BIBLIOGRAPHY

MARIO T. SILDON. APRIL 2012. Effect of the Different Drying Techniques on the Physical and Chemical Properties of Salted Pork. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted to determine the physical and chemical properties of salted pork as affected by using different drying techniques. Following the completely randomized design (CRD), a total of 16 kilograms of pork were obtained from a commercial pig and divided into four treatments with four replications each. The different drying techniques were sun drying and three solar drying with different materials as coverings.

Results of the study revealed that the pork dried using a solar dryer covered with clear glass and GI-Sheet had the highest amount of shrinkage at 29.38% as compared to the pork dried in solar driers covered with GI-Sheet + black polyethylene + white polyethylene; black polyethylene + white polyethylene; and sun drying which had shrinkage percentage of 29.13%, 27.75%, and 25.88%, respectively. In addition, it had the lowest moisture content of 10.39% compared to the pork dried in solar driers covered with GI-Sheet + black polyethylene + white polyethylene; black polyethylene + white polyethylene; and sun drying which had 55.07%, 35.67%, and 19.00%, respectively.

The results of the chemical composition of the treatments like nutrient composition and nutrition facts were dependent on the proportion of fat and lean of the samples subjected for analysis.

INTRODUCTION

Meat is the most valuable livestock product and for many people, serves as their first choice of animal protein (Heinz and Hautzinger, 2007). Meat also is an excellent source of proteins, B vitamins particularly B1 (Thiamin), B2 (Riboflavin), B6 and B12 (Cyanocobalamin), Niacin (Nicotinic Acid), Vitamin A (Retinol) and certain minerals needed by the body.

However, in spite of the numerous benefits of the dietary meat, it is highly perishable due to its high moisture and protein content which can be utilized by micro-organisms. This situation shortens the extension of the shelf life of meat. Therefore, creating an unfavorable environment for the microorganism is a must. Meat preservation is concerned mainly with preventing or delaying microbial spoilage; to ensure no nutrients are lost, and avoidance of any changes in taste and texture.

A preservation method includes the use of low or high temperatures, reduction of water content or adoption of chemical preservations. Among many preservation methods, dehydration or drying is probably one of the earliest and most effective methods developed. Solar drying works as a dehydrating mechanism to reduce the moisture content of the product to a specified value which in turn helps to preserve it. Moisture content (wet basis) is expressed as the weight of water as a proportion of total weight. In the Cordillera region, one ancient and indigenous technology of meat preservation that exists and still being practiced is the “etag” making.

Surprisingly, “etag” is not purposely to preserve the meat for variety of reasons but also because of its use in the performance of the religious and social rituals of the

Cordilleras (Longboan, 2010). “Etag” is a preserved meat using salt then dried either by smoking or sun drying.

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

The study used solar dryers to remedy the disadvantages of sun drying and to have a more hygienic dried meat as there is no secondary contamination. The result would be a great help to our meat industry particularly to the local producers of dried salted pork. The quality of improved quality “etag” if improved would also improve its market demand as it would attract more consumers or buyers. Also it would help encourage our “etag” producers to invest more on the product and go into commercial scale business and not producing it only for their own food consumption.

Generally, the study was conducted to evaluate the physical and chemical properties of solar dried pork.

The specific objectives are as follows:

1. determine the physical properties of solar dried pork in terms of color, and shrinkage;

2. determine the water content, protein, fat, minerals, and carbohydrates of the products,

3. calculate the nutrition information such as energy in calories, total fat, and protein per serving of the dried salted pork products; and

4. estimate the cost and return of drying salted pork using the different drying techniques.

The study was conducted at the Animal Genetic Resources (TANGERE) Project Laboratory of Benguet State University at Long-long, La Trinidad, Benguet on January 2012. Chemical analysis of solar dried pork was done at the DOST-CAR Regional Standards and Testing Laboratory in La Trinidad, Benguet.

REVIEW OF LITERATURE

Meat Curing

Preservation by curing with salt is very ancient; it was used by the Egyptians in 2000 BC. It's original meaning 'curing' meant 'saving' or preserving. Food-curing process therefore includes preservation processes such as drying, salting and smoking (Ranken, 2000).

Salt cures are ancient method of food preparation practiced by many cultures, and the process is still being practiced in the modern day. Meat curing was particularly important before refrigeration was widely available. In Medieval Europe, for instance, meat was often kept cool in underground caverns, but this practice was not always sustainable in salt to keep it from decomposing. Fishermen, particularly those in Scandinavia. Meat mongers began curing excess meat and meat to be consumed in the winter months developed salt cure processes to preserve fish around the same time (Adams, 2011).

Sun Drying

The basic traditional drying method is called sun drying, characterized by direct solar radiation and natural air circulation on the product. Sundried meat is a hand meat food produced by salting and dehydration procedures and commonly consumed by people from the north and north east areas of Brazil. Dried food retains more nutrients than canned foods and don't require the energy of a freezer. Dried food is concentrated, reducing bulk and weight to ½ to 1/15th that of hydrated food. Drying requires fewer containers and less storage space. A power failure can result in the loss of all frozen, but your dried foods will be A-ok. Drying can actually improve the flavor of many foods. Dried foods are convenient and easy to handle (Fodor, 2009).

According to Rajagopal (2005) sunlight not only removed maximum moisture but also its UV rays killed micro-organisms facilitating longer shelf life. An advantage of sun drying is that the natural taste would return upon reconstruction. FAO (2001) reported that in the absence of a cold chain, meat drying remains the most practical way of preserving and storing meat in developing countries with warm climate. It however, stated that the open air sun drying process which involves exposing pieces of meat to air and sunlight unprotected has a lot of disadvantages over oven-drying, as such meat pieces can be exposed to dust, rain, insects which contribute to general acceptability of the meat or non-acceptability of meat. Drying in the open air is a common phenomenon in developing countries and the effects need to be examined.

Sun drying is known to have disadvantages as a method of meat preservation. With sun drying, the meat is directly exposed to sources of contamination such as dust, sprays, gases, insects, rodents and birds. Changes in color, flavor, and surface microbial contamination may occur (Heinz and Hautzinger, 2007).

Little if any loss of nutritive value occurs during dehydration process of sun drying. Only water is removed from the meat. If the meat was brined or salted before drying, expect elevated levels of sodium to be present (Shaffer, 1998).

The higher foaming capacity of the sun dried sample is due to its higher protein content and lower fat content. This is an agreement with Iwe (2003) who reported that the foaming capacity of a substance depends on the surface active properties of the protein involved.

The most common problems of the respondents in Kalinga on "etag" making is the maggots brought about by flies. "Etag", when attacked by maggots, does not taste good and even have a foul odor. Majority 39 (69.90%) of the respondent said that the "etag" can be kept for a year. Seventeen or 27.42% of them said that the "etag" can be kept for two years and there were six among the respondents who said that the "etag" can be kept for years and years for as long as it has been dried well and stored in a dry place (Liggayo, 2009).

Solar Drying

In contrast to the open air sun drying, solar drying takes place in closed systems. Here a specific micro-climate is created, with higher temperature and lower relative humidity than in the outside surrounding air, and also with a reinforced air circulation through convection and tentatively with additional fans. These conditions favor the fast evaporation of a substantial part of the meat moisture. Furthermore, even under partly or fully clouded skies, there is still a certain amount of solar energy absorbed by the solar collectors, which keeps the air humidity low in the system, so that the drying process takes place. In contrast, during open air drying or "sun drying", the drying process will be slowed or stop in cloudy weather conditions (Heinz and Hautzinger, 2007).

They added that in this closed system, without direct exposure of the meat to the environment, meat drying is more hygienic as there is no secondary contamination of the products through rain, dust, insects, rodents or birds. The products are dried by hot air only. There is no direct impact of solar radiation (sunshine) on the product. The solar energy produces hot air in the solar collectors. Increasing the temperature in a given volume of air decreases the relative air humidity and increases the water absorption capacity of the air.

A steady stream of hot air into the drying chamber circulating through and over the meat pieces results in continuous and efficient dehydration.

In solar drying, maximum temperature is generally in the range of 50-55^0 C occurring at day-time with the strongest solar radiation at noon. Total drying time is approximately 48 hours including night time, the effective drying periods lost for eight hours a day during the main solar impact. Solar drying reduces to 45-35% of the original weight after one day, and 30-20% after one day. This corresponds to remaining moisture content in the meat of about 40-45% after one day and 12-18% after two days respectively. Continuous evaporation and weight losses during drying cause changes of the shape of the meat through shrinkage. The meat pieces become smaller, thinner and to some degree wrinkled and darker in color. The texture also changes from soft to firm to hard. The fact that dried meat is no longer comparable to fresh meat in terms of appearance; it has to be weighed against the significant extension of the shelf-life. Most nutritional properties of meat, in particular the protein content, remain unchanged through drying (Heinz and Hautzinger, 2007).

David and Whitfield (2000) stated that dried foods are tasty, nutritious, lightweight, easy-to-prepare, and easy-to-store and use. The energy input is less than what is needed to freeze or can, and the storage space is minimal compared with that needed for canning jars and freezer containers. They are also high in fiber and carbohydrates and low in fat, making them healthy food choices. Dried foods that are not completely dried are susceptible to mold. He stated that microorganisms are effectively killed when the internal temperature of food reaches 145 degrees Fahrenheit (^{o}F).

According to Morton (2008) "The eyes are the first that must be convinced before food is even tried. This means that some food products fail in the market not because the consumer never got that far". This is how important the appearance is.

Health Attributes

Health has been of increasing importance for consumer choice for the last 50 years. Nowadays, consumers have learned that there is a link between eating and health, they do not expect the consumption of a particular product on a particular occasion to have a health implication that they can experience. Many health effects of food are rather abstract in nature, like the risk of a particular disease being reduced by a certain percentage, and thus do not lead to consequences that are readily accessible to experience. Healthiness of various types of products in the past has been conflicting and consumers have constructed their own subjective theories of healthiness of products. These theories depend on the learning history of the consumers and thus individually different, but there are recurring themes like that industrial production is less healthy than craftsmanship, that additives are unhealthy, that fat is bad and that vegetables are good. These health claims will have a relevant impact on the consumer's food choice (Tepper and Ullrich, 2002).

MATERIALS AND METHODS

Materials

The materials used in making solar dried pork were fresh pork belly, rock salt and three improvised solar dryers. Other materials used were knives, straw, weighing scale, chopping board, glass thermometer, pan, basin, pen, and record book.

Methods

Preparation of the materials. A total of 16 kilograms of fresh pork belly from a warm hog carcass was used. Meat pieces were cut into 1-inch thick strips containing the skin, fat and lean. Then the meat strips were washed thoroughly with water and drained in a basin (Figure 1). After draining, the strips were placed in a pan for curing.

Curing/Salting. For every kilogram of meat, 180 grams of ordinary salt (NaCl) were rubbed on all sides of the meat strips (Figure 3). After rubbing, the meat strips were placed in a clean stainless container with cover and stored for 120 hours or 5 days (Figure 3). The curing period allowed the salt to penetrate into the meat.

Figure 1. Washing the meat strips

Experimental treatments. The cured meat strips were divided into four equal parts and allotted to the four treatments with four replications. Figures 3 and 4 show the drying techniques used in the study.

Figure 2. Pork strips dry cured (left) and placed in a stainless container for curing (right)

Figure 3. Pork strips being sun dried (T_0 - left) and solar dried (T_1 - right)

Figure 4. Pork strips dried inside the solar dryers (T_2 - left) and T_3 (right)

Following the completely randomized design of an experiment, the following drying techniques served as treatments.

T_0 = Sun drying (TA)

T_1 = Solar drying using white polyethylene as front cover and black polyethylene covering the left, right, back and the bottom (TB)

T_2 = Solar drying using white polyethylene as cover in front side and flat GI sheet on the back side including the bottom. The left and right side were covered with black polyethylene (TC)

T_3 = Solar drying using clear glass covering the front side and flat GI sheet covering the left, back, right, and the bottom side of the dryer (TD)

The drying techniques were as follows:

Sun drying. The technique involved exposing the pork pieces directly to sunlight and natural air circulation. The pork strips were hanged in the open air on a sun dryer made of wood.

Treatments 1, 2 and 3 used indirect solar radiation. The principle of solar drying techniques is to collect solar energy by heating up the air inside the solar chamber. Thus, the meat products were dried by hot air only. Treatment one made use of a wooden solar dryer with transparent polyethylene in the front side and black polyethylene in the back side. The bottom was covered with black polyethylene.

Solar dryer (T_2) consisted of white polyethylene in the front side and flat GI sheet in the backside. The left and right sides were covered with black polyethylene while the bottom was covered with flat GI sheet.

A solar dryer for treatment 3 had a clear glass cover on the front side and flat GI-sheet on the left, right and back sides. The bottom was covered with black polyethylene.

Solar drying. The four kilos salted pork were arranged by suspending them inside the solar dryers. There were spaces in between each meat to allow sufficient air circulation. The different dryers with each containing four kilograms of pork strips were placed in direct sunlight in an open area, away from animals, traffic exhaust, and dust. The different treatments had been solar dried starting at 8:00 o'clock in the morning until 3:00 o'clock in the afternoon. Meat was collected from the four treatments at 3:00 o'clock PM and placed in a clean basin separately. After, it was put in an airy and dry shade to prevent scorching. The drying temperature for outside temperature of T_0 and internal temperature of T_1, T_2, and T_3 was collected at 9:00 o'clock AM, 12:00 o'clock noon and 3:00 o'clock in the afternoon. This drying routine had been continuous for a maximum of six days until a water content of about 80% is attained. One procedure had been followed to produce the solar dried meat.

Sanitation and hygiene. To prevent or minimize microbial contamination, good hygienic practices in meat processing and handling of solar dried products had been 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 the work.
5. Cleaning/Disinfection of tools, knives, chopping boards, utensils, and other materials for meat handling.
6. Taking any necessary precautions to protect against contamination of meat and finished product.

Data Gathered:

1. Weight before drying (kg). This was the weight of the salted pork before it had been subjected to drying in the morning from day one to six.

2. Weight after drying (kg). This was the weight of the salted meat after it had been dried in the afternoon from day one to seven.

3. External and internal temperature. This was the temperature outside and inside the solar dryers that had been taken at 9:00 o'clock AM, 12:00 o'clock noon and 3:00 o'clock PM.

4. Drying period. This was the number of days the salted meat was dried.

5. Cost. The cost of meat, salt, solar driers and labor that was recorded.

7. Sales. All the dried products were considered sold at Php 375.00 per kilogram.

6. Physical Properties.

6.1. Salinity. This was taken by using brine meter or Salonometer.

6.2. Color of the product. This had been determined by ocular observation.

Data Computed:

1. Shrinkage percentage (%) per day. This was obtained by subtracting the final weight after drying from the initial weight and dividing it by its weight before drying then multiplied by 100 percent.

2. Nutrient analysis. This was the amount of the minerals (ash), crude fat, crude protein, and moisture contents of the products that had been analyzed using the methods of AOAC (2005) while carbohydrate and energy contents were been calculated based on FNRI-DOST handbook (1997).

2.1 Ash by gravimetric method (AOAC Method No. 942.05)

2.2 Crude fat by Soxhlet extraction (AOAC Method No. 920.39)

2.3 Crude protein was calculated from the nitrogen content of the food (% N x 6.25), as determined by Kjeldahl method (AOAC Method No. 981.10) and in accordance with the 2000 Digestion System and Kjeltec 1002 Distilling Unit Instruction Manual)

2.4 Moisture by oven drying method (AOAC Method No. 934.01)

2.5 Carbohydrate by calculation (FNRI-DOST Handbook)

2.6 Energy by calculation (FNRI-DOST Handbook)

3. Nutrient Facts. Amount of calories, calories from fat, total fat, sodium and protein had been analyzed at the College of Home Economics.

4. Total Cost of Production (TCP). This was computed by adding the cost of the meat, labor and the depreciation cost of the dryers.

5. Net Income (NI). This had been obtained by subtracting the TCP from the sales of the solar dried products.

6. Return on investment (ROI). This had been obtained by dividing the NI by the TCP multiplied by 100.

Statistical Analysis

The data gathered had been recorded, tabulated and analyzed for their difference using the analysis of variance for CRD. The Duncan's Multiple Range Test (DMRT) had been used to determine the significant differences among treatments.

RESULTS AND DISCUSSION

Drying Temperature

The drying temperature was gathered using a glass thermometer. Drying temperature for sun drying was gathered outside while temperature for treatment 1, 2, and 3 was gathered inside the solar dryers. Table 1 presents the mean temperature of the different treatments used in the study. Treatment 3 showed the highest mean temperature of 42 ^{0}C while sun drying had the lowest temperature of 23^{0}C. Whitfield (2000) stated that temperature ranges of 100 to 160 degrees F. (37.2^{0}C to 71.2^{0}C) will effectively kill bacteria and inactivate enzymes, although temperatures around 110 degrees F (43.2^0 C) are recommended for solar dryers. Maximum temperatures are generally in the range of +50-55°C during day-time with the strongest solar radiation (usually at noon). During the other periods of the day the temperatures gradually decline in relation to the solar impact to reach minimum values of approx. +30°C in the morning and evening hours.

An increase of 12^{0}C was observed between sun drying and solar drying that made use of black and white polyethylene as cover. Treatment 2 was made up of flat GI-

Table 1. Mean drying temperature (^{0}C) of the different treatments

TREATMENTS	DAYS						TOTAL	MEAN (^{0}C)
	1	2	3	4	5	6		
TA	24	22	24	22	24	23	139	23
TB	35	29	35	38	36	37	210	35
TC	40	32	40	40	42	40	234	39
TD	44	36	43	43	44	44	254	42

*TA=Sun drying ; TB= Solar dryer with black and white polyethylene; TC= Solar dryer with flat GI-Sheets, black and white polyethylene ; TD= Solar dryer with flat GI-Sheets and clear glass

Sheet as a bottom cover, black and white polyethylene for the sides was 4^0C higher than treatment 1. Moreover, 3^0C was the difference between the mean temperature between solar dryer for treatment 2 and 3. It is therefore understandable that since the mean temperature was lower in sun drying and higher in solar drying, the materials used as covering for the solar dryers had an effect on the rise in temperature inside the solar dryers.

Color of the Product

The color of the dried pork was derived using ocular observation to provide objective index for food quality. The color of the fresh pork before it was salted had a purple red lean with a white fat portion. According to Heinz and Hautzinger (2007) meat color is dependent on myoglobin protein, which is part of the sarcoplasmic, or plasma, proteins (water soluble proteins). Fresh meat, in the presence of oxygen appears bright red; in the absence of oxygen, it appears purple-red. According to Coultate (1996) freshly cut surface of a piece of meat, as one would expect, the corresponding shade of dark red/ purple. Soon, diffusion of oxygen into the surface begins to convert myoglobin (Mb) into oxy-myoglobin (MbO_2) and the meat acquires an attractive bright red appearance as a layer of MbO_2 develops.

After drying, the dried pork (Figure 5) from the different treatments had no differences in terms of color of the peripheral layer of the lean. However, the colors of the center and fat from each sample differed from each other. The pork dried directly under the sun had a reddish center and white fat between the lean and the skin. The skin was colored brown red as compared to the pork dried in the solar dryers. Pork dried in treatment 1 had a center colored light red and light brown fat including the fat in between the skin and the lean. Pork dried from treatment 2 had a fat with a uniform brown in appearance observed in its skin and fat. Moreover, pork dried in treatment 3 had a completely dark lean at the center and brown fat. However; some portions of the fat especially the external sides exposed to more heat were colored orange brown. The differences in color confirm the effect of the different treatments on the physical characteristics of the dried samples.

Figure 5. Pork strips after drying

Amount of Shrinkage

The shrinkage percentage represents the moisture lost from the samples due to heat during the drying period. Table 2 shows the amount of shrinkage of the salted dried pork significantly different as affected by the drying techniques used.

According to Parker (2003), water is lost rapidly at first during drying because it is being lost from the surface of the food. The outer dry layer creates an insulation barrier preventing rapid heat transfer into the food. The result shows that pork in treatment 1 had 27.75% shrinkage while pork dried in treatments 2 and 3 had a 29.13% and 29.38% shrinkage respectively. Pork dried using sun drying technique had the lowest shrinkage of 25.88% as compared to the pork dried in the solar dryers. The sample dried in treatment 3 had the highest shrinkage percentage or having the highest moisture loss since it had been dried in a solar dryer with the highest temperature. It is also shown that when pork was dried using solar dryer, 1.87% shrinkage occurred and when it was dried in a solar dryer, another 1.38% occurred. In addition, 0.25% shrinkage occurred in samples from treatment 3.

Analysis of variance revealed highly significant differences ($P \leq 0.05$) in shrinkage among pork dried from the different treatments. Pork dried in treatment 3 was significantly higher than the pork dried in sun drying. Differences between the shrinkage among pork dried in treatment 1 and 2, were found to be not significant. This confirms the beneficial effects of the drying techniques on the shrinkage of pork, and also shows that drying pork using solar dryers is a faster way in decreasing moisture content.

Table 2. Mean shrinkage (%) of solar dried pork as affected by different drying techniques for six days

TREATMENT	MEAN
TA	25.88[b]
TB	27.75[ab]
TC	29.13[ab]
TD	29.38[a]

[1] TA=Sun drying ; TB= Solar dryer with black + white polyethylene; TC= Solar dryer with flat GI-Sheets + black polyethylene + white polyethylene ; TD= Solar dryer with flat GI-Sheets + clear glass
[2] Means with the same letter are not significantly differed at 5% level of significance ($P \geq 0.05$)

Nutrient Composition

The chemical analysis determines the content of the samples to establish its nutritive value and economic value. Analysis for ash, crude fat, crude protein, moisture, energy in calories and sodium of the samples from the different treatments are presented in Table 3.

Lonergan (2012) stated that muscle contains approximately 75% water. The other main components include protein (approximately 20%), lipids or fat (approximately 5%), carbohydrates (approximately 1%) and vitamins and minerals (often analyzed as ash, approximately 1%).

Results in the table show that the pork dried in a solar dryer enclosed with clear glass and flat GI-Sheets had the least moisture content of about 10.39% followed by the sundried pork having 19.00% moisture. Pork dried in a solar dryer enclosed with a GI-Sheet, black and white polyethylene had 35.07% moisture. Lastly, pork dried in a solar dryer with white and black polyethylene covering had 35.67%. The more the micro climate of the drying medium through use of heat absorbing materials like flat GI- sheets as covering, the more heat is absorbed thus resulting to a faster moisture loss in the meat. The accuracy of moisture determination according to Meloan and Pomeranz (1994) is affected by the drying temperature, and relative humidity of the drying chamber, depth and particle size of samples, and the number and position of samples. The moisture content of meat is dependent on the fat contents, and varies to a lesser degree with the age, source, and growth season of the animal.

Table 3. Nutrient composition of salted pork dried as affected by different drying techniques

TREATMENT	Ash, (% w/w)	Carbohydrate (% w/w)	Crude Fat, (% w/w)	Crude Protein (% w/w)	Moisture (% w/w)	Energy (kcal)	Sodium, (mg/100 g)
TA	16.87	0	46.29	21.03	19.00	501	5727
TB	10.33	0	29.08	30.03	35.67	382	3288
TC	6.09	0	30.26	28.58	35.07	387	1484
TD	26.67	0	30.90	36.52	10.39	424	6105

[1] TA=Sun drying ; TB= Solar dryer with black + white polyethylene; TC= Solar dryer with flat GI-Sheets + black polyethylene + white polyethylene ; TD= Solar dryer with flat GI-Sheets + clear glass
[2] Analyzed by the Regional Standards and Testing Laboratory of the Department of Science and Technology-CAR, La Trinidad, Benguet

Table 3 shows that sample from treatment 3 had the highest crude protein percentage of about 36.52% as compared to samples from treatment 1 having 30.03%, treatment 2 had 28.58%, and sun drying which had 21.03% crude protein.

Results presents that the pork dried in sun drying had the highest crude fat content of 46.29% and at the same time energy value of 501 kcal of energy while treatment 1 had 29.08% crude fat and an energy of 382 kcal. On the other hand, the pork dried in treatment 2 had 30.26% crude fat content and an energy value of 387 kcal. Treatment 4 had also crude fat content of 30.90% and an energy value of 424 kcal. According to Gamman and Sherington (1994) the energy value and crude fat content are closely related since the higher the crude fat content the higher the energy value content of the product. Fat has more than twice the caloric value of carbohydrates and is therefore a more concentrated source of energy.

Results in the table also show that the pork dried in the solar dryer with glass (T_3) had the highest crude protein of 36.52% and an ash content of 26.57% followed by the pork dried directly under the sun having 21.03% crude protein and 16.87% ash. Pork dried inside the solar dryer with black and white polyethylene had 30.03% crude protein and 10.33% ash while pork dried inside the solar dryer with galvanized iron and black and white polyethylene cover had 28.58% crude protein and 6.09% ash. It was observed that samples dried using solar dryers had less in ash and more crude protein than the samples dried directly under the sun. The pork dried in the solar dryers and sun drying had a sodium content of 6105 mg, 1484 mg, 3288 mg and 5727 mg, respectively. Table 3 shows that all the samples from the different treatments had zero carbohydrate. Carbohydrates in meat are the metabolic reserves called glycogen a polysaccharide is stored in muscles and mainly in the liver (Meloan and Pomeranz, 1994).

Nutrient Facts

The nutrition facts normally appear in food labels as prescribed by the Bureau of food and drugs (BFD) of the Department of Health. Table 4 presents the computed nutritional facts of the solar dried products in the different treatments in terms of crude fat, crude protein, moisture, energy, and sodium.

The carbohydrates, fats, and proteins in food supply energy are measured in calories. Carbohydrates and proteins provide 4 calories per gram. Fat contributes more than twice as much as about 9 calories per gram. Foods that are high in fat are also high in calories (Parker, 2003).

Table 4. Nutrition facts of 240 grams dried pork sample as affected by drying techniques

TREATMENT	CRUDE FAT (g)	CRUDE PROTEIN (g)	ENERGY (kcal)	SODIUM (mg/100g)
TA	111.10	50.47	501	5727
TB	69.79	72.07	382	3288
TC	72.62	68.59	387	1484
TD	74.16	87.65	424	6105

[1] TA=Sun drying ; TB= Solar dryer with black + white polyethylene; TC= Solar dryer with flat GI-Sheets + black polyethylene + white polyethylene ; TD= Solar dryer with flat GI-Sheets + clear glass
[2] Fat=9 kcal/gram, Carbohydrate=4 kcal/gram

Results show that the sample weighing 240 grams dried pork from sun drying had the highest crude fat content of 111.10g, and a crude protein of 50.47g and in it having an energy value of 501 kcal, whereas, the pork dried in treatment 2 and 3 had a lesser energy values of 382 kcal and 387 kcal, respectively. Samples dried from treatment 3 were not the highest in fat content than the other samples. Moreover, it had the highest crude protein content (87.65%) and energy values of 424 kcal.

The differences in the energy content of the dried salted pork in this study was due to differences in the proportion of fat and lean of the sample subjected for analysis.

The protein content of the dried salted pork products ranges from 50.47 to 87.65 depending on the part of meat subjected to analysis. However, it must be considered that meat and meat products provide a complete protein source that contains, in favorable quantities of all the essential amino acids.

Daily Values

The recommended intake of a 2,000 calorie diet for nutrients were all declared as percent daily values in Table 5. Pork dried directly under the sun had 50 grams of crude fat, 10.10 grams of crude protein thus producing the least energy of about 25.05 kilo calories. Treatment 1 and 2 had 31.41g, 32.68g of crude fat with an energy value of 19.10 kcal and 19.35 kcal, respectively. Obviously, the pork with the highest amount in crude fat, crude protein and energy had the highest percent daily value required. All the sodium content of pork dried from the different treatments exceeded to the required percent daily intake of 18 years old and above, therefore, these should be eaten or cooked with mixture instead of eating it singly in one meal.

Table 5. Percent daily values of dried pork as affected by drying techniques

TREATMENT	CRUDE FAT (g)	CRUDE PROTEIN (g)	ENERGY (kcal)	SODIUM (mg/100g)
TA	50	10.10	25.05	Amount is exceeding the recommended intake of 500mg for eighteen years old and above
TB	31.41	14.41	19.10	
TC	32.68	13.72	19.35	
TD	33.37	17.53	21.20	

[1]TA=Sun drying ; TB= Solar dryer with black + white polyethylene; TC= Solar dryer with flat GI-Sheets + black polyethylene + white polyethylene ; TD= Solar dryer with flat GI-Sheets + clear glass
[2] Computed based on 2,000 calorie-diet

Table 6. Return on investment of the dried products from the different treatments

TREATMENT	SALES (Php)	EXPENSES (Php)	NET INCOME (Php)	ROI (%)
TA	2,780	1,959	821	42
TB	2,709	1,960	749	38
TC	2,658	1,960	698	36
TD	2,648	1,961	687	35

*TA=Sun drying ; TB= Solar dryer with black + white polyethylene; TC= Solar dryer with flat GI-Sheets + black polyethylene + white polyethylene ; TD= Solar dryer with flat GI-Sheets + clear glass

<u>Return on Investment</u>

The sales, expenses, net income, and return on investment of each treatment are shown in Table 6.

A. Return on investment of the dried products from the different treatments was obtained using the following assumptions:

1. 10 kg raw pork was to be dried per treatment

2. Dried products was sold at 375 Php /kg

3. Weight of finished products:

T_0= 7.412

T_1= 7.225

T_2= 7.087

T_3= 7.062

4. Shrinkage per treatment:

T_0= 25.88%

T_1= 27.75%

T_2= 29.13%

T_3= 29.38%

B. Solution:

Weight of moisture loss = (percent shrinkage /100) Initial weight

Final weight of product = initial weight – moisture loss

Sales = Final weight of product X price / kg

Dried products from treatment 1 had the highest ROI of 42 % followed by treatment 2 which was 38%. Treatment 2 had a lower net income and ROI because it had a lesser sales and greater expenses than dried products from sun drying and treatment 1. Moreover, treatment 3 having made use of a flat GI-Sheet and a clear glass as a cover had the highest expenses plus it had produced the lowest weight of products had the lowest income thus having the lowest return on investment. The table also reveals that sun drying had the lowest cost of production, and the highest in terms of sales, thus realizing a higher income and ROI.

However it must be considered that sales depend on the number and educational knowledge of consumers. Consumers nowadays preferred products that had a high quality, longer shelf life and some preferred low in fat for meat products. These attributes were the characteristics of pork dried in the solar drying techniques. Pork dried in treatment 3 would likely have the highest sales, net income and return on investment.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The study was conducted to determine the effects of the different drying techniques on the physical and chemical properties of pork. The study was conducted at the Animal Genetic Resources (TANGERE) Project Laboratory of Benguet State University in Bektey, Puguis, La Trinidad, Benguet on January 2012.

A total of 16 kilograms of salted pork belly was obtained from a three months old landrace was used in the study. These were equally divided into four treatments following the Completely Randomized Design (CRD). Each treatment had four replications with one kilogram of pork per replication. Solar dryers used were all triangular in shape

To produce the solar dried pork, the same procedure was followed in all the four treatments except on the techniques of drying used. The meat assigned in the control treatment was sundried while treatments 1, 2 and 3 are solar dried except on the types of materials used as coverings differed. Drying meat in sun drying was exposing the meat externally with no coverings. Solar dryer in treatment 1 had a front side covered with white polyethylene and its left and right side including the bottom was covered with black polyethylene while treatment 2 had a front side covered with white polyethylene, the left and right sides covered with black polyethylene with its bottom coved with flat GI-Sheet and lastly the treatment 3 had a front side covered with clear glass while the back, left, and right sides were all enclosed with flat GI-Sheets.

The data gathered were all focused on the physical properties of pork in terms of shrinkage percentage, color, and chemical properties in terms of food composition; moisture, crude protein, crude fat, carbohydrate, ash, energy contents and nutritional facts.

In terms color, the pork dried in sun drying had a reddish lean at the center and had a larger white portion of fat while pork dried in treatment 3 had a completely dark lean at the center and brown fat with some portions of the fat in the external sides were colored with yellow brown. In terms of shrinking percentage, the pork dried directly under the sun had the lowest shrinkage and the pork dried in T_3 had the highest shrinkage. These results prove that the higher the drying temperatures of the different treatments, the higher the water loss and the more the center of the meat turns darker.

The results of the chemical composition of the treatments, i.e. nutrient composition and the nutrient facts, were dependent on the portion of the pork subjected for analysis and the effect of the drying techniques.

The pork dried in sun drying had the highest net income produced and return on investment while pork dried in treatment 3 had the lowest in terms of dried products produced, net income, and return on investment.

Conclusions

Based on the results the following conclusions were drawn:

a. The pork dried in sun drying technique had a white fat, an indication of insufficiently dried, making it more susceptible for bacterial growth.

b. The pork dried using solar dryer covered with GI-Sheet + clear glass technique had the lowest moisture content, therefore it can be stored for a longer time.

c. The pork dried using solar dryer covered with GI-Sheet + clear glass technique had the least in terms of products produced, net income and return on investment but superior in terms of quality.

Recommendations

Based on the above results, the following recommendations were offered for consideration:

a. The pork can be dried using solar drying if the purpose is to have a dried meat that will be consumed immediately.

b. The pork should be dried using solar dryer covered with flat GI-sheets at the sides and a front side covered with a clear glass if the product is to be stored for a long period of time.

c. The pork to be dried should be the lean parts with no visible fat proportion if the purpose is to have a lesser fat content.

d. More studies should be conducted on the effect of drying techniques on the nutrient composition of dried salted pork.

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