

## INTRODUCTION

Sausage is a meat product usually made from ground meat, often pork, beef, or veal, mixed with salt, spices, and other flavorings. Typically, a sausage is formed in a casing traditionally made from an intestine, which is edible, but sometimes from synthetic materials which are inedible. Sausages are usually cooked in many ways, including pan-frying, broiling, and barbecuing. Some sausages are mainly cooked during processing, and the casing may be removed.

The Philippine processed meat industry has six categories: fresh processed meat products, cured meat pieces, raw-cooked products, pre-cooked products, raw (dry) – fermented sausages, and dried meat. Major export products are sausages, corned beef, bacon, luncheon meat, and other indigenous meat products (DTI, n.d.).

Meat processing can serve as an essential technology to solve the problem of food insecurity. Processing raw meat into products adds value, increases yield, extends the meat's shelf life, and provides employment (Smith & Hui, 2004). Meat is processed to reduce spoilage by adding ingredients or mechanical action to convert it into specific products, which may include sausages, burgers, and many more, to meet the desires of consumers (Teye, 2007).

The conventional use of artificial additives and chemicals as preservatives is receiving a lot of mixed feelings from consumers for health reasons. Some ingredients are indispensable because they are essential in inhibiting the growth of food-poisoning microorganisms, but their use is reduced. Hypertension and obesity are perceived to be associated with artificial additives (Lawrie & Ledward,

2006). One way of solving this problem is by using natural spices and herbs, which are believed to have beneficial health effects.

Tarragon (*Artemisia dracunculus* L.), Thai basil (*Ocinum basilicum* var. *thyrasiflora*), and Lemon basil (*Ocinum citriodorum*) are some herbs used in culinary arts but may be used in the manufacture of sausage. They provide healthy sausage products, as the study indicated that Tarragon helps treat high blood pressure, diabetes, and other illnesses. These results of the study also will help the health-conscious individuals to venture into healthier food options, specifically with choosing sausages that are infused with natural spices and herbs like those used in this study (<http://articles.mercola.com/herbs-spices/tarragon.aspx>).

The general objective of the study was to evaluate the sensory characteristics of sausages processed from chilled pork with different herbs like Tarragon (*Artemisia dracunculus* L.), Thai basil (*Ocinum basilicum* var. *thyrasiflora*) and lemon basil (*Ocinum citriodorum*).

### **Study 1. Yield and Sensory Characteristics of Sausages Using Pork Chilled at Different Periods**

The objectives of this sub-study were to (1) Determine the effect of chilling on the yield and recovery of sausages and (2) Evaluate the sensory characteristics of sausages processed using pork chilled at different periods. The results served as the basis for the chilling time in Study 2.

## **Study 2. Sensory Characteristics, Consumer Preference, and Shelf Life of Sausages Processed from Chilled Pork with Different Herbs**

The pork used in processing sausages with different herbs was chilled based on the results of Study 1. After chilling, sausages were processed with three herbs: Tarragon, Thai basil, Lemon basil, and without herbs (control). The sausages were evaluated for their sensory characteristics and acceptability to consumers. Specifically, Study 2 aimed to: (1) Evaluate the sensory characteristics of pork sausages with Tarragon, Thai basil, and Lemon basil, (2) Determine consumer preferences, and (3) Determine the shelf life based on the microbial count of sausages.

The study results will be able to serve as a guide and provide processors and consumers with additional variants to the typical sausages. Healthy sausages will be offered to consumers.

Study results will explain the potential benefit of using Tarragon, lemon basil, and Thai basil in chilled pork sausage. The herbs will enhance the nutritional value of processed meat because of the essential components of these herbs added to the product.

For researchers, the study will provide information to both students and future researchers on the utilization of culinary herbs in the manufacture of processed meats.

Herb growers. More demand for these herbs would mean more income to growers.

The study focused on the sensory characteristics, consumer preference, and shelf life of pork sausage processed with different herbs. The meat were

sourced from a reputable meat dealer, including the casing while the other ingredients, and the herbs used were planted in the backyard.

The study was conducted from December 2018 to February 2019 at the CBSUA Department of Animal Science, Meat Laboratory, San Jose, Pili, and Camarines Sur. For the shelf life, samples were analyzed at the Food Testing Laboratory, Department of Food Technology, CBSUA Compound San Jose, Pili, and Camarines Sur.

For a better understanding of the study, the following terms were operationally defined:

Aroma is the characteristic odor due to the volatile compounds of roasted sausage with different herbs perceived by the olfactory nerves while the sample is still warm or hot.

Color is the property of roasted sausage with different herbs perceived by the eyes.

Consumer preference refers to the preference tests, where products tested are ordered by the panelists in order of preference of specific attributes like color, texture, and consistency.

Cooking loss is derived by getting the difference between the weight before and after cooking divided by cooking multiplied by 100%.

Curing salt is a specially formulated salt and contains 99.6% sodium chloride and 0.4% sodium nitrite, and sodium nitrate. It provides a different cured pigment and flavor and helps prevent rancidity.

The flavor is the distinctive quality of roasted sausage with different herbs perceived by the tongue upon chewing.

General acceptability is the totality of the attributes of the roasted sausage with different herbs.

Lemon basil is a common herb with a tangy fragrance and is very strong in taste.

"Longanisa," or generally fresh sausage, consists of meat cut into pieces or ground and filled into a casing with other ingredients.

Meat processing is a process done to prolong storage or shelf life.

Meat refers to animal carcasses sufficiently matured and healthy and thus fit for human consumption.

The sausage casing is the container used for the processed sausage and serves as the mold. It determines the sausage's size and shape and processes mold during handling, shaping, drying, or display.

Sensory characteristics refer to the determinant of the sausage, which will be the basis of its acceptability. These are color, aroma, flavor, tenderness, juiciness, and general acceptability.

Sensory evaluation is a scientific discipline used to evoke, analyze, measure, and interpret those characteristics of foods and other materials as they are perceived by the senses of sight, smell, taste, touch, and hearing.

Tarragon (*Artemisia dracunculus* L.) is an herb used for culinary purposes.

Tenderness is the softness of the food for the teeth to go through quickly without chewing or refers to the ease of separating the particles during the first few chews.

Thai Basil (*Ocimum basilicum* var. *thyrsiflora*) is a tropical variety of sweet basil that provides the unusual basil flavor present in so many Thai dishes that it has come to be identified as "Thai basil" in America, even though the Vietnamese and Laotians also use lots of it in their cuisines.

Total plate count (microbial count) is the enumeration of aerobic, mesophilic organisms (Microorganisms) that grow in aerobic conditions under moderate temperatures of 20-45°C.

9-Point Hedonic Scale is the most widely used scale for measuring food acceptability based on color, aroma, flavor, tenderness, juiciness, and general acceptability.

## **REVIEW OF RELATED LITERATURE**

This chapter presents studies conducted on meat preservation and processing.

### **Effects of Chilling the Meat**

In batch chilling, carcasses are loaded into a chiller throughout slaughter, and all carcasses in a chill room are cooled together overnight. Chilling requires 14-16 hours.

The efficiency of chilling is defined mainly by the air temperature and velocity in the chill room, the carcass weight range, and the loading pattern of the chiller. As a guide, pig carcasses under 110 kg should be chilled below 7<sup>0</sup> C within a 24-hour processing cycle with an air temperature close to 0<sup>0</sup> C at a 3.0 meters per second or more velocity. Less powerful chilling equipment obviously cannot achieve these targets. Conventional chilling avoids cold shortening and therefore results in enhanced pork eating quality (tenderness) compared to faster chilling regimes Water-holding capacity of processing capacity is generally good (Carcass Chilling System and Their Impact on Meat Quality).

Temperature control is a crucial element in improving the safety and eating quality of meat, and this has led to more emphasis being placed on the design and operation of meat refrigeration processes. One development has been reintroducing aging (maturing) rooms for beef, lamb, and, more recently, pork and turkey. Aged meat is expected to take up a higher percentage of the total market. In the past decade, using impingement technology to increase surface heat

transfer in freezing systems has received attention. Under chemical conditions, differences in freezing rates are unlikely to produce noticeable changes in the organoleptic quality of the meat produced. However, legislation requires a minimum meat temperature of  $-12^{\circ}\text{C}$  before moving meat from the freezing system. Freezing time is, therefore, of considerable economic importance (Christian & Stephen, 2010)

### Sausages

Sausages are defined as comminuted seasoned meats stuffed into casings. They may be cured, dried, or fermented. They are made from any edible part of animals and some non-meat ingredients (FAO, 2010). Meat processing provides farmers with a ready animal market, encouraging improved and increased production (FAO, 1991; Teye, 2010). Based on the method of processing, there are six types of sausages. These include; fresh, cooked, smoked and cooked and uncooked smoked, semi-dried, dried, and specialty sausage (FAO, 1992).

### **The Composition of Meat and its Nutritive Value**

The Philippines is a net exporter of processed meat products. In 2013, the industry generated US\$ 47.3 million in exports. Major export markets include the United Arab Emirates, Qatar, Saudi Arabia, Kuwait, Japan, the United States, Canada, Guam, and Taiwan—the local industry imports around 85% of its raw material inputs. In terms of finished processed meat, the majority of its output meets domestic demand. There are 175 meat processors in the country, the majority of which are located in the National Capital Region, Region III, and Region IV-A. The Philippine Association of Meat Processors, Inc. (PAMPI) comprises



member companies that produce about 600 million kilos of meat products worth over P 90 billion. Canned and processed meat products include ham, hotdogs, luncheon meat, sausage, and bacon. (Securing the Future of Philippine Industries <http://industry.gov.ph/industry/processed-meat/>)

Meat has long been known for its nutritive value, which could explain why it is being consumed by many people worldwide. The protein profile of meat consists of amino acids that have been described as excellent due to the presence of all essential ones required by the body (FAO, 2010). Many of the world's population relies on meat as a food source. It has also been proven that some proteins and vitamins (especially A and B12) in meat could not be substituted for by plant protein sources, further justifying the nutritive importance of meat (FAO, 2010).

The composition of meat, after rigor mortis but before post-mortem degradative changes, can be approximated to 75% water, 19% protein, 3.5% soluble, non-protein substances, and 2.5% fat. The proteins in muscle can generally be divided into those which are soluble in water or dilute salt solutions (the sarcoplasmic proteins), those which are soluble in concentrated salt solutions (the myofibrillar proteins), and those which are insoluble in salt solution (the connective tissue proteins). The sarcoplasmic proteins are a mixture of several hundred molecular species. Several sarcoplasmic proteins are enzymes of the glycolytic pathway and may be present in more than one form of isozymes. Proteins of beef consist of essential amino acids such as leucine, isoleucine, lysine, methionine, cysteine, phenylalanine, threonine, tryptophan, valine, arginine, and histidine; of these, the last two are considered essential for infants.

Amino acids are necessary for maintaining and repairing human body tissues (Lawrie & Ledward, 2006).

Meat is also a good source of micronutrients: low-fat pork contains 1.8 mg iron and 2.6 mg zinc, and pigs' liver contains 360 mg magnesium, 20 mg iron, and 60 µg selenium per 100 µg (Biesalski, 2005). A daily intake of 100 g of meat and liver can supply up to 50% of the recommended daily allowance for iron, zinc, selenium, vitamins B1, B2, B6, and B12, and 100% of vitamin A (Biesalski & Nohr, 2009).

Meat products such as sausages and burgers require the use of spices. Spices are esoteric food adjuncts used as flavoring agents and preservatives in meat products (Srinivisan, 2005). Spices and herbs are valued for their distinctive flavor, color, and aroma. They are among the most versatile and widely used ingredients in food preparation; hence the meat industry cannot be imagined without spices (Skrinjar et al., 2012). Over 400 spices have been used worldwide (Ceylan & Fung, 2004). Herbs and spices have tremendous importance in the lives of humans as ingredients in food, alcoholic beverages, medicine, and cosmetics (Ravindran et al., 2002).

The importance of meat as an essential source of some micronutrients is because it is their only source or they have a higher bioavailability. Vitamins A and B12 occur exclusively in meat and can hardly be compensated for by plant-derived pro-vitamins (Biesalski, 2005). Iron has a higher bioavailability from meat than from plants, as is folic acid, which is nearly 10fold more, especially from liver or eggs, than vegetables (Biesalski & Nohr, 2009). Deficiency and repeated

respiratory infections can be treated therapeutically with moderate vitamin A supplementation (Biesalski, 2005). Vitamin A is also responsible for lung development and maturation and for the development of other tissues, and control of these processes depends on the expression of Retinoic Acid (RA receptors) (Biesalski & Nohr, 2009). Although the liver is the best available source of vitamin A, it has a 'bad reputation' due to other potentially harmful constituents such as heavy metals, hormones, or xenobiotics (Biesalski, 2005). In order to obtain the recommended 1 mg retinol per day from vegetables, 500 mg of mixed and  $\beta$ -carotene-rich vegetables have to be eaten daily, while 100 g of liver twice a month is sufficient and is neither toxic nor teratogenic (Biesalski, 2005; Nohr & Biesalski, 2007). In addition, elderly people are particularly at risk of vitamin B12 deficiency, mainly due to suboptimal intestinal absorption (Biesalski & Nohr, 2009).

There are several groups of people, especially elderly people, that could be at risk of deficiencies of one or more micronutrients: A, D, E, folate, iron, and calcium, primarily because of diseases and an age-adapted lifestyle, less because of physiological problems (except for iron and vitamin B12 uptake due to gastric mucosal atrophy) (Biesalski & Nohr, 2009)

### **Meat Processing by Comminution**

Comminution is the process of reducing whole muscle to small particles (FAO, 1991). The degree of comminution differs among various processed products. It ranges from coarsely finely comminuted to form an emulsion (FAO, 2010). Meat trimmings, meat pieces, and fatty tissues that could otherwise not be utilized are comminuted and spiced to form high-quality meat products (FAO,

2010). Typical examples of comminuted meat products include; sausages, meat loaves, burgers, and liver patties.

Since chemical and enzymatic reactions influence microbial activities, the effect of low temperatures on microorganisms is essentially a growth radiation process. Most microorganisms will not grow at freezing temperatures due to reduced metabolic activities: however, these microorganisms will begin to grow again when placed in warmer temperatures (Ingram and Mackly, 1976; Cunningham and Cox, 1987; Mountey & Gould, 1988).

### **Ingredients and Preservatives**

An ingredient is a recipe component added in a specific quantity to the products. Most ingredients may be purchased at local supermarkets or meat markets unless it comes from the livestock farm or game. Home-grown or custom meat should come from healthy and disease-free livestock. Specific cuts of meat, generally of lower economic value, are suggested for sausage making (FAO, 1991).

Non-meat ingredients are used to impart flavor, slow bacterial growth, and increase the yield of the sausage. These include water, salt, sugar, non-fat dry milk, extenders and binders, and spices (FAO, 2007).

Salt is an ingredient that is always used in sausage products. Technically, it is the only non-meat substance required for a product to be considered a sausage (FAO, 2007). Salt serves three functions in the meat. It lowers the amount of available water (which allows for preservation or shelf-life extension), extracts the meat myofibrillar proteins needed to make the product bind and

emulsify fat, and for flavor enhancement (FAO, 2007). Salt is added at 1% to 2% (w/w) of the total sausage batter weight.

Sugar is used for flavor and to counter the slightly bitter taste of salt. It is also added as a medium for microbial fermentation to reduce the pH of dry and semi-dry sausages (for example, pepperoni). The lactic acid produced by fermentation of the sugar (usually dextrose) reduces the meat's pH and gives these sausages a tangy flavor (Meat Board, 1991). Additives can be included in sausage products under strict conditions and legal limits. They impact the color, minimize rancidity, or inhibit microbial growth. Examples are sodium nitrite, phosphates, sodium ascorbate, and sodium erythorbates (Feiner, 2006).

Sodium nitrite is used for curing meat. It inhibits the growth of several pathogenic and spoilage microorganisms, most importantly *Clostridium botulinum* (Tronsky et al., 2004). It is also used to retard the development of rancidity, stabilize the color of lean meat, and contribute to the flavor of cured meat. It is usually manufactured as a pink-colored salt (to distinguish it from regular sodium chloride salt) that can be purchased from ingredient suppliers as "Rapid Cure." It is highly undesirable to add too little or too much nitrite to sausage (Tronsky et al., 2004).

Ascorbates and erythorbates are chemicals used interchangeably in cured sausages to which nitrite has been added. They are active reducing agents that react with nitrite to accelerate curing. Ascorbate is derived from ascorbic acid (that is vitamin C) (Heinz and Hautzinger, 2010).

Milk-protein-derived extenders are used widely in processed meat products. These include non-fat dry milk, dried whey, and buttermilk solids and are added to improve binding qualities, flavor, cooking yields, and slicing characteristics. They also help to stabilize meat emulsion products such as bologna and frankfurters (FAO, 2007).

The flavor and aroma of meat, poultry, and fish products vary widely, with each species having its characteristics, flavor, and aroma. The meaty flavor from the various kinds of meat products is water-extractable, crocker 1948

### **Casings**

After the meat has been chopped or ground, it is formed into patties or placed into a container. The containers, such as pans for loaves and casings for links, will hold their shape during cooking (Bradley, 2002). Traditional sausage casings are made from parts of the alimentary canal of various animals. These natural casings are primarily made of collagen, which has the unique characteristic of variable permeability. Moisture and heat make casings more porous and tend to soften them. Natural casings readily permit smoke penetration and do not contribute any undesirable flavor (INSCA, 2003). When stuffed, natural casing sausages have a characteristic curved shape. Natural casings are readily purchased from local meat markets. Natural casings are usually obtained from hogs, beef cattle, and sheep (INSCA, 2003). There are five classifications of hog casings: bungs, middles, small intestines, stomachs, and bladders. Bungs and middles are generally used for liver sausage. Middles are used for dry sausage. Small intestine casings are used for fresh [www.udsspace.uds.edu.gh](http://www.udsspace.uds.edu.gh) sausage,

Buckhurst, Polish sausage, frankfurters, and chorizos. Head cheese is generally stuffed into stomachs. Bladders are used for minced luncheon meats. Like the hog, almost the entire beef gastrointestinal tract can be used. Beef rounds are the most common of all beef casings. Rounds are used for ring bologna, Holsteiner, and mettwurst. Commercial sausage makers often use "sewed-casings." Sewed casings are obtained from two natural casings that are slit, matched up, and stitched together, increasing the uniformity and strength of the casings (INSCA, 2003). Each type of casing can be stored for a reasonable length of time if salted in a controlled, refrigerated environment. All natural casings need to be prepared before use. The casings are rinsed thoroughly in lukewarm water to remove salt before use. Dried middles, bladders, and similar casings are softened by soaking in warm water (INSCA, 2003). The alternatives to natural casings are synthetic casings made from edible or inedible materials. The three most common synthetic casings are collagen, cellulose, and artificial (All About Sausage, 2004). Collagen casings are made from the gelatinous substance found in all mammals' connective tissue, bones, and cartilage. The substance is harvested from the animals and reconstructed as a paper-like edible casing. Cellulose casings are made from solubilized cotton linters, the short fibers that adhere to cottonseed. The interior surface of the cellulose casings can contain a water-soluble dye that colors the sausage surface during heat processing (FAO, 1985). Briefly submerging cellulose casings (30 minutes) in room temperature water can facilitate the stuffing process. They are uniform, firm, and generally used for slicing sausages such as salami. Skinless hotdogs are made with this form of the inedible casing; the casing

is removed after smoke processing and before consumption. Artificial, inedible casings are made from plastics and do not require refrigeration. Commercial producers use artificial casings, which can be made in different colors. For example, some manufacturers use red casings for bologna, transparent for salami, and white for liverwurst. Artificial casings' strength and uniformity are similar to cellulose. Synthetic casings are more consistent in diameter throughout their length, have a higher tensile strength than natural casings, and are cost-effective for large manufacturers (All about Sausage, 2004).

Color is essential in the acceptability of meat, poultry, and meat products. The changes in the color associated with the muscle and blood pigments (myoglobin and hemoglobin, respectively), to a considerable extent, determine the attractiveness of fresh red meat, while the formation of cured meat pigments and their stability influence the acceptability of cured meat products, Fox et al., (1966)

### **Herbs and Their Uses**

Tarragon (*Artemisia dracunculus*), shown in (Figure 1), also known as estragon, is a perennial herb species in the sunflower family. It is widespread in the wild across much of Eurasia and North America and is cultivated for culinary and medicinal purposes. One sub-species, *Artemisia dracunculus* var. *sativa*, is cultivated using its leaves as an aromatic culinary herb. In some other sub-species, the characteristic aroma is largely absent. The species is polymorphic. Informal names for distinguishing the variations include "French tarragon" (best for culinary use), "Russian tarragon," and "wild tarragon" (covers various states).



Tarragon has an aromatic property reminiscent of anise due to the presence of estragole, a known carcinogen and teratogen in mice. The European Union investigation revealed that the danger of estragole is minimal, even at 100–1,000 times the typical consumption seen in humans. Estragole concentration in fresh tarragon leaves is about 2900 mg/kg.

Tarragon is one of the four *fine herbs* of French cooking and is particularly suitable for chicken, fish, and egg dishes. Tarragon is the main flavoring component of Béarnaise sauce. Fresh, lightly bruised tarragon sprigs are steeped in vinegar to produce tarragon vinegar.

Tarragon is used to flavor a popular carbonated soft drink in Armenia, Azerbaijan, Georgia, and, by extension, Russia, Ukraine, and Kazakhs. The drink, Tarhun, is made of sugary tarragon concentrate and colored bright green. In Iran, tarragon is a side dish in sabzi khordan (fresh herbs), stews, and Persian-style pickles, particularly khiar shoor (pickled cucumbers). In Slovenia, tarragon is used in a variation of the traditional nut roll sweet cake called *potica*. In Hungary, a popular kind of chicken soup is flavored with tarragon. *cis*-Pellitorin, an isobutyramide eliciting a pungent taste, has been isolated from the tarragon plant.

Lemon Basil (Figure 2) is a common herb that contains a tangy fragrance and is known to be very strong in its taste. One of the prime ingredients found in numerous kitchens, lemon basil, is a herb obtained after hybridization between holy and African basil. This herb is known to grow up to a height of 40 cm. and is

known to be one of the famous herbs in Persian and Thai cuisine. This herb has numerous benefits, some of which are known to be mentioned.

This herb is primarily effective in treating common health conditions such as colds and fevers. It has also been known to be effective in maintaining the immune system's health.

Health Benefits of Lemon Basil is known to help with the problem of infertility. This herb is widely recognized for its ability to promote the chance of conceiving a child. This herb has been known to improve the health of children as well. It helps in increasing the health of the immune system. It is known to be one of the prime compounds which prevent cell death, and adequate levels of Vitamin C are known to help with the process of prevention against numerous diseases and also help in controlling the levels of blood pressure.

This herb has been known to be found effective in the treatment of high levels of blood pressure. It tends to calm down the nerves and, at the same time, is known to allow smooth passage of blood through veins. It helps in curing specific digestive issues. This herb is also known to be effective in treating numerous digestive issues, particularly constipation, and bloating. It is known to allow smooth digestion and, at the same time, tends to be effective in curing acidity. It helps in maintaining the health of bones. This herb is known to contain exceptional amounts of iron and calcium and is known to be effective in the treatment and maintenance of bone health. This herb has been known to prevent diseases such as osteoporosis from occurring.

The leaves of this herb are known to be used in numerous types of food items in order to add a distinct taste to them. The plant is also known to be utilized for topical usage on areas of skin for the treatment of wounds as well as infections.

Lemon basil (Figure 3) has a citrus flavor because it contains more citral and limonene than other basil varieties. Limonene is responsible for the citrus flavor present in other herbs, such as lemon peppermint and kaffir lime leaves. Lemon basil has clear citrus notes. Lemon and lime notes make it perfect for salads and other raw preparations. Its flavor is mild enough that it does not overpower subtler flavors.



Figure 1. Tarragon (*Artemisia dracunculus*)



Figure 2. Lemon Basil (*Ocimum citriodorum*)

In order to get the most benefit from lemon basil, it should be chopped and added fresh towards the end of cooking time. Its delicate flavor does not stand up well to longer cooking times. Health benefits of lemon basil

Lemon basil has high levels of various nutrients, including those responsible for its distinctive fragrance and flavor.

Citral and Limonene: Limonene has well-known anti-inflammatory benefits. Those anti-inflammatory benefits are among the reasons that it may be able to protect against skin cancer. Researchers have found that it is a potential inhibitor of cancer cell growth. It may also be particularly effective at protecting against breast and colon cancers. Research has shown citral to be effective at inhibiting

the growth of hepatic cancers and preventing the production of new cancer cells. Evidence also exists that citral limits the growth of breast cancer cells.

**Beta Carotene:** Lemon basil is rich in beta carotene, a pigment in many brightly colored vegetables. The body converts beta carotene into vitamin A, essential for good vision and functioning mucus membranes.

**Vitamin K:** Lemon basil is an excellent source of this vitamin, which is used to help with blood clotting and the development of healthy bones. The body absorbs this vitamin in the small intestine and stores it in the fatty tissue and the liver.

The stored basil is slightly aromatic, while fresh basil has aromatic reason basil has the highest quality aroma, containing linalool and methylchavicol as the major constituents, Simon et al. 1990, cited by Calibara 2015.

### **Lemon Basil and Gastrointestinal Conditions**

Because of its limonene content, lemon basil can be used to treat heartburn. Research has shown that limonene may help to treat heartburn and gastro oesophageal reflux. It neutralizes gastric acid and regulates peristalsis.

In Indonesia, lemon basil is called kemangi. It is served raw with raw cabbage or cucumber alongside the fried duck. Indonesians also eat the flowers from the lemon basil plant; they are considered enjoyable in salads. Thai cooks use lemon basil in various curries, and in the fermented noodle dish, khanom chin. In Malaysia, it is used in Nasi ulam, a dish consisting of rice and various herbs and vegetables.

In the West, lemon basil is sometimes served with seafood; it can also be chopped and served with julienned vegetables. It is beneficial for sweet

applications and can be added to pastries or simple syrup for making lemonade.

<https://ayushology.com/health-benefits-of-herbs/health-benefits-of-lemon-basil/>

Lemon basil can be used in both raw and cooked applications. Wash leaves and pat them to dry. Put whole leaves in vinegar or oils to impart a citrusy basil flavor; chop or chiffonade for use in marinades or dressings. Add whole or chopped leaves to poultry or fish dishes, vegetables, soups, sauces, or stir-fry. Chopped Lemon basil will add a citrusy anise flavor to cookies, scones, or other baked goods. Add Lemon basil at the end of the cooking process to maintain the herb's flavor and aromatic qualities. Fresh or dried leaves can be used for making teas or infusing liquors. Lemon basil is delicate and highly perishable; it will keep in the refrigerator for up to 3 days when wrapped loosely. Place cut stems in a glass of water for longer storage, cover them loosely with a plastic bag, and refrigerate. [https://www.specialtyproduce.com/produce/Lemon\\_Basil\\_152.php](https://www.specialtyproduce.com/produce/Lemon_Basil_152.php)

Thai basil is a type of basil native to Southeast Asia cultivated to provide distinctive traits. Widely used throughout Southeast Asia, its flavor, described as anise- and licorice-like and slightly spicy, is more stable under high or extended cooking temperatures than sweet basil. Thai basil has small, narrow leaves, purple stems, and pink-purple flowers.

Thai basil is widely used in the cuisines of Southeast Asia, including Thai, Vietnamese, Lao, and Cambodian cuisines. Thai basil leaves are a frequent ingredient in Thai green and red curries, though, in Thailand, the basil used in drunken noodles and many chicken, pork, and seafood dishes is holy basil. In the West, however, such dishes typically contain Thai basil instead, which is

much more readily available than holy basil. Thai basil is also essential in the famous Taiwanese dish sanbeiji (three-cup chicken). Used as a condiment, a plate of raw Thai basil leaves is often served as an accompaniment to many Vietnamese dishes, such as phở, bún bò Huế, or bánh xèo, so that each person can season to taste with the anise-flavored leaves.

No study has been found utilizing tarragon, Thai Basil, and Lemon Basil in pork sausage.



Figure 3. Thai basil (*Ocimum basilicum* var. *thyrsiflora*)



## **MATERIALS AND METHODS**

This chapter contains the different materials used in the study and the procedures undertaken in the conduct of the study.

### **Study1. Yield and Sensory Characteristics of Sausages Using Pork Chilled at Different Periods**

#### **Experimental Samples and Procedure**

The first part of the study used three kilograms of fresh pork meat from the market. After purchasing the first sample, the pork was washed and allowed to drip to reduce the moisture. It was labeled and stored in the chiller for 48 hours. The second sample was purchased the next day and was stored for 24 hours. On the third day, the last sample was purchased, washed, dripped, and later ground. The first and second samples were taken from the chiller and grounded separately. Each sample was processed into sausage using only one formulation of 80% lean and 20% back fat.

The processed sausages were cured overnight. On the second day, the samples were cooked to determine the cooking recovery and the sensory characteristics. Data was collected. The following are the treatments used:

T1 – Fresh (No chilling)

T2 – Chilling for 24 hours

T3 – Chilling for 48 hours

After curing, cooking was done to get the following:



The yield was taken by weighing the sausages produced from the un-chilled (zero chilling) pork and chilled for 24 and 48 hours.

Cooking recovery was calculated by dividing the weight after cooking by the fresh weight multiplied by 100.

The sensory attributes evaluated include color, aroma, flavor, juiciness, tenderness, and general acceptability. The panel that evaluated the sausages comprised five members of the GAC, five graduate students, and five undergraduates. The 9-point Hedonic Scale was used in rating the attributes of the sausages.

## **Study 2. Sensory Characteristics, Consumer Preference, and Shelf Life of Sausages Processed from Chilled Pork with Different Herbs**

### **Experimental Samples and Procedure**

In the second study, 12 kg pork was used, of which 9.6 kg was pork lean meat while 2.4 kg was back fat. The pork was purchased at Pili Public Market. After purchasing, the meat was appropriately washed to remove surface contaminants and chilled for 48 hours before grinding. The non-meat ingredients used were refined salt, curing salt, phosphate (Accord), vitamin C powder, refined sugar, ground black pepper, chopped garlic, pineapple juice, and anisado wine. The casing used was purchased at Rael's Meat Shop in Naga City. The fresh tarragon, lemon balm, and Thai Basil came from the researcher's garden at San Antonio, Milaor, Camarines Sur.

## **Experimental Design and Treatment**

The study was laid out in Randomized Complete Block Design, shown in Figure 4. It has four treatments and three blocks with 12 experimental units. Each experimental unit was allocated with one kilogram of pork. The treatments of the study were the following:

T1 – Control (no herbs)

T3 – 20 g Thai Basil/kg

T2 – 20 g Tarragon/kg

T4 – 20 g Lemon Basil/kg

## **Preparation of Herbs**

The herbs used in the study were grown in the backyard of the researcher. Tarragon, Thai basil, and Lemon balm leaves were freshly harvested from the researcher's garden. The harvested herbs were washed and placed in a tray to drain excess water. Each herb was chopped separately. Finely chopped herbs were measured according to the amount needed in the respective treatments, where 20 grams of each for every kilogram of meat.

## **Sausage Formulation**

Table 1 shows the formulation of the sausage used in the study. Only one formulation was used, and the treatments were the different herbs that would be used. Twenty grams of each herb were added for every kilogram of processed pork. All other ingredients were the same for all treatments. The control will be the original formulation of the sausage.

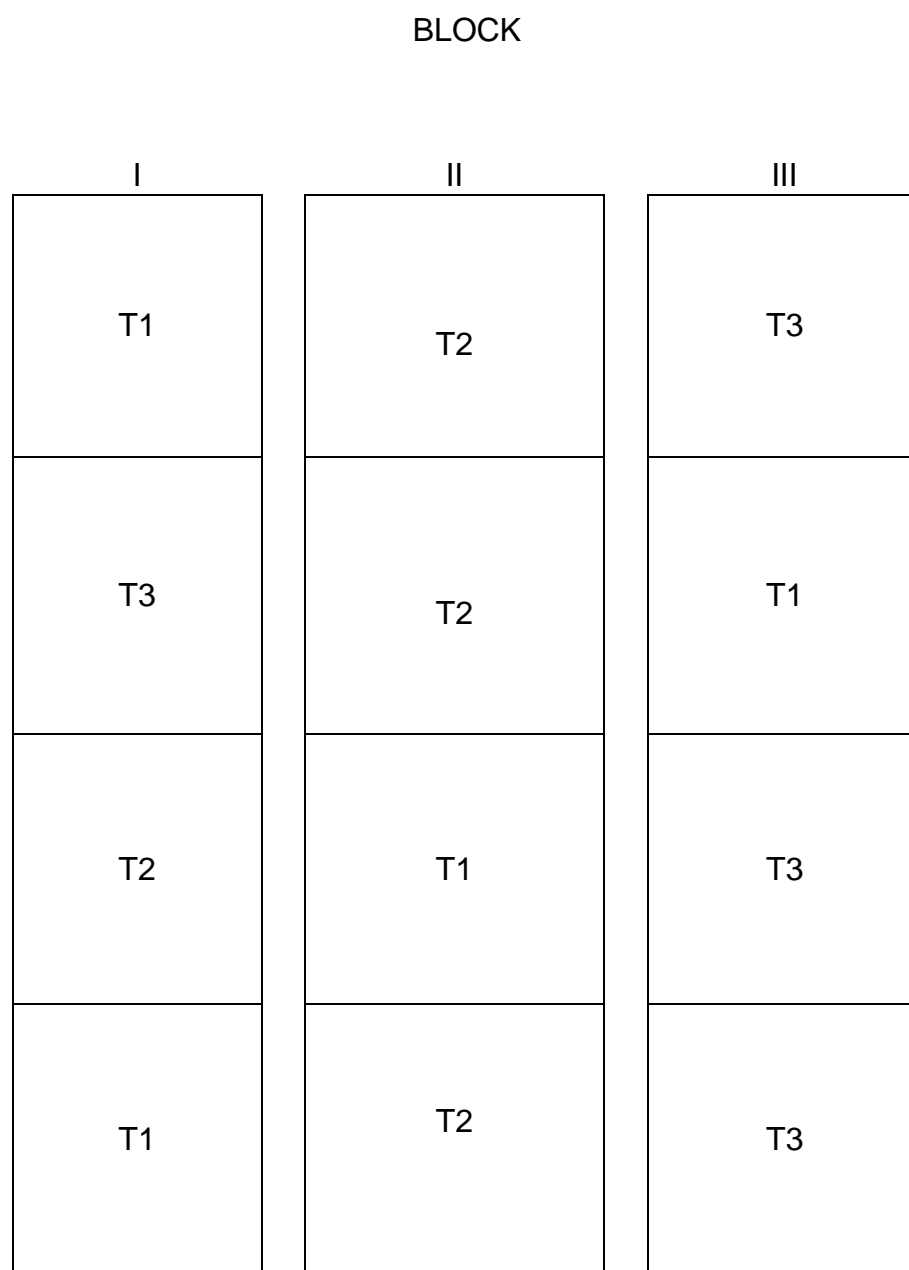


Figure 4. The layout of the study



Figure 5. Herbs used (a) Tarragon, (b) Thai Basil, and (c) Lemon Basil

Table 1. Formulation of sausage using one kilogram of pork

INGREDIENT	TREATMENT			
	Control	Tarragon	Thai basil	Lemon basil
Pork Lean Meat, g	800	800g	800g	800g
Pork Back Fat, g	200	200g	200g	200g
Carageenan, g	4.25	4.25	4.25	4.25
Salt, refined, g	13	13	13	13
Curing salt, g	2.125	2.125	2.125	2.125
Phosphate, g	4.25	4.25	4.25	4.25
Vit. C Powder, g	2.125	2.125	2.125	2.125
Water Chilled, ml	57	57	57	57
Sugar, refined, g	104	104	104	104
Garlic, Chopped, g	26	26	26	26
Anisado wine, ml	26	26	26	26
Tarragon, g		20		
Thai Basil, g			20	
Lemon Basil, g				20

Source: National Course on Basic Meat Processing July 1-5, 2013. International Training Center on Pig Husbandry (ITCPH), Lipa City, Philippines 4217)

### Procedure for Making Sausage

The procedure of making sausage starts with the proper cleaning of the working area and washing of the hands before the actual processing. Chilling was done for 48 hours at 4°C. After chilling, the meat was sliced into cubes. Pork lean meat was separated from the back fat. Pork lean was ground finely using the meat grinder, while the back fat was sliced into small cubes to avoid melting during

processing. After the process, the meat samples were allocated into different treatments.

The next step was measuring the ingredients for each treatment. Each ingredient was measured accurately. When the ingredients needed were ready, salt, curing salt, phosphate, and vitamin C powder were mixed, and then chilled water was added for dissolving to produce a solution mixed with the meat. The meat and ingredients were mixed together until the mixture became sticky. The seasonings were added next to the meat mixture, while the chopped herbs were added last according to the treatments. Separate mixing was done for the different treatments, following the same procedure and using the same amount and ingredients except for the chopped tarragon leaves, Thai basil leaves, and chopped lemon balm leaves.

The pork sausage mixtures were stuffed in the casings and were linked or tied at four inches in length. After casing and linking, the sausages were weighed, packed in transparent plastics, and labeled corresponding to the treatments and blocks representing the number of sensory evaluation sessions. Curing was done for one day inside the refrigerator.

The products were weighed and packed in a transparent container and stored in the refrigerator until time for sensory, consumer preference, and microbial analysis.



Figure 6. Grinding of meat and measuring of ingredients



Figure 7. The prepared ingredients and mixing the sausages





Figure 8. Staffing and sausages



Figure 9. The pork sausages with different herbs



## **Sensory Evaluation**

A total of 45 panelists were selected from among the food technology students to evaluate the sensory characteristics of pork sausage processed with different herbs. Sensory evaluations were done on day one after processing, after two weeks, and after four weeks with three blocks each. The scale that was used in the evaluation of the sausages was the 9-Point Hedonic Scale. On this scale, the highest is "9," described as "like extremely," while the lowest is "1," described as "dislike extremely."

On the days of each sensory evaluation, samples of the four treatments of the sausages with different herbs used for sensory evaluation were taken out from the freezer. The sausage samples were weighed, recorded, and labeled before cooking. The uncooked weight was used in determining the cooking loss and percentage cooking recovery of the sausage. Cooking was done for 45 minutes at 160<sup>0</sup> C oven temperature. The cooked sausages were weighed to get the cooking weight.

The cooked samples were sliced in uniform sizes of one cm thick and arranged in trays following the master sheet previously prepared. The master sheet contains the three code numbers of samples and the randomized serving order. Each tray was served to the fifteen evaluators in similar containers with a glass of water, the 9-Point Hedonic Scale, the score sheet, and a pencil. Sensory evaluation was done for three sessions at the Department of Animal Science.



**Figure 10.** Set up of the samples for sensory evaluation, the panel evaluating the sausages

### **Consumer Acceptability**

The respondents were 30 people from the three age groups; (young, middle, and old), ten from the young ages 10 to 20 years old, ten from 21 to 30, and 31 and above. The respondents ranked the pork sausage with different herbs according to their order of preference, where: Rank 1 - for the sample that they extremely preferred, Rank 2 - for the sample they preferred very much, Rank 3 - for the sample they moderately preferred, and Rank 4 - for the sample they slightly preferred. After evaluating each sample, each respondent was given the randomized samples, a score sheet, a pencil, and a bottle of water to rinse their palate.

### **Microbial Count**

Four samples were submitted for microbial analysis at the food testing laboratory, 900g per treatment, a total of 3.6 kilos. 300g per treatment was brought

to the food testing laboratory for total plate count, which was done after processing the sausages, after two weeks, and after four weeks of storage from the date of processing, Figure 12. Results were expressed in terms of colony forming units per mg of sausages.



Figure 11. Weighing and roasting of the sausages



Figure 12. The sausages before and after roasting



Figure 13. Microbial analysis

## **Data Gathered**

The data gathered presents the parameters collected to satisfy the study's objectives.

### **Study 1. Yield and Sensory Characteristics of Sausages Using Pork Chilled at Different Period**

#### **Yield or Cooking Recovery**

This was calculated by dividing the weight after cooking multiplied by 100.

#### **Sensory Attributes**

Color is the property of roasted sausage with different herbs perceived by the eyes.

Aroma is the characteristic odor due to the volatile compounds of roasted sausage with different herbs perceived while the sample is still warm.

The flavor is the distinctive quality of roasted sausage with different herbs perceived by the tongue upon chewing.

Tenderness is the softness of the food for the teeth to go through quickly without chewing.

Juiciness is related to the amount of juice or moisture the roasted sausage holds and is perceived upon chewing.

General acceptability is the totality of the attributes of the roasted sausage with different herbs.

## Study 2. Sensory Characteristics, Consumer Preference, and Shelf Life of Sausages Processed from Chilled Pork with Different Herbs

### Sensory Characteristics

Color is the property of roasted sausage with different herbs perceived by the eyes.

Aroma is the characteristic odor due to the volatile compounds of roasted sausage with different herbs perceived while the sample is still warm.

The flavor is the distinctive quality of roasted sausage with different herbs perceived by the tongue upon chewing.

Tenderness is the softness of the food for the teeth to go through quickly without chewing.

Juiciness is related to the amount of juice or moisture the roasted sausage holds and is perceived upon chewing.

General acceptability is the totality of the attributes of the roasted sausage with different herbs.

### Percent Cooking Recovery

This was calculated by dividing the weight after cooking by the weight before cooking multiplied by 100. The formula is:

$$\% \text{ Cooking recovery} = \frac{\text{Cooked weight, g}}{\text{Fresh weight, g}} \times 100$$

### **Consumer Preference**

A total of 30 panelists were selected by age group. A total of 10 persons in every age group were the respondents for the consumer preference of pork sausages flavored with different culinary herbs, Tarragon, Thai Basil, and Lemon Basil. The respondents ranked them according to the order of their preference by writing 1, 2, 3, 4, where: 1 is like very much, two is like much, three is like, and lastly, 4 for dislike. Code numbers were assigned to each treatment and randomized, like in the sensory evaluation.

The groups of respondents who ranked the samples were Senior and Junior High school students, young faculty, and senior faculty members of \_\_\_\_.

### **Microbial Analysis**

Standard Plate count was done after curing (no storage), after two and four weeks of storage. Results were expressed regarding Colony Forming Units (CFU) per mg of Longganisa. Three hundred-gram samples were brought to CBSUA-DOST Food Testing Laboratory for analysis.

### **Statistical Analysis**

The data gathered in the study was subjected to Analysis of Variance (ANOVA) in a 4 x 3 factorial in Randomized Complete Block Design (RCBD). Parameters with significant differences were subjected further to Duncan's Multiple Range Test.

## RESULTS AND DISCUSSION

### **Study 1. Cooking Recovery and Sensory Characteristics of Fresh Sausages (Longganisa) Using Pork Chilled at Different Periods**

#### **Yield and Cooking Recovery**

One kilogram of pork each was subjected to different chilling periods, where the first sample was chilled 24 hours ahead of the second sample. Both samples were terminated simultaneously; the first was chilled for 48 hours, the second for 24 hours, and the third was purchased on the day the samples were cooked, with no chilling. The chilled pork samples were used in processing sausages using one formula.

**Yield.** Shown in Table 1 is the yield of sausages processed using meat chilled at 48 and 24 hours and meat without chilling. The yield of the processed sausages from the three pork samples were similar at 1240 g; this means that the samples chilled at 48 and 24 hours had similar yield to non-chilled pork. Chilling the pork samples did not affect the yield of the processed sausages. Since only one formula was used and the difference was in the pork chilling, the samples exhibited exactly the same weight across all treatments and the control.

**Cooking Recovery.** The percent cooking recovery was calculated by dividing the weight of the sausages after roasting by the weight before roasting multiplied by 100. The highest cooking recovery was obtained from sausages using pork chilled for 48 hours at 87.10 %, followed by the sausages that used



pork chilled for 24 hours at 83.87 %. Very low cooking recovery was obtained from un-chilled pork sausages at 75.81 %.

The standard procedure of slaughtering and handling the meat after slaughter requires chilling the whole carcass with all the muscles still attached to the bones before fabrication. This procedure allows the passing of the rigor mortis. Rigor mortis is the rapid contraction of the muscles utilizing the reserved energy and chemicals in it that powers muscle contraction. The peak of rigor mortis results in a stiff carcass which occurs for some time depending on the number of energy reserves left in the muscles. Glycogen, the starch found in muscles, is simultaneously reduced to lactic acid because of the absence of oxygen. Lactic acid production determines the final pH of the meat ranging from 5.0 to 5.5, the required pH to extend the shelf life of the fresh meat, Ibarra (1983).

After rigor mortis, when all energy and chemical reserves are used up, the muscles relax, termed as the resolution of rigor. In this condition, the carcass muscles are now converted into meat. The meat has a different flavor, tenderness, juiciness, and water-holding capacity compared to that taken and cooked just a few hours after slaughter. The developed flavor is produced due to the partial degradation of proteins during rigor mortis caused by the absence of circulation.

Cooking or processing meat undergoing rigor mortis results in contracted meat that is less tender and with very high shrinkage due to low water holding capacity, Eskin (1990); Price and Schweigert (1980).

Table 2. Yield, cooking recovery, and cooking loss of pork chilled at different periods

PARAMETER	TREATMENT		
	No Chilling	24 Hours Chilling	48 Hours Chilling
Yield, g	620.00	620.00	620.00
Cooking Recovery, %	75.81	83.87	87.10
Cooking Loss, %	24.19	16.13	12.90

### Sensory Characteristics

The sensory attributes of the sausages processed using pork chilled (48, 24 hours) and un-chilled (no chilling) were evaluated for color, aroma, flavor, juiciness, tenderness, and general acceptability.

**Color.** The mean score for the color of sausages ranged from 7.73 to 8.40, described as like very much to like significantly, but found to be comparable among treatments. However, as shown in Table 2, a higher score was given to sausages processed from pork chilled for 48 hours, while lower scores were given to sausages processed from un-chilled and pork chilled for 24 hours. Chilling the pork for 48 hours favored the development of cured color.

Cured color is developed when curing salt is added to the curing ingredients. Curing salt contains sodium nitrate and sodium nitrite that yield nitric oxide, which combines with myoglobin to produce the cured pigment according to Bard & Townsend as cited by Cornejo in 2007. The availability and amount of myoglobin and nitric oxide determine the cured color of the sausage or other meat product.

Table 3. Scores and descriptions for color and aroma of sausages processed from chilled and un-chilled pork

TREATMENT	COLOR <sup>ns</sup>		AROMA <sup>ns</sup>	
	Mean	Description	Mean	Description
Fresh (0 Chilling)	7.73	Like very much	7.93	Very strong
24 Hours (Chilling)	7.73	Like very much	8.13	Very strong
48 Hours (0 Chilling)	8.40	Like extremely	8.20	Extremely strong

**Aroma.** A higher score for the aroma was given to sausages processed from pork chilled for 48 hours with 8.20 and was followed by sausages processed pork chilled for 24 hours with 8.13. A lower score, however, was given to sausages processed from un-chilled pork, with 7.93. The scores were described as extremely strong and very strong aroma.

As may be observed, though not statistically significant, there was a trend of the scores, where a slightly higher score for sausages processed from pork chilled for 48 hours, followed by that from 24 hours while slightly lower in un-chilled pork.

In converting muscles into meat (Eskin, 1990), animal circulation stops after exsanguination (bleeding), including the immune-regulatory system in the body; this occurs during chilling for 24 to 48 hours, where rigor mortis occurs, and, at the same time, partial degradation of the proteins in the muscles produced by-products that contribute to the development of an improved aroma of the meat. Unchilled pork has no by-products available, thus no improved aroma. This support the results of the scores given by the panel.

**Flavor.** A similar trend of the scores for color is also similar to the scores obtained for flavor, where a higher score was given to sausages from pork chilled for 48 hours with 8.13, slightly lower for 24 hours with 7.80, and much lower for sausages from un-chilled pork with 7.73. The scores were described as very much meaty flavor to full meaty flavor. No differences were noted statistically from among the samples.

Forty-eight and 24 hours of chilling the pork improved the flavor of the sausages compared to the un-chilled pork. The pork chilling period contributed to the sausage's improved flavor, Eskin (1990); Warris (2000).

**Juiciness.** The scores for juiciness were slightly higher in sausages chilled for 48 and 24 hours, with 8.00 described as very juicy, while slightly lower in sausages from un-chilled pork, with 7.80 described as juicy. The differences observed were not significant. Chilling improved the juiciness of the sausages. Forty-eight and 24 hours chilling allowed completion of rigor mortis that allowed the muscles to relax and improved the water holding capacity, thus contributing to juicier sausages compared to sausages from un-chilled pork.

Table 4. Scores and descriptions for flavor and juiciness of sausages processed from chilled and un-chilled pork

TREATMENT	FLAVOR <sup>ns</sup>		JUICINESS <sup>ns</sup>	
	Mean	Description	Mean	Description
No Chilling	7.73	Full meaty flavor	7.80	Very Juicy
24 Hours	7.80	Full meaty flavor	8.00	Very Juicy
48 Hours	8.13	Very much meaty flavor	8.00	Very Juicy

**Tenderness.** Shown in Table 4 are the scores for tenderness of sausages processed from chilled and un-chilled pork. A slightly higher score was obtained for sausages processed from pork chilled for 48 hours with 8.07, followed by sausages processed from pork chilled for 24 hours with 7.93, and 7.80 for un-chilled pork.

The differences among means were insignificant, meaning the tenderness of sausages from pork chilled for 48 and 24 hours are similar to the un-chilled. Processing fresh sausages uses ground meat that may have resulted in similar tenderness, particularly the control, and pork chilled for 24 hours.

**General acceptability.** The description of the scores for general acceptability is desirable to very desirable. Slightly higher scores for the sausages using pork chilled for 24 and 48 hours, with 8.13 and 8.00, respectively. A slightly lower score was given to sausages processed using un-chilled pork with 7.87. However, the difference noted was not statistically significant; this means that the 48 and 24-hour chilling did not influence the general acceptability of sausages.

Table 5. Scores and description for tenderness and general acceptability of sausages processed from chilled and un-chilled pork

TREATMENT	TENDERNESS <sup>ns</sup>		GENERAL ACCEPTABILITY <sup>ns</sup>	
	Mean	Description	Mean	Description
No Chilling	7.93	Very tender	7.87	Desirable
24 Hours	7.80	Very tender	8.13	Very Desirable
48 Hours	8.07	Extremely tender	8.00	Very Desirable

## **Study2. Sensory Characteristics, Consumer Preference, and Shelf Life of Sausage Processed from Chilled Pork with Different Herbs**

### **Sensory Evaluation**

Based on the results of Study 1, the pork used in Study 2 was chilled for 48 hours. The score for all the sensory attributes of the sausages using pork chilled at different periods was not significant statistically. However, sausages processed from pork chilled for 48 hours obtained slightly higher scores in all attributes than sausages chilled for 24 hours and the control (No chilling).

Color. The mean score for color given by the sensory evaluators is presented in Table 2. There were two factors evaluated, herbs and storage, to determine the variations of color as perceived by the panel.

As shown in the table, the length of storage does not influence the color of the sausages. Sausages with lemon basil consistently obtained the highest scores ranging from 7.91 to 7.71, in all storage periods; all were described as moderate. Sausages with tarragon obtained comparable scores of 7.78 at four weeks of storage, while slightly lower scores were obtained at zero storage, 7.78, and at two weeks of storage with 7.40.

The color of sausages without herbs, and those with Lemon and Thai basil, was stable even up to four weeks of storage, whereas sausages with tarragon was not but appeared to be enhanced at four weeks of storage.

Table 6. Herbs x storage interaction effects on the color of sausages

FACTOR A Herbs	FACTOR B. Storage, Weeks			OVERALL MEAN Factor A**	DESCRIPTION
	0	2	4		
No herbs	7.89 <sup>abc</sup>	7.91 <sup>abc</sup>	7.80 <sup>abc</sup>	7.87 <sup>ab</sup>	Like moderately
Tarragon	7.48 <sup>bc</sup>	7.40 <sup>c</sup>	7.78 <sup>abc</sup>	7.55 <sup>b</sup>	Like moderately
Thai Basil	7.71 <sup>abc</sup>	7.73 <sup>abc</sup>	7.84 <sup>abc</sup>	7.76 <sup>a<sup>b</sup></sup>	Like moderately
Lemon Basil	8.09 <sup>ab</sup>	8.22 <sup>a</sup>	8.25 <sup>a</sup>	8.19 <sup>a</sup>	Like very much
Overall Mean Factor B <sup>ns</sup>	7.79	7.82	7.83		

It means having the same letter is statistically not significant using DMRT.

ns – not significant

\*\* - highly significant

Significant differences were obtained in overall means for factor A (herbs), while comparable values were obtained for factor B (storage). Overall scores indicated that sausages with Lemon basil significantly differ in color, 8.19, from sausages with tarragon, 7.55, but comparable to sausages without herbs and with Lemon basil, 7.87 and 7.76, respectively.

Color is essential in the acceptability of meat, poultry, and meat products. To a considerable extent, the changes in the color associated with the muscle and blood pigments (myoglobin and hemoglobin, respectively) determine the attractiveness of fresh red meat. In contrast, the formation of cured meat pigments and their stability influence the acceptability of cured meat products (Fox et al., 1966)

Aroma. Shown in Table 6 are the scores for the aroma of fresh sausages with Tarragon, Thai, and Lemon basil. The scores for aroma ranged from 8.29 to 7.33, described as very strong to strong aroma. Analysis of variance indicated

significant differences in Factor A (herbs) and Factor B (storage). However, DMRT failed to detect the differences among means.

As shown in Table 6, the aroma of sausages with Lemon basil and Thai basil improved at two to four weeks of storage, 7.84 to 8.29; 7.79 to 7.91, respectively. Sausages with tarragon obtained a lower score for aroma at two weeks of storage at 7.33, while a slightly higher score was obtained at zero storage at 7.35 and at four weeks at 7.98. In contrast, sausages in control obtained a slightly higher score at two weeks storage, 8.13, and lower at zero and four weeks storage, 7.41 and 7.79, respectively.

The stored basil is slightly aromatic, while fresh basil has aromatic reason basil has the highest quality aroma, containing linalool and methyl chavicol as the major constituents, Simon et al. 1990, cited by Calibara 2015.

Table 7. Herbs x storage interaction effects on the aroma of sausages

FACTOR A Herb	FACTOR B. Storage, Week			OVERALL MEAN Factor A <sup>ns</sup>	DESCRIPTION
	0	2	4		
No Herbs	7.41	8.13	7.79	7.78	Very strong aroma
Tarragon	7.35	7.33	7.98	7.55	Very strong aroma
Thai Basil	7.79	7.90	7.91	7.87	Very strong aroma
Lemon Basil	7.84	8.13	8.29	8.09	Very strong aroma
Overall Mean					
Factor B <sup>ns</sup>	7.60	7.87	7.99		

It means having the same letter is statistically not significant using DMRT.

ns – not significant

\*\* - highly significant



Flavor. The scores for the flavor of fresh sausages processed with different herbs are presented in Table 7. Highly significant differences were obtained in Factor A (herbs) while significant differences in Factor B (storage); however, no significant differences were found in the overall means for both factors.

As shown in the table, the scores for the flavor of the sausages ranged from 8.51, the highest score, to 7.45, the lowest score. The description of the scores is very much meaty flavor to full meaty flavor. The length of storage likely influenced the flavor of the sausages.

Sausages with lemon basil were consistently given the highest and increasing scores for flavor ranging from 8.25, 8.49, and 8.51 for zero, two, and four weeks of storage, respectively. Sausages without herbs obtained a similarly high score for flavor, with 8.38 at four weeks of storage. Sausages with Thai basil obtained slightly lower but increasing scores. In contrast, sausages with tarragon obtained the lowest score at two weeks of storage with 7.45, but comparable scores at zero and four weeks of storage with Thai basil and the sausages without herbs at zero and two weeks of storage.

The results suggest that the flavor of sausages without herbs, Lemon basil, and Thai basil were stable and enhanced at two and four weeks of storage, while sausages with tarragon appear to be slightly enhanced at four weeks.

Overall mean scores for Factor A (herbs) were higher in sausages with Lemon basil, followed by sausages without herbs, while lower scores were observed for Thai basil and tarragon. For Factor B (storage), overall mean scores for flavor were higher at four weeks with 8.22, slightly lower at two weeks with 7.96,

and zero storage at 7.89. Although the differences are insignificant, storage at four weeks enhanced the flavor of the sausages.

The flavor and aroma of meat, poultry, and fish products vary widely, with each species having its characteristics, flavor, and aroma. The meaty flavor of various meat products is water-extractable (Crocker 1948).

Sugar is used for flavor and to counter the slightly bitter taste of salt. It is also added as a medium for microbial fermentation to reduce the pH of dry and semi-dry sausages (for example, pepperoni). The lactic acid produced by fermentation of the sugar (usually dextrose) reduces the meat's pH and gives these sausages a tangy flavor (Meat Board, 1991). Additives can be included in sausage products under strict conditions and legal limits. They impact the color, minimize rancidity, or inhibit microbial growth. Examples are sodium nitrite, phosphates, sodium ascorbate, and sodium erythorbates (Feiner, 2006).

Table 8. Herbs x storage interaction effects on the flavor of sausages

FACTOR A Herbs	FACTOR B. Storage, Weeks			OVERALL MEAN Factor A <sup>ns</sup>	DESCRIPTION
	0	2	4		
No herbs	8.00 <sup>ab</sup>	8.20 <sup>ab</sup>	8.38 <sup>a</sup>	8.19	Very much meaty flavor
Tarragon	7.64 <sup>ab</sup>	7.45 <sup>b</sup>	7.73 <sup>ab</sup>	7.61	Full meaty flavor
Thai Basil	7.64 <sup>ab</sup>	7.71 <sup>ab</sup>	8.27 <sup>ab</sup>	7.87	Full meaty flavor
Lemon Basil	8.25 <sup>ab</sup>	8.49 <sup>a</sup>	8.51 <sup>a</sup>	8.42	Very much meaty flavor
Overall Mean Factor B <sup>ns</sup>	7.89	7.96	8.22		

Spices and herbs are valued for their distinctive flavor, color, and aroma. They are among the most versatile and widely used ingredients in food preparation; hence the meat industry cannot be imagined without spices (Skrinjar et al., 2012).

Juiciness. The results for the juiciness of the sausages are shown in Table 8. Highly significant differences were found in Factor A (herbs), while no significant differences in Factor B (storage). The significantly highest score at 8.45 was given to sausages with Lemon basil at two weeks of storage, while the lowest was in sausages with tarragon in all storage periods, with 7.52 to 7.69.

Comparable scores for juiciness were obtained consistently in sausages without herbs and with Thai basil ranging from 8.00 to 7.93 in all storage periods, similarly with sausages with Lemon basil at zero and four weeks, 8.00 and 8.22, respectively. Similar scores for juiciness were also obtained in tarragon at two and four weeks of storage with 7.67 and 7.69, but the significantly lowest score at zero storage with 7.53.

No significant differences were obtained in the overall means for factor A (herbs) and factor B (storage), which may mean that the herbs did not significantly influence the juiciness of the sausages, just like the storage periods.

The crucial importance of mouth feel and the concept of juiciness while eating these animal products is difficult to quantify but profoundly affects the other sensory attributes of meat, poultry, and fish. Dryness is associated with a decrease in the other palatability attributes, especially with the lack of flavor and increased toughness (A.M Pearson et al., n.d.)

Table 9. Herbs x storage interaction effects on the juiciness of sausages

FACTOR A Herbs	FACTOR B. Storage, Weeks			OVERALL MEAN Factor A <sup>ns</sup>	DESCRIPTION
	0	2	4		
No Herbs	7.93 <sup>ab</sup>	7.96 <sup>ab</sup>	8.00 <sup>ab</sup>	7.96	Very juicy
Tarragon	7.53 <sup>b</sup>	7.67 <sup>ab</sup>	7.69 <sup>ab</sup>	7.63	Very juicy
Thai Basil	7.92 <sup>ab</sup>	8.00 <sup>ab</sup>	7.96 <sup>ab</sup>	7.96	Very juicy
Lemon Basil	8.00 <sup>ab</sup>	8.45 <sup>a</sup>	8.22 <sup>ab</sup>	8.22	Extremely juicy
Overall Mean					
Factor B <sup>ns</sup>	7.85	8.02	7.97		

Tenderness. The mean scores for tenderness of the sausages with different herbs with zero, two, and four weeks storage periods are shown in Table 9. As reflected in the table, the tenderness of the sausages was not influenced by the duration of the storage and the herbs.

A slightly higher score was obtained in sausages with Lemon basil, 8.42, while slightly lower in sausages with tarragon, 7.80. The scores were described as highly tender to for Lemon Basil sausages and sausages without herbs than with Tarragon and Thai basil.

The comparable scores for tenderness may be attributed to the product. Sausages are comminuted meat products processed using ground meat ingredients, added with the curing and seasonings, and mixed thoroughly. The mixture is stuffed in casings made of a hog's cleaned intestine to form a complete product. In this case, the tenderness of the sausages does not vary even with the use of various herbs and stored at various periods.

Table 10. Herbs x storage interaction effects on the tenderness of sausages

FACTOR A Herbs	FACTOR B. Storage, Weeks			OVERALL MEAN Factor A	DESCRIPTION
	0	2	4		
No herbs	7.93	8.09	7.87	7.96	Very tender
Tarragon	7.87	7.80	7.79	7.82	Very tender
Thai Basil	7.97	8.04	7.93	7.98	Very tender
Lemon Basil	8.16	8.42	8.29	8.29	Extremely tender
Overall Mean Factor B <sup>ns</sup>	7.78	8.09	7.97		

Rapid chilling of the carcass, including blast chilling, decreases carcass weight loss and improves the technological quality of the meat up to 48 hours post-mortem, Rybaczy et al. (2012)

General Acceptability. It is the totality of the attributes of the sausages with herbs stored at different periods. Highly significant differences were found in Factor A (herbs), while there were no significant differences in Factor B (storage); the interaction effect was insignificant, as shown in Table 10.

The scores for general acceptability ranged from 8.42 in sausages with Lemon basil to 7.56 in sausages with tarragon, described as extremely desirable to very desirable. The highest score for general acceptability was obtained in sausages with Lemon basil, 8.40 and 8.42 at four and two weeks of storage. Comparable scores, however, were obtained in sausages without herbs and with Thai basil in all storage periods and with tarragon at zero and four weeks of storage. The lowest score was in sausages with tarragon stored for two weeks.

Comparable means for general acceptability were obtained in the overall means for Factor A and Factor B. It may mean that herbs and storage periods did not affect the sausages' general acceptability.

The analysis of variance shows no significant differences among treatments which confirms the result of Nacario (2017). The general acceptability of pork longanisa with different levels of chopped tarragon leaves had no significant differences.

Table 11. Herbs x storage interaction effects on the general acceptability of sausages

FACTOR A Herbs	FACTOR B. Storage, Weeks			OVERALL MEAN Factor A	DESCRIPTION
	0	2	4		
No herbs	7.95 <sup>ab</sup>	8.02 <sup>ab</sup>	7.98 <sup>ab</sup>	7.98	Very desirable
Tarragon	7.65 <sup>ab</sup>	7.56 <sup>b</sup>	7.76 <sup>ab</sup>	7.66	Very desirable
Thai Basil	7.85 <sup>ab</sup>	7.82 <sup>ab</sup>	8.20 <sup>ab</sup>	7.96	Very desirable
Lemon Basil	8.27 <sup>ab</sup>	8.42 <sup>a</sup>	8.40 <sup>a</sup>	8.36	Extremely desirable
Overall Mean Factor B <sup>ns</sup>	7.93	7.96	8.09		

### Cooking Recovery

Shown in Table 1 are the percentages of cooking Recovery of sausages with different herbs. Slightly higher percent cooking recovery was obtained in sausages with no herbs or the control with 85.59 % at four weeks storage, while slightly lower in sausages with Lemon basil with 73.05 % at zero storage.

Table 12. Herbs x storage interaction effects on cooking Recovery of sausages

FACTOR A Herbs	FACTOR B. Storage, Weeks			OVERALL MEAN Factor A
	0	2	4	
No herbs	80.46	82.65	85.59	82.90
Tarragon	78.54	82.97	83.03	81.51
Thai Basil	79.55	85.06	84.03	82.88
Lemon Basil	73.05	82.63	75.38	77.02
Overall Mean Factor B <sup>ns</sup>	77.90	83.33	82.01	

Statistical analysis of the percent cooking recovery of the sausages showed no significant differences among herbs and storage. It means that the differences observed in the percent cooking recovery were comparable among treatment means. Likewise, overall means for Factor A and Factor B were not significant.

### Consumer Preference

The results of consumer preference are shown in Table 11. Ten senior high schools TVL- Food Processing students served as the respondents of the first group. The result revealed that 80 % of the students preferred the sausages without herbs, followed by Thai basil and lemon basil with 10%, and none of the respondents preferred the sausages with tarragon.

For the young faculty group, 30 % of the respondents preferred both the sausages with Thai basil and Lemon basil, while 20 % both the sausages without herbs and with tarragon.

For the senior faculty group, 70 % of the respondents preferred sausages with Lemon basil, 20 % for sausages with Thai basil, and 10 % for sausages with tarragon. No senior faculty preferred the sausages without herbs. The young group preferred sausages without herbs, while the older group preferred those with herbs.

In general, 36.67 % of the respondents preferred sausages with Lemon basil, 33.33 % preferred sausages without herbs, 20 % preferred Thai basil, and only 10% preferred sausages with tarragon. Generally, Thai basil-flavored sausages are most preferred, and tarragon flavored is the least preferred by the groups of consumer respondents.

Table 13. Consumers who preferred sausages processed with Tarragon, Thai basil, and Lemon basil, %

TREATMENT	GROUP			MEAN
	Senior High School	Young Faculty	Senior Faculty	
No Herbs	80	20	0	33.33
Tarragon	0	20	10	10.00
Thai Basil	10	30	20	20.00
Lemon Basil	10	30	70	36.67
Total	100	100	100	100.00

### Microbial Analysis

Shown in Table 12 is the result of the microbial analysis. The sausages, which were freshly prepared after 48 hours of chilling, were submitted to the food testing laboratory for microbial analysis. On the day the samples are submitted to



the laboratory, which is the start of the data collection from the sample for total plate count after two and four weeks of storage. The remaining samples were kept in the laboratory to prevent further contamination.

Herb-flavored sausages were subjected to Total Plate Count in the Petri film method. The results were expressed in a number of colony-forming units or cfu. At zero storage,  $1.4 \times 10^5$  cfu the lowest count was in sausages without herbs, followed by Lemon basil at  $1.8 \times 10^5$  then, Tarragon with  $2.9 \times 10^5$  and  $3.5 \times 10^5$  Thai basil being the highest.

At two weeks of storage,  $3.4 \times 10^6$  was obtained in sausages, with lemon basil being the lowest and sausages without herbs  $4.5 \times 10^6$ . Sausages with tarragon obtained  $3.7 \times 10^6$ , while sausages with Thai basil obtained the highest colony forming units at  $4.8 \times 10^6$ .

At four weeks of storage, was obtained  $3.5 \times 10^8$  with no herbs being the lowest, followed by tarragon at  $3.7 \times 10^8$ , then lemon basil at  $3.8 \times 10^8$ , and  $5.4 \times 10^8$  Thai basil being the highest.

The analysis showed a significant increase in the number of colonies obtained consistently in Thai Basil.

Standards for fresh sausages (chopped, mined, or manufactured uncooked meat product), an acceptable level for aerobic plate count at  $35^\circ\text{C}$  minimum is  $5 \times 10^5$  and the maximum is  $5 \times 10^6$ .

Since chemical and enzymatic reactions influence microbial activities, the effect of low temperatures on microorganisms is essentially a growth radiation process. Most microorganisms will not grow at freezing temperatures due to

reduced metabolic activities: however, these microorganisms will begin to grow again when placed in warmer temperatures (Ingram and Mackly, 1976; Cunningham and Cox, 1987; Mountey & Gould, 1988).

Table 14. Microbial analysis of pork sausages processed with different herbs

TREATMENT	STORAGE, WEEKS		
	0	2	4
No Herbs	$1.4 \times 10^5$	$3.5 \times 10^6$	$3.5 \times 10^8$
Tarragon	$2.9 \times 10^5$	$3.7 \times 10^6$	$3.7 \times 10^8$
Thai Basil	$3.5 \times 10^5$	$4.8 \times 10^6$	$5.4 \times 10^8$
Lemon Basil	$1.8 \times 10^5$	$3.4 \times 10^6$	$3.8 \times 10^8$

## SUMMARY, CONCLUSIONS, AND RECOMMENDATION

### Summary

The study was conducted to evaluate the sensory characteristics, consumer acceptability, and shelf life of sausages processed from chilled pork with different herbs: Tarragon (*Artemisia dracunculus L.*), Thai basil (*Ocinum basilicum var. thyrsiflora*) and Lemon basil (*Ocinum citriodorum*). Two sub-studies were conducted to obtain the objectives of this thesis. Study 1 dealt with the cooking recovery and sensory characteristics of fresh sausages using pork chilled at different periods, while Study 2 focused on the sensory characteristics, consumer preference, and shelf life of sausages processed from chilled pork with different herbs. The objectives of Study 1 focused on the effect of chilling on pork sausages, specifically on (1) yield, recovery and sensory characteristics of pork sausages. Study 2 focused on the sensory characteristics, consumer preference, and shelf life of pork sausages processed from chilled pork with different herbs: Tarragon (*Artemisia dracunculus L.*), Thai basil (*Ocinum basilicum var. thyrsiflora*), Lemon basil (*Ocinum citriodorum*). Specifically, the latter aimed to: (1) evaluate the sensory characteristics, (2) determine consumer preference, and (3) evaluate the microbial count of sausages processed from chilled pork with different herbs.

This was conducted from December 2018 to February 2019 at the Meat Laboratory, Department of Animal Science. Samples of the sausages were submitted to the CBSUA-DOST Food Testing Laboratory, Central Bicol State University of Agriculture, San Jose Pili Camarines Sur, for microbial analysis for the shelf life of the sausages.

Study 1 was laid out in RCBD with three treatments: T1 – zero chilling, T2 – 24 hours, and T3 – 48 hours chilling. The study was laid out in a two-factor factorial experiment in Randomized Complete Block Design. There were four treatments for Factor A – Herbs (T1 - Control – No herb; T2 – Tarragon; T3 – Thai basil and T4 – Lemon basil), while Factor B – storage period (zero storage, two weeks and four weeks storage). Study 2 used the pork chilled for 48 hours due to the slightly positive results found in Study 1. Only one formulation for processing fresh sausage was used, and only adding herbs made the difference. For study 1, the first pork sample was purchased 24 hours (48 hr chilling) before the second sample (24 hr chilling) and purchased last was the zero chilling. After the chilling period, the pork was processed into one formulation of fresh sausage and later submitted for sensory and consumer evaluation.

For study 2, pork was purchased and chilled for 48 hours before fresh sausages were processed with herbs. After processing, the fresh sausages with different herbs were divided into three packages per treatment to be submitted for evaluation at three storage periods. Fifteen animal science students evaluated the samples for the sensory characteristics for three separate sessions per storage period. Likewise, the same samples were evaluated by three groups of respondents for consumer preference, Senior High school students, young faculty, and senior faculty of San Antonio National High School, San Antonio, Milaor, Camarines Sur.

Results in study 1 showed no significant differences in yield and cooking recovery (75.81 %, 83.87 %, and 87.10 % for zero, 24, and 48 hours chilling) but recorded increasing values from the un-chilled to 48-hour chilling. In terms of color, aroma, flavor, juiciness, and tenderness, the differences in the scores were not significant. However, they noted a slight value in sausages processed from pork chilled for 48 hours. In the general acceptability, however, a slightly higher score was obtained in sausages from pork chilled for 24 hours.

In Study 2, the results indicated no interaction effects between Factor A (herbs) and Factor B (storage) in the color of sausages. However, the overall mean for Factor A (herbs) recorded significant differences; Lemon basil scored the highest, 8.19, 7.87 for the control and Thai basil, while lowest for Tarragon, 7.55. The overall mean for Factor B (storage) was not significant.

For the aroma, there were no interaction effects between Factor A and Factor B. Overall means for both factors were insignificant. There was no significant interaction effect between the two factors for the flavor of the pork sausages with herbs. However, significant differences were found among treatment means. Consistently highest scores for flavor were found in sausages with Lemon basil ranging from 8.25 to 8.51, while the lowest score was in Tarragon with 7.45. Overall mean scores for Factor A (herbs) and B (storage) were insignificant.

The scores for the juiciness of the sausages were highly significant differences found in Factor A (herbs). No interaction effects between the two

factors were noted. The significantly highest score, 8.45, was obtained in Lemon basil-flavored sausages, while the lowest in Tarragon flavored.

The results in the tenderness analysis showed no significant differences among treatment means and overall means for Factor A (herbs) and Factor B (storage).

For general acceptability, significant differences were obtained among treatment means, with consistently highest scores in Lemon basil flavored sausages ranging from 8.27 to 8.42, while consistently lowest in Tarragon flavored with 7.56.

The percentage of cooking recovery of the sausages with different herbs was insignificant among treatment means and overall means of Factor A and B. For Factor A, the cooking recovery ranged from 77.02 % to 82.90 %, while for Factor B, 77.90 % to 83.33%.

Respondents for consumer preference in general, 36.67% of the respondents preferred Lemon Basil, followed by control with 33.33%, Thai basil, and the lowest was Tarragon with 10% result. Generally, Thai basil-flavored sausages are most preferred, while Tarragon flavored is the least preferred by the consumer respondents.

The analysis results for microbial counts were expressed as the number of colony-forming units. Microbial load for sausages with different herbs was found acceptable as determined by total plate count at Zero to 2 weeks of storage. Hence, at four weeks of storage, the microbial exceeded the standard, which means these are no longer safe for human consumption.

## Conclusion

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

For Study 1.

1. Chilling pork at zero, two, and four weeks did not significantly affect the percent cooking recovery of the sausages.
2. Chilling time significantly affected the color of the sausages. At the same time, the aroma, flavor, juiciness, tenderness, and general acceptability were not significantly affected by chilling time but somehow had higher scores in pork chilled for 48 hours except in general acceptability.

Study 2.

Based on the results of Study 2, the following conclusions were drawn;

1. The sensory characteristics of pork sausages processed with Tarragon, Thai, and Lemon basil significantly influenced the color, flavor, juiciness, and general acceptability. However, they were not affected by the length of storage.
2. Generally, most consumers preferred sausages with Lemon basil, followed by sausages without herbs; the least preferred tarragon-flavored sausages.
3. For the shelf life, all herb-flavored sausages be stored up to two weeks only, as indicated by the results of the microbial analysis

.

**Recommendation**

The following recommendations are given based on the results of the study:

1. Lemon basil can be used as flavoring in fresh sausages, as indicated by the consistently highest scores of sensory characteristics.
2. Further study be conducted on the shelf life of cooked and fresh sausages using herbs as flavorings.



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## APPENDICES

Appendix Table 1. ANOVA for color of fresh sausages

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Treatment	2	4.44	2.22	7.93**	3.36	
Panel	14	9.24	0.66			
Error	28	8.22	0.28			
Total	44					

Appendix Table 1a DMRT for color of fresh sausages

TREATMENT	MEANS	DMRT
3	8.40	a
2	7.73	b
1	7.73	b

Appendix Table 2. ANOVA for aroma of fresh sausages

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Treatment	2	0.28	0.56	1.08	3.36	
Panel	14	0.59	8.31			
Error	28	0.26	7.17			
Total	44					

Appendix Table 3. ANOVA for Flavour of fresh sausages

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Treatment	2	0.5	1.00	0.78	3.36	
Panel	14	2.5	35.00			
Error	28	0.65	18.33			
Total	44					

Appendix Table 4. ANOVA for Juiciness of fresh sausages

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Treatment	2	0.2	0.4	0.34	3.36	
Panel	14	2.34	32/8			
Error	28	0.58	16.47			
Total	44					

Appendix Table 5. ANOVA for Tenderness of fresh sausages

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Treatment	2	0.27	0.53	0.62	3.36	
Panel	14	1.77	24.8			
Error	28	0.39	10.8			
Total	44					

Appendix Table 6. ANOVA for General Acceptability of fresh sausages

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Treatment	2	0.27	0.53	0.42	3.36	
Panel	14	2.29	32.00			
Error	28	0.65	16.8			
Total	44					

Appendix Table 7. Color of sausages processed with herbs at different storage periods

Control					
SHELF LIFE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	8.15	8.00	8.27	24.42	8.14
2 weeks storage	7.80	8.00	7.73	23.53	7.84
4 weeks storage	7.86	8.13	8.07	24.06	8.02
Garlic					
SHELF LIFE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.61	8.14	8.40	24.15	8.05
2 weeks storage	8.07	7.80	8.13	24.00	8.00
4 weeks storage	8.43	7.80	8.53	24.76	8.25
Italian Oregano					
SHELF LIFE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.61	8.00	7.13	22.74	7.58
2 weeks storage	7.93	7.80	7.40	23.13	7.71
4 weeks storage	7.86	7.67	7.67	23.20	7.73
Pepper					
SHELF LIFE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	8.15	8.00	7.40	23.55	7.85
2 weeks storage	7.67	7.80	8.00	23.47	7.82
4 weeks storage	8.07	7.93	7.53	23.53	7.84
Block Total	95.21	95.07	94.26		
Grand Total				284.54	
Grand Mean					7.90



## No Herb (Control)

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.93	7.62	8.13	23.68	7.89
2 weeks	7.80	8.00	7.93	23.73	7.91
4 weeks	7.73	7.93	7.73	23.39	7.80

## Tarragon

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.50	7.23	7.71	22.44	7.48
2 weeks	7.53	7.13	7.53	22.19	7.40
4 weeks	7.60	7.87	7.87	23.34	7.78

## Thai Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.36	7.69	8.07	23.12	7.71
2 weeks	7.60	7.60	8.00	23.20	7.73
4 weeks	7.73	8.00	8.00	23.73	7.91

## Lemon Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	8.07	7.92	8.27	24.26	8.09
2 weeks	8.20	8.27	8.20	24.67	8.22
4 weeks	7.87	8.40	8.47	24.74	8.25

Appendix Table 8. Aroma of sausages processed with herbs at different storage periods

No Herb (Control)

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.50	7.00	7.73	22.23	7.41
2 weeks	7.80	8.27	8.33	24.40	8.13
4 weeks	7.80	7.80	7.67	23.27	7.76

Tarragon

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.50	6.54	8.00	22.04	7.35
2 weeks	7.40	7.00	7.60	22.00	7.33
4 weeks	7.87	7.73	8.33	23.93	7.98

Thai Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.71	7.92	7.73	23.36	7.79
2 weeks	8.20	7.76	7.73	23.69	7.90
4 weeks	7.73	8.00	8.00	23.73	7.91

Lemon Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.93	7.31	8.27	23.51	7.84
2 weeks	7.73	8.27	8.40	24.40	8.13
4 weeks	8.13	8.27	8.47	24.87	8.29

Appendix Table 9. Flavor of sausages processed with herbs at different storage periods

No Herb (Control)

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.64	7.92	8.45	24.01	8.00
2 weeks	8.07	8.00	8.53	24.60	8.20
4 weeks	7.93	8.87	8.33	25.13	8.38

Tarragon

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.57	7.23	8.13	22.93	7.64
2 weeks	7.47	7.48	7.40	22.35	7.45
4 weeks	7.67	7.60	7.93	23.20	7.73

Thai Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.43	7.77	7.73	22.93	7.64
2 weeks	7.87	7.80	7.47	23.14	7.71
4 weeks	8.20	7.93	8.67	24.80	8.27

Lemon Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	8.00	8.08	8.67	24.75	8.25
2 weeks	8.27	8.53	8.67	25.47	8.49
4 weeks	8.40	8.47	8.67	25.54	8.51

Appendix Table 10. Juiciness of sausages processed with herbs at different storage periods

No Herb (Control)

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.71	8.00	8.07	23.78	7.93
2 weeks	8.07	7.93	7.87	23.87	7.96
4 weeks	7.93	7.73	8.33	23.99	8.00

Tarragon

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.64	7.31	7.60	22.55	7.52
2 weeks	7.57	7.76	7.67	23.00	7.67
4 weeks	7.53	7.47	8.07	23.07	7.69

Thai Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.64	8.20	7.93	23.77	7.92
2 weeks	7.87	8.20	7.93	24.00	8.00
4 weeks	8.13	7.47	8.27	23.87	7.96

Lemon Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.79	8.00	8.20	23.99	8.00
2 weeks	8.47	8.20	8.68	25.35	8.45
4 weeks	8.60	8.20	7.87	24.67	8.22

Appendix Table 11. Tenderness of sausages processed with herbs at different storage periods

No Herb (Control)

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.50	8.15	8.13	23.78	7.93
2 weeks	8.27	8.00	8.00	24.27	8.09
4 weeks	7.87	7.73	8.00	23.60	7.87

Tarragon

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	8.21	7.59	7.80	23.60	7.87
2 weeks	7.80	7.73	7.87	23.40	7.80
4 weeks	7.80	7.67	7.87	23.34	7.78

Thai Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.64	8.15	8.13		7.97
2 weeks	8.00	8.13	8.00		8.04
4 weeks	7.93	7.80	8.07		7.93

Lemon Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.77	8.31	8.40	24.48	8.16
2 weeks	8.53	8.33	8.40	25.26	8.42
4 weeks	8.53	8.07	8.27	24.87	8.29

Appendix Table 12. General acceptability of sausages processed with herbs at different storage periods

No Herb (Control)

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.64	8.08	8.13	23.85	7.95
2 weeks	7.93	7.80	8.33	24.06	8.02
4 weeks	7.93	7.93	8.07	23.93	7.98

Tarragon

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.57	7.45	7.93	22.93	7.65
2 weeks	7.67	7.47	7.53	22.67	7.56
4 weeks	7.67	7.60	8.00	23.27	7.76

Thai Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.43	8.00	8.13		7.85
2 weeks	7.73	8.13	7.60		7.82
4 weeks	8.40	7.87	8.33		8.20

Lemon Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	7.71	8.71	8.40	24.82	8.27
2 weeks	8.67	8.13	8.47	25.27	8.42
4 weeks	8.60	8.13	8.47	25.20	8.40

Appendix Table 13. Cooking recovery of sausages processed with herbs at different storage periods

No Herb (Control)

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	80.77	84.62	76.00	241.39	80.46
2 weeks	79.17	88.00	80.77	247.94	82.65
4 weeks	88.00	80.77	88.00	256.77	85.59

Tarragon

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	74.07	84.62	76.92	235.61	78.54
2 weeks	76.92	88.00	84.00	248.92	82.97
4 weeks	88.00	88.00	73.08	249.08	83.03

Thai Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	73.91	82.14	82.61	238.66	79.55
2 weeks	79.17	88.00	88.00	255.17	85.06
4 weeks	81.48	82.61	88.00	252.09	84.03

Lemon Basil

STORAGE	BLOCK			TOTAL	MEAN
	I	II	III		
0 storage	69.51	76.92	72.72	219.15	73.05
2 weeks	77.28	88.00	82.61	247.89	82.63
4 weeks	77.27	79.31	69.57	226.15	75.38

Appendix Table 14. ANOVA for color of fresh sausages processed with herbs

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Block	2	0.2021	0.4042	6.0557**	3.44	5.72
Herbs	3	0.6179	1.8536	18.5150**	3.05	4.82
Storage	2	0.0689	0.1378	2.0653 <sup>ns</sup>	3.44	5.72
Herbs x storage	6	0.0411	0.2466	1.2316 <sup>ns</sup>	2.55	3.76
Error	22	0.0517	1.1383			
Total	35		3.3764			

R-squared(A+B+AB) = 66.29%

ns = not significant

\* = significant at  $\alpha = 5\%$

\*\* = highly significant at  $\alpha = 5\%$

Appendix Table 14a. DMRT of Color of fresh sausages

TREATMENT	MEANS	DMRT
Lemon basil, 4 weeks storage	8.42a	a
Lemon Basil, 2 weeks storage	8.40a	a
Lemon basil, 0 storage	8.27ab	ab
Control, 2 weeks storage	8.20ab	ab
Control, 0 storage	8.02ab	ab
Thai basil, 4 weeks storage	7.98ab	ab
Control, 4 weeks storage	7.95ab	ab
Tarragon, 4 weeks storage	7.85ab	ab
Thai basil, 2 weeks storage	7.82ab	ab
Thai basil, 0 storage	7.76ab	ab
Tarragon, 0 storage	7.65ab	ab
Tarragon, 2 weeks storage	7.56b	b

Any two means having the same letter are statistically non-significant using DMRT at  $\alpha = 5\%$



Appendix Table 14b. DMRT of Color of fresh sausages Factor A

TREATMENT	MEANS	DMRT
4	8.19	a
1	7.87	ab
3	7.78	ab
2	7.55	b

Appendix Table 15. ANOVA for Aroma of fresh sausages processed with herbs

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Block	2	0.4178	0.8355	4.3635*	3.44	5.72
Treatments	3	0.4428	1.3285	4.6254*	3.05	4.82
				5.0272		
Storage	2	0.4813	0.9626	ns	3.44	5.72
AxB	6	0.1632	0.9792	1.7045 <sup>ns</sup>	2.55	3.76
Error	22	0.0957	2.1063			
Total	35		6.2121			

R-squared(A+B+AB) = 52.64%

ns = not significant

\* = significant at  $\alpha = 5\%$

\*\* = highly significant at  $\alpha = 5\%$

Appendix Table 15a. DMRT of Aroma of fresh sausages

TREATMENT	MEANS	DMRT
Lemon basil, 4 weeks storage	8.29	a
Control, 2 weeks storage	8.13	ab
Lemon basil, 2 weeks storage	8.13	ab
Tarragon, 4 weeks storage	7.98	ab
Thai basil, 4 weeks storage	7.91	ab
Thai basil, 2 weeks storage	7.90	ab
Lemon basil, 0 storage	7.84	ab
Thai basil, 0 storage	7.79	ab
Control, 4 weeks storage	7.76	ab
Control, 0 storage	7.41	b
Tarragon, 0 storage	7.35	b
Tarragon, 2 weeks storage	7.33	b

Any two means having the same letter are statistically non-significant using DMRT at  $\alpha$

Appendix Table 16. ANOVA for Flavour of fresh sausages processed with herbs

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Block	2	0.3781	0.7562	5.5428*	3.44	5.72
Treatments	3	1.1353	3.4058	16.6423**	3.05	4.82
Storage	2	0.3744	0.7488	5.4888*	3.44	5.72
AxB	6	0.0689	0.4133	1.0098ns	2.55	3.76
Error	22	0.0682	1.5007			
Total	35		6.8248			

R-squared(A+B+AB) = 66.93%

ns = not significant

\* = significant at  $\alpha = 5\%$

\*\* = highly significant at  $\alpha = 5\%$

Appendix Table 16a. DMRT of Flavour of fresh sausages

TREATMENT	MEANS	DMRT
Lemon balm, 4 week storage	8.51	a
Lemon balm, 2 week storage	8.49	a
Lemon balm, 0 storage	8.38	ab
Control, 2 weeks storage	8.27	abc
Control, 0 storage	8.25	abc
Thai basil, 4 week storage	8.20	abc
Control, 4 week storage	8.00	abcd
Tarragon, 4 week storage	7.73	bcd
Thai basil, 2 week storage	7.71	bcd
Thai basil, 0 storage	7.64	cd
Tarragon, 0 storage	7.64a	cd
Tarragon, 2 week storage	7.45	d

Any two means having the same letter are statistically non-significant using DMRT at  $\alpha = 5\%$

Appendix Table 16b. DMRT of Flavour of fresh sausages Factor A

TREATMENT	MEANS	DMRT
4	8.42	a
1	8.19	ab
3	7.87	ab
2	7.61	a

Appendix Table 17. ANOVA for Juiciness of fresh sausages processed with herbs

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Block	2	0.0928	0.1856	1.4109 <sub>ns</sub>	3.44	5.72
Treatments	3	0.5419	1.6257	8.2382**	3.05	4.82
Storage	2	0.1000	0.2000	1.5205 <sub>ns</sub>	3.44	5.72
AxB	6	0.0296	0.1776	0.4499 <sub>ns</sub>	2.55	3.76
Error	22	0.0658	1.4472			
Total	35		3.6362			

R-squared(A+B+AB) = 55.10%

ns = not significant

\* = significant at  $\alpha = 5\%$

\*\* = highly significant at  $\alpha = 5\%$

Appendix Table 17a. DMRT of Juiciness of fresh sausages

TREATMENT	MEANS	DMRT
Lemon basil, 4 weeks storage	8.45	a
Lemon basil, 2 weeks storage	8.22	ab
Lemon basil, 0 storage	8.00	ab
Control, 2 weeks storage	8.00	ab
Control, 0 storage	8.00	ab
Thai basil, 4 weeks storage	7.96	ab
Control, 4 weeks storage	7.96	ab
Tarragon, 4 weeks storage	7.93	ab
Thai basil, 2 weeks storage	7.92	ab
Thai basil, 0 storage	7.69	ab
Tarragon, 0 storage	7.67	ab
Tarragon, 2 weeks storage	7.52	b

Any two means having the same letter are statistically non-significant using DMRT at  $\alpha = 5\%$

Appendix Table 18. ANOVA for Tenderness of fresh sausages processed with herbs

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Block	2	0.0398	0.0795	0.8085 ns	3.44	5.72
Treatments	3	0.3579	1.0736	7.2769** 1.0647	3.05	4.82
Storage	2	0.0524	0.1047	ns	3.44	5.72
AxB	6	0.0180	0.1078	ns	2.55	3.76
Error	22	0.0492	1.0819			
Total	35		2.4475			

R-squared(A+B+AB) = 52.55%

ns = not significant

\* = significant at  $\alpha = 5\%$

\*\* = highly significant at  $\alpha = 5\%$

Appendix Table 18a. DMRT of Tenderness of fresh sausages

TREATMENT	MEANS	DMRT
Lemon basil, 4 weeks storage	8.29	a
Control, 2 weeks storage	8.13	a
Lemon basil, 2 weeks storage	8.13	ab
Tarragon, 4 weeks storage	7.98	ab
Thai basil, 4 weeks storage	7.91	ab
Thai basil, 2 weeks storage	7.90	ab
Lemon basil, 0 storage	7.84	ab
Thai basil, 0 storage	7.79	ab
Control, 4 weeks storage	7.76	ab
Control, 0 storage	7.41	ab
Tarragon, 0 storage	7.35	ab
Tarragon, 2 weeks storage	7.33	b

Any two means having the same letter are statistically non-significant using DMRT at  $\alpha = 5\%$

AppendixTable 19. ANOVA for General Acceptability of fresh sausages processed with herbs

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Block	2	0.1451	0.2901	1.9404 <sup>ns</sup>	3.44	5.72
Treatments	3	0.7642	2.2926	10.2225 <sup>**</sup>	3.05	4.82
Storage	2	0.0800	0.1601	1.0706 <sup>ns</sup>	3.44	5.72
AxB	6	0.0354	0.2123	0.4733 <sup>ns</sup>	2.55	3.76
Error	22	0.0748	1.6447			
Total	35		4.5998			

R-squared(A+B+AB) = 57.94%

ns = not significant

\* = significant at  $\alpha = 5\%$

\*\* = highly significant at  $\alpha = 5\%$

Appendix Table 19a. DMRT of General Acceptability of fresh sausages

TREATMENT	MEANS	DMRT
Lemon basil, 4 weeks storage	8.42	a
Lemon basil, 2 weeks storage	8.40	ab
Lemon basil, 0 storage	8.27	abc
Control, 2 weeks storage	8.20	abc
Control, 0 storage	8.02	abc
Thai basil, 4 weeks storage	7.98	abc
Control, 4 weeks storage	7.95	abc
Tarragon, 4 weeks storage	7.85	abc
Thai basil, 2 weeks storage	7.82	abc
Thai basil, 0 storage	7.76	abc
Tarragon, 0 storage	7.65	bc
Tarragon, 2 weeks storage	7.56	c

Any two means having the same letter are statistically non-significant using DMRT at  $\alpha = 5\%$

Appendix Table 19b. DMRT of General Acceptability of fresh sausages Factor A

TREATMENT	MEANS	DMRT
4	8.37	a
1	7.98	ab
2	7.96	ab
2	7.65	b

Appendix Table 20. ANOVA for Cooking Recovery of fresh sausages processed with herbs

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN OF SQUARES	SUM OF SQUARES	COMP. F	TABULAR F	
					5%	1%
Block	2	96.3188	192.6375	4.6398 <sub>ns</sub>	3.44	5.72
Treatments	3	69.6414	208.9241	3.3547 <sub>ns</sub>	3.05	4.82
Storage	2	96.0892	192.1783	4.6288 <sub>ns</sub>	3.44	5.72
AxB	6	14.7496	88.4978	0.7105 <sub>ns</sub>	2.55	3.76
Error	22	20.7592	456.7024			
Total	35		1138.9401			

R-squared(A+B+AB) = 42.99%

ns = not significant

\* = significant at  $\alpha = 5\%$

\*\* = highly significant at  $\alpha = 5$

## APPENDICES

Appendix Table 21. The 9-point Hedonic Scale of Sensory Evaluation

<b>SCORE</b>	<b>COLOR</b>	<b>AROMA</b>	<b>FLAVOR</b>	<b>JUICINESS</b>	<b>TENDERNESS</b>	<b>GENERAL ACCEPTABILITY</b>
9	Like extremely	Extremely Strong	Extremely full meat flavour	Extremely juicy	Extremely tender	Extremely desirable
8	Likely Very Much	Very strong aroma	Very rich full meaty flavor	Very juicy	Very tender	Very desirable
7	Like moderately	Strong aroma	Full meaty flavor	Juicy	Tender	Desirable
6	Like slightly	Slightly Strong aroma	Slightly full meaty flavor	Slightly juicy	Slightly tender	Slightly desirable
5	Neither like or dislike	Neither strong nor perceptible	Neither full nor weak meaty	Neither juicy nor dry	Neither tender nor tough	Neither desirable nor undesirable
4	Dislike slightly	Slightly dry	Slightly meaty flavor	Slightly dry	Slightly tough	Slightly desirable
3	Dislike moderately	Moderately perceptible	Very weak meaty flavor	Moderately dry	Moderately tough	Moderately desirable
2	Dislike extremely	Slight perceptible	Very weak meaty flavor	Very dry	Very tough	Very desirable
1	Dislike very much	Non	Extremely weak meat flavor	Extremely dry	Extremely tough	Extremely undesirable



Appendix Table 22. The score sheet to be used in the sensory evaluation

**SCORE SHEET**

Panel No. \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Evaluate the samples presented to you from left to right. Write your evaluations for each quality attributes by writing the score on the table provided below.

QUALITY ATTRIBUTES	CODE NUMBER			
Color				
Aroma				
Flavor				
Juiciness				
Tenderness				
General Acceptability				

Appendix Table 23. The score sheet for consumer preference

Panel No. \_\_\_\_\_

Name: \_\_\_\_\_

Age: \_\_\_\_\_

Instruction: Rank the samples according to your order of preference by writing; 1- like very much, 2- like much, 3- like, 4- dislike

CONSUMER	CODE			
Consumer No.				