sulfite (BS) Agar, Xylose Lysine Deoxycholate (XLD) Agar and Hektoen Enteric (HE) Agar incubate for 24 hours at 35ºC.XL

F. Hygiene and sanitation. Good hygiene practices in processing and handling on the recommendation of the Department of Health (2004) were observed as follows:

1. Maintaining adequate personal cleanliness.
2. Wearing adequate garments and hand glove.
3. Washing hands before starting to work and repeatedly during work.
4. No rings, watches and bracelets shall be worn during work.
5. Cleaning and disinfection of tool, knives, chopping board, utensils and other material for meat handling.
6. Taking the necessary precautions to protect against contamination of meat and finished products.

Data Gathered

1. Microbial Parameters

    1.1 Presence of *Escherichia coli.*

    1.2 Presence of *Salmonella* spp.

    1.3 Presence of *Staphylococcus aureus*

2. Smoked- Meat Attributes

2.1 Taste. The panelists evaluated each sample using a 9-point scale as

(1) like extremely (2) like very much (3) like moderately (4) like slightly (5) neither like or dislike (6) dislike slightly (7) dislike moderately (8) dislike very much (9) dislike extremely.

2.2 Aroma. The panelists evaluated each sample using a 9-point scale as (1) like extremely (2) like very much (3) like moderately (4) like slightly (5) neither like or dislike (6) dislike slightly (7) dislike moderately (8) dislike very much (9) dislike extremely.

2.3 Texture. The panelists evaluated each sample using a 9-point scale as (1) like extremely (2) like very much (3) like moderately (4) like slightly (5) neither like or dislike (6) dislike slightly (7) dislike moderately (8) dislike very much (9) dislike extremely.

2.4 Color. The panelists evaluated each sample using a 9-point scale as (1) like extremely (2) like very much (3) like moderately (4) like slightly (5) neither like or dislike (6) dislike slightly (7) dislike moderately (8) dislike very much (9) dislike extremely.

2.5 Overall acceptability. The panelists evaluated each sample using a 9-point scale as (1) like extremely (2) like very much (3) like moderately (4) like slightly (5) neither like or dislike (6) dislike slightly (7) dislike moderately (8) dislike very much (9) dislike extremely.

Data Computed

1. Sales Estimates

1.1 Sales of Smoked Products. The prevailing price of the smoked meat was used for estimating the sales.

2. Cost and Return Analysis

2.1 Total Cost of the Production (TCP).This was obtained by adding the cost of meat, cost of salt, cost of labor and cost of smoking material.

2.2 Net Income (NI). This was obtained by subtracting the total cost of production from the sales of the smoked product.

2.3 Return on Investments (ROI). This was obtained by dividing the net income by the total cost of production and multiplied by 100%.

2.4 Mean Rating. This was obtained by multiplying the numerical rating to the number of respondents and dividing to the total number of respondents.

RESULTS AND DISCUSSION

Microbiological Analysis

Table 1 shows the result of the microbiological testing done on the smoked pork at the DOST-CAR Regional Standards and Testing Laboratory.

The report of analysis (APPENDIX G, H and I) indicates that the Total Coliform Count (TCC) and Fecal coliform in all treatments are within the standard limit set of <3.0 Most Probable Number (MPN) of coliform organisms that are present in 100 grams of sample. All meat samples were found to be negative for *Escherichia coli* and *Salmonella* spp. Although, *Staphylococcus aureus* had been seen in smoked pork from 8 hours of hot-smoking with a count of 5 CFU/g, thus, it is considered as coagulase negative. Samples from 16 hours and 24 hours of hot smoking were also found to be negative for *Staphylococcus aureus*.

In smoking, smoke has high antimicrobial properties. The drying effect of the heat produced during smoking also aids in inhibiting and killing the microorganisms in the products (PCARRD, 1991).

Table 1. Results of microbiological analysis on smoked- pork

TREATMENT	TCC (MPN/g)	FCC (MPN/g)	*E. coli* (MPN/g)	*S. aureus* (CFU/g)	*Salmonella* spp.
8 hours smoked pork	< 3.0	< 3.0	Negative	5	0
16 hours smoked pork	< 3.0	< 3.0	Negative	0	0
24 hours smoked pork	< 3.0	< 3.0	Negative	0	0

Microorganisms of relevance with regards to meat hygiene include parasites, mold, bacteria, and viruses. Within this group bacteria plays the most important role and depending on the slaughter hygiene. These bacteria find their way into the carcass or to contaminate the meat during slaughter operations.

Fortunately, these bacteria can be killed by normal cooking. However, *Salmonella spp.* can be prevented by storing the food above 140ºF (60ºC) or below 40ºF (4ºC). *Escherichia coli* can be killed at 50ºC while *Staphylococcus aureus* can be killed with the temperature of above 148ºF (60ºC) or below 40ºF (4ºC) (Basnic, 2010).

In addition, McLauchlin and Little (2007) cited that smoke that contains a wide variety of organic compounds, tarry fiction and formaldehydes as well as antioxidants and oxides of nitrogen that is generally effective against gram negative rods, microccoci and staphylococci.

The standard limit set for food by the Bureau of Food and Drugs were as follows: Total Coliform Count = <3.0MPN/g; Fecal Coliform = <3.0MPN/g; *E.coli* = Negative; *S. aureus* Enumeration = 100CFU/g; and *Salmonella* Detection = 0 on 25g.

Aroma Rating of the Hot- Smoked Pork

The mean aroma rating of hot- smoked pork as affected by the duration of smoking is presented in Table 2. It also shows the verbal description for each of the mean.

The table showed that there are no differences in term of mean aroma rating and verbal description as evaluated by both consumers. Smoked pork from 8 hours of hot smoking had 2.2 as mean rating from traditional consumers which is similar for the non-traditional consumers. Both of the consumers like the smoked pork very much as their

Table 2. Mean aroma rating from traditional and non- traditional smoked pork consumers

TREATMENT	TRADITIONAL MEAN	TRADITIONAL DESCRIPTIVE RATING	NON- TRADITIONAL MEAN	NON- TRADITIONAL DESCRIPTIVE RATING
8 hours smoking	2.2	Like very much	2.2	Like very much
16 hours smoking	2.3	Like very much	2.2	Like very much
24 hour smoking	2.3	Like very much	2.7	Like very much

n=10

verbal description. It further shows that hot- smoked pork from 16 hours and 24 hours of smoking were given a verbal description as “like very much”.

McWilliams (2008) cited that, the volatility and detection of aroma are related to the temperature of food. It is the high temperature tends to volatize aromatic compounds making them apparent for judging, and the color should be judge when they are in temperature as which ordinarily would be served and consumed. In addition, Wardle (2003) states that smoking can be used to complement the taste and aroma of meat, poultry, fish. However, smoking for too long can cause undesirable flavor.

Color Rating of the Hot- Smoked Pork

The mean color rating of hot- smoked pork as affected by the duration of smoking is presented in Table 3. It also shows the verbal description for each of the treatment.

Evaluation from traditional and non-traditional consumers thru the colors of hot-smoked pork showed that mean rating by traditional consumers were 2.6, 2.4, and 2.5 while for the non- traditional consumers were rated as 2.2, 2.2, and 2.7 for the pork smoked from 8 hours, 16 hours and 24 hours of hot smoking, respectively.

Table 3. Mean color rating from traditional and non- traditional smoked pork consumers

	TRADITIONAL	NON- TRADITIONAL

TREATMENT	MEAN	DESCRIPTIVE RATING	MEAN	DESCRIPTIVE RATING
8 hours smoking	2.6	Like very much	2.1	Like very much
16 hours smoking	2.4	Like very much	2.2	Like very much
24 hour smoking	2.5	Like very much	2.8	Like very much

n=10

Furthermore, it shows that there is a similarity in terms of descriptive ratings as "like very much" between traditional consumers and the non- traditional consumers. As the result of hot smoking in terms of color, all meat samples turns into light brown and light red.

According to Strom (2011), color depends on the wood used as smoking material. Oakwood is popular wood for smoking pork, beef and wild game. The density of oak provides a long burning fuel while the wood imbues meat with a wild aroma, flavor as well as rich color.

It is then stated by McWilliams (2008) that, color is often the most critical in foods the aspects of appearance. Color often triggers the mind to expect a particular flavor of foods. The brain or mind creates a perception on the food in accordance to the color of the food.

Texture Rating of the Hot- Smoked Pork

The mean texture rating of hot-smoked pork as affected by the duration of smoking is presented in Table 4. It also shows the verbal description for each of the mean.

Table 4. Mean texture rating from traditional and non-traditional smoked pork consumers

TREATMENT	TRADITIONAL		NON- TRADITIONAL	
	MEAN	DESCRIPTIVE RATING	MEAN	DESCRIPTIVE RATING
8 hours smoking	2.5	Like very much	2.4	Like very much
16 hours smoking	2.0	Like very much	2.3	Like very much
24 hour smoking	2.7	Like very much	2.6	Like very much

n=10

The table shows that the mean texture rating from traditional consumers were rated as 2.5, 2.0, and 2.7 with a verbal description of "like very much" while the non-traditional consumers gave 2.4, 2.3, and 2.6 with a verbal description of "like very much" from the hot- smoked pork from 8 hours, 16 hours, and 24 hours of smoking. This shows that the treatments have the same texture when they are cooked. The textural quality of food has a relationship to the appearance of the product and to its evaluation into mouth (McWilliams, 2008).

Taste Rating of the Hot- Smoked Pork

The mean taste rating of hot- smoked pork as affected by the duration of smoking is presented in Table 5. It also shows the descriptive rating for each of the mean.

Hot-smoked pork from 8 hours of smoking evaluated by traditional and non-traditional consumers showed that they had the same rating as 2.2. As for the smoked pork from 24 hours of smoking showed that traditional consumers gave 2.5 as the mean rating while non-traditional consumers gave 2.4. They were all given a verbal description as "like very much".

Table 5. Mean taste rating from traditional and non-traditional smoked pork consumers

TREATMENT	TRADITIONAL		NON-TRADITIONAL	
	MEAN	DESCRIPTIVE RATING	MEAN	DESCRIPTIVE RATING
8 hours smoking	2.2	Like very much	2.2	Like very much
16 hours smoking	1.8	Like extremely	2.3	Like very much
24 hour smoking	2.5	Like very much	2.4	Like very much

n=10

On the other hand, hot-smoked pork from 16 hours were "like extremely" (1.8) by the traditional consumers which is differ to the description of non-traditional consumers which is "like very much" with a mean rating of 2.3.

In addition, the table shows that the samples from the different treatments have more or less the same taste. As stated by McWilliams (2008), which the flavor of the resulting product from the smoke standpoint leaves something to the meat to be desirable. Ciano (2010) also added that the one of the desirable effect of smoking is the heat that generates. Heat brings about color and flavor changes and improves palatability.

Acceptability Rating of the Hot- Smoked Pork

The mean acceptability rating of hot- smoked pork as affected by the duration of smoking is presented in Table 6. It also shows the descriptive rating for each of the mean.

As the result of the overall acceptability of the pork subjected from hot- smoking, it showed that smoked-pork from 8 hours of smoking were consistently rated as 1.7 with a verbal description by traditional consumers as "like extremely" which is vary among other samples either from the traditional and non-traditional consumers that were all rated

Table 6. Mean acceptability rating from traditional and non-traditional smoked pork consumers

TREATMENT	TRADITIONAL MEAN	TRADITIONAL DESCRIPTIVE RATING	NON- TRADITIONAL MEAN	NON- TRADITIONAL DESCRIPTIVE RATING
8 hours smoking	1.7	Like very much	2.0	Like very much
16 hours smoking	2.1	Like extremely	2.2	Like very much
24 hour smoking	2.5	Like very much	2.0	Like very much

n =10

as "like very much" regardless of its different smoking durations.

Return on Investments

The sales, expenses, net income and ROI of the treatments are presented in Table 7. Treatment 1, in which pork was smoked for 8 hours smoking, had the highest mean of 57.31 % ROI. This is followed by Treatment 2 or 16 hours of smoking with the mean of 29.14 %, and Treatment 3 (24 hours of smoking) resulted in a mean of 7.53 % because the treatment has low total sales and low total income. The table also reveals that 8 hours of smoking has the lowest cost of production. It also shows that it is the highest in terms of sales, thus realizing the higher income and ROI. This is because of the higher weight produced, and lesser materials used in the study.

Table 7. Return on Investments

TREATMENT	SALES (Php)	EXPENSES (Php)	NET INCOME (Php)	ROI (%)
8 hours smoking	3,865.20	2,457	1,408.20	57.31
16 hours smoking	3,728.40	2,887	841.20	29.14
24 hour smoking	3,563.60	3,314	282.55	7.53

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The study was conducted to determine the effects of the duration of hot smoking on the microbial and sensory properties of smoked-pork using oak tree as the smoking material. The study was conducted at the Animal Genetic Resources (TANGERE) Project Laboratory of Benguet State University in Bektey, Puguis, La Trinidad, Benguet on March 2011.

Following the completely randomized design (CRD), a total of 30 kilograms of pork obtained from one-year native pig was used to come up with three treatments. Each treatment has four replications; with two and a half kilograms of pork served as one replication. In every kilogram of pork a total of 180 grams of dry salt was used for curing. The different treatments were exposed into the hot chamber; treatment 1 for 8 hours, treatment 2 for 16 hours and treatment 3 for 24 hours of hot smoking.

This study focus in determining the sensory properties using oak wood as smoking material and its duration of smoking in terms of aroma, color, texture, taste and acceptability. It is then evaluated by two teams composed of ten traditional smoked-meat consumers and ten non- consumers. It also aimed to determine the presence of the pathogenic bacteria such as *Escherichia coli*, *Salmonella spp*., and *Staphylococcus aureus* in the product.

It further showed that there are differences among the different treatments in terms of aroma, color, texture, taste and acceptability of the product. Overall analysis that the samples had the same result in terms of descriptive rating which panelist gave a rating as "like very much". Although, in term of taste rating, smoked pork from 16 hours of was

given a verbal description by the traditional smoked- meat consumers as “like extremely” and in terms of acceptability smoked pork from 8 hours was given a verbal description as “like extremely”. However, it shows that the product signify a positive result for commercialization of hot- smoked pork.

The pathogenic bacteria such as *Escherichia coli*, *Staphylococcus aureus* and *Salmonella spp.* was not detected in the laboratory analysis from DOST-CAR. The bacteria could be eliminated through proper handling and preparation of the product.

Among the different treatments, 24 hour of hot smoking had the highest cost of production at Php 3,314 followed by 16 hour of hot smoking with Php 2,887 and 8 hours of hot smoking got the lowest expenses which are Php2, 457. It shows that the 8 hours of hot smoking has the higher Return on Investments (ROI) which is 57.31 % while 16 hour of hot smoking has a 29.14 % and 24 hour of hot smoking has 7.53 % ROI. This was expected because of more expenses rather than sales or income.

Conclusions

Based on the result of the study the following conclusions were drawn:

a.) In the evaluation, among the different treatments, it was consistent to be rated as “like very much”.

b.) The smoked meat from 16 hours of smoking was consistently rated as “like extremely” in terms of taste rating by the traditional smoked-meat consumers and it was constant to have the highest mean.

c.) All treatments, regardless of exposure of pork to hot smoking in different durations shows that *Escherichia coli*, *Staphylococcus aureus* and *Salmonella spp*. were all negative.

d.) Hot-smoked pork from 8 hours of smoking had the highest ROI due to high production weight, and less production cost.

e.) Smoking using oak wood result in mild aroma and flavor as well as rich color in the product.

Recommendations

Since the duration of smoking did not significantly affect the sensory properties of the smoked product, eight hours of hot smoking is recommended. Moreover, strict hygienic handling and processing techniques are necessary to prevent contamination with microorganisms.

LITERATURE CITED

ABERLE, D., J.C. FORREST, H.B. HEDRICK., M.D. JUDGE, R.A. MERKEL.1975. The Principle of Meat Science. W.H. Freeman and Company, San Francisco

ANONYMOUS, 2006. Hot Smoking. Retrieved November 25, 2010 from http:/www.hotsmokebbq.com

BASNIC, L.P. 2010. Effect of Cold Smoking Using Acacia Wood Chips On Sensory Properties of Smoked Native Pork (Etag). BS Thesis. Benguet State University, La Trinidad, Benguet

BARBOUR, B. 1978. The Complete Food Preservation. David McKay Company, Inc., New York

COPLAS, C.J. 2010 Introducing "Etag". Benguet State University-HARRDEC, La Trinidad, Benguet

DAMRON, S. 2009. Introduction to Animal Science; Global, Biological, and Industry Perspective. Pearson Education, Inc., Upper Saddle River, New Jersey

DAVID, L.L. 1992. Oak Regeneration Southern Forest Experimental Station, Ashville, N.C.

DEPARTMENT OF HEALTH. 2004. Good Hygienic Practices. Administrative order no 158s 2004. San Lazaro Compound, Rizal Ave., Sta. Cruz, Manila

DIDICAN, C.D. 1995. Cultural Method of Preserving Pork in Sagada, Mountain Province. BS Thesis. Benguet State University, La Trinidad, Benguet

FOOD AND AGRICULTURE ORGANIZATION ON THE UNITED NATIONS REGIONAL OFFICE FOR ASIA AND THE PACIFIC. 2007. Good Practices for the Meat Industry. Daya Publishing House, Deva Ram Park, Tri Nagar. Delhi.

FOOD AND AGRICULTURE ORGANIZATION ON THE UNITED NATIONS REGIONAL OFFICE FOR ASIA AND THE PACIFIC. 2008. The State of Food and AGRICULTURE IN Aaia and the Pacific Region. RAP Publication, Bangkok, Thailand

GODFREY, H.C.J.,J.R. BREDDINGTON, I.R. CRUTE., L.HADDAD, D. LAWRENCE, J.F. MUIR, J. PRETTY, S. ROBINSON, S.M. THOMAS and C. TOULMIN. 2010. Food Security: The Challrnge of Feeding 9 Billion People.Science. VOL. 327. No. 5967

HEINZ, G. and P.HAUTZINGER.2007. Meat Processing Technology for Small to Medium- Scale Producers. Food and Agricultural Organizations of the United Nations Regional Office for Asia AND THE Pacific. Bangkok, Thailand.

HELDMAN,D., R.W. HARTEL, 1997. Principles of Food Processing. Aspen Publishiers, Inc., Gaithersburg, Maryland

IBBARA, P.I. 1983. Meat Processing For Small and Medium Scale Operations. University of the Philippines, Los Baños, Laguna

LITTLE, C., J. MCLAUCHLIN. 2007. Food Poisoning and Food Hygiene. 7th Edition. Hodder Headline Group, Hachette, Livre, UK Company 338 Euston Road, London NWI 3BH

MCWILLIAMS, M. 2008. Food Experimental Perspective. Pearson Education, Inc., Upper Saddle River, New Jersey

PCARRD. 1991. The Philippines Recommends for Meat Processing. Los Baňos, Laguna

POTTER, N.N., J.H. HOTCHKISS. 1995. Food Science, 5th Edition, Chapman and Hall.29 West, New York

STANDAGE, T. 2009. An Edible History of Humanity. Published by Atlantic Books. Retrieved January 05, 2011 from www.atlantic-book.co.uk

WHITNEY, E.N., S. RADYROLFES. 2002. Understanding Nutrition. 9th Edition. Thompson Learning 60 Albert Street, No. 15-01 Albert Complex, Singapore

WIKIPEDIA. 2010. Smoking. Retrieved November 25, 2010 from http:/ en. Wikipedia.org/wiki/Smoking