# Czech University of Life Sciences

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**Faculty of Tropical AgriSciences**



# USE OF PLANT EXTRACTS TO EXTEND THE SHELF LIFE OF MEAT IN VIETNAM

## Bachelor Thesis

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**Declaration**

I, Thanh Nga Luu, declare that I have elaborated my thesis independently and I have cited only literature listed in the References.

Prague, April 21th, 2017

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Thanh Nga Luu

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## Abstract

Meat is an indispensable source of nutrition as well as being a favorite food of majority of humanity. Part of the thesis was focused on the classification of meat and the chemical composition. They were also taken into consideration extracts from plants, mainly herbs and spices, which could serve as preservative to prevent or reduce the risk of proliferation of microorganism to a minimum and to increase the shelf life of meat and meat products. Part of the thesis investigated the main mechanism of spoilage of meat and meat products after slaughter animals and storage process.

**Key words**: **meat, microorganisms processes, food additives, plant antimicrobial, plant antioxidants.**

## Abstrakt

Maso je nepostradatelným zdrojem výživy, je taktéž oblíbeným jídlem velké části lidské populace. Část bakalářské práce byla zaměřěna na klasifikaci masa a jeho chemické složení. Dále byly zohledněny extrakty z rostlin, především z bylinek a koření, které mohou být použity jako konzervační prostředky k prevenci nebo snížení rizika proliferace mikroorganismů a ke zvýšení trvanlivosti masa a masných produktů. Část bakalářské práce byla také věnována hlavním mechanismům kažení masa a masných produktů po porážce zvířat a možnostem skladování.

**Klíčová slova**: **maso, procesy mikroorganismů, potravinová aditiva, rostlinné antioxidanty, rostlinné antimikrobiální**.

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# 1. Introduction

Food preservation involves the action taken to maintain foods with the desired properties of nature for as long as possible. In most countries, innovation, sustainability, and safety have become the main focus of modern industry and economy (Rahman and Shafiur, 2007).

A range of herbs and spices are known to possess antibacterial activity as a consequence of their chemical composition. Antimicrobial agents can occur in foods of both animal and vegetable origin. Herbs and spices have been use for centuries by many cultures to improve the flavor and aroma of foods (Rahman and Shafiur, 2007). While some spices inhibit growth of microorganism and some retard their growth other reduce mycotoxin production (Bullerman, 1997).

Many plants contain compounds that have some antimicrobial activity, collectively referred to as "green chemicals" or "bio preservatives" (Smid, 1999).

Herbs and spices are not just valuable in adding flavour to foods. Their antioxidant activity also helps to preserve foods from oxidative deterioration, increasing their shelf-life. There has been increasing research in the role of herbs and spices as natural preservatives (Peter, 2000).

## 2. Objective

The aim of the thesis was the investigation of available literature sources and electronic information databases to get a general overview of the possibilities of using various plant extracts for the preservation of meat in the tropics and subtropics in Southeast Asia, particularly in Vietnam. Specific objective was to describe the composition of the meat, processing of meat products, and research plants which could serve as preservative to prevent or reduce the risk of proliferation of microorganisms to a minimum and to prolong the shelf life of meat and meat product.

## 3. Methods

Collection of information on the topic was conducted from specific internet databases. The most used were: Google Scholar (www.scholar.google.com), ScienceDirect (www.sciencedirect.com). Web of Knowledge (www.webofknowledge.com) and own experience and the knowledge acquired during study. The most searched keywords were : „preservation“, „ herb and spices“, and „ food spoilage“. All sources were listed in the list of references.

# 4. Literature Review

## 4.1 Characteristic of meat

Meats are defined as all parts of animals, including fish and invertebrates in fresh or conditioned state, which is suitable for human consumption (Pipek, 1998).

When meat is industrially processed in preparation of consumption, it may be enriched with additives to protect or modify its flavor or color, to improve its tenderness, juiciness or cohesiveness, or to aid with its preservation (Mills, E. 2004).

### 4.1.1 Classification of meat

Meat is the flesh and organs of animals and fowls. There are various legal definitions of meat in different countries designed to control the composition of products made with meat (Bender, 1992). Meat divide into:

#### 4.1.1.1. Beef

Beef is sources of full of vitamins, proteins and minerals that humans need. This is the most important group of farm animals. Beef cattle belong to the family *Bovidae*. Domesticated ox can be classified according to various criteria, according to the appearance, origin or performance (meat, milk) (Pipek, 1995). According to Janet (2003), beef is the third most consumed meat in the world (about 25% of total meat production worldwide), after pork is 38% and chicken is 30%. The US and Brazil are the world's top beef producers. The US holds a 25% and Brazil holds a 20% market share for 2010(Daily Livestock Report, 2010).

#### 4.1.1.2. Pork

Pork is a very popular meat in the world. This is because of several factors. Pork is traditionally the preferred meat and cheaper to produce than beef and sheep meat.

The production of pork increased by 122% between 1984 and 1994 in China, compared with 45% in the countries of the European Union (EU) and only 20% in the USA. In Asia and the Far East, the consumption of pork is nearly two-third of the total meat production (Warriss, 2000).

#### 4.1.1.3. Poultry

Poultry meat is meat from chicken and some other form farm raised birds such as chickens, turkeys, ducks, and quails (Sheevani, 2016). Chicken is the most common type of poultry in the world. Poultry meat called white meat, diet (low in fat). It is rich in animal protein (FAO, 2001). Poultry is also generally thought by consumers in the develop world to be healthier to eat (Warriss, 2000).

#### 4.1.1.4. Venison

Venison is considered the meat of animals that live in the wild and are hunted. The venison is considered to be deer, wild pigs, hare, etc. Vension meat is dark red to reddish-brown, has a low fat content. Each type of venison has a typical taste, smell, color and delicacy. The meat has a higher protein content, vitamin B and minerals (potassium, iron, phosphorus). Because of the low fat content it is easily digestible and there are special dishes are preferred by many people (Naše vyživa, 1999).

#### 4.1.1.5. Fish

Fish is an important food source for many cultures. According FAO (2011), fish is a food of excellent nutritional value, providing high quality protein and a wide variety of vitamins and minerals, including vitamins A and D, phosphorus, magnesium, selenium, and iodine in marine fish. Its protein–like that of meat-is easily digestible and favourably complements dietary protein provided by cereals and legumes that are typically consumed in many developing countries.

#### 4.1.1.6. Frog

Frog meat is considered nutritious and traditional in many food cultures such as China, Vietnam, Indonesia, and some country in Africa. Frog meat is the most delicious and nutritious in the legs. Frog meat is white, lean and delicious like chicken. Meat of the frog is sweet, fragrant, delicious. Flesh is the most delicious and nutritious frog in the thighs. Flesh is high in nutrients, high in protein, omega 3, calcium, vitamin B, D, E. Frogs are very popular in Vietnam. Traditional medicine says that frog meat is sweet, non-toxic and has a healthy, nutritious effect. Frogs are good for malnourished children (Nguyen Huong, 2011).

#### 4.1.1.7. Alligator

Crocodiles have been cultivated extensively on Vietnamese farms. Alligator meat is considered a specialty with gourmets. Meat is usually pink and sweet. Alligator meat is very lean compared to meat such as pork, beef or lamb. It has 21-22 % protein, 1-1.4 % fat, 1.3 % minerals and 75-76.6 % water. It is also nutritious, high protein content and good for health (Tran Viet Hung, 2014).

Figure 1: The live crocodile was bandaged with tape, tied to his feet and released to the sidewalk and alligator meat sold in the market in Vietnam (Tienphong, 2013).

#### 4.1.1.8. Goat

The goat species is an important component of animal genetic resources, commonly called "small ruminants". Goats were the first animals to be domesticated by man and continue to hold an important niche particularly in subsistence agriculture in the

developing countries, and they support a variety of socioeconomic functions throughout the world. Goats produce meat, milk, fiber and skins. Goat meat is widely consumed locally and may be exported. Goat meat, especially meat from one to two-year-old goats. However, it has a more pronounced spicy taste. Goat's meat is low in fat, fat under the skin, and relatively low between muscles. Goat's milk and goat's milk products and notably cheese are sold commercially and consumed widely in developed countries (Solaiman, 2010).

#### 4.1.1.9. Lamb and mutton

"Lamb refers to the meat of a sheep younger than one year old. Meat from older sheep is called hogget, and from even older sheep is called mutton" (Manuel, 2011). As with other meats, lamb is meat with a full source of nutrition, with a full source of vitamins such as vitamin B3, vitamin B12 and other essential health substances such as zinc, iron, phosphorus, and selenium. In lamb have also Omega 3-a healthy fat is also found in fish, which good for brain health and protects against heart disease (Kelley, 2014).

#### 4.1.1.10. Horse

Horse is a kind of animal close, gentle, emotional and creates positive emotions with humans so it is considered as a pet. For that reason, horse meat is consumed less. However, "The consumption of horse-meat is currently not popular in most countries, but because of its availability and recognized nutritional value consumption is slowly increasing in several western European countries based on claims that it could be an alternative red meat". Horse meat has been produced the most in Asia (46%), the United States (30%), Europe (18%), Oceania (4%) and Africa (2%) (Fao, 2015) (Xabier et al., 2015).

### 4.1.2. The importance of meat in human nutrition

Meat is a source of full and proper development of the human organism important substance. Wyness (2011) reported that proteins in meat provide energy

and are essential for growth, development, maintenance and the repair of the tissues. Taurine can be found mainly in shellfish like scallops, mussels and clams as well as in chicken and turkey dark meat. This aminoacid has shown several important biological functions such as acting like an antioxidant and anti-inflammatory agent which can be related to cardiovascular disease prevention and is almost exclusively found in animal products (Wojcik et al., 1998).

Heinz and Hautzinger (2007) described: “Rich nutriet matrix meat is the first choice-source of animal protein for many people all over the world. It is also significant for its organoleptic properties suitable for which there is a significant enrichment of the diet. Avowedly, meat has long occupieds a special place in the diet of humans”.

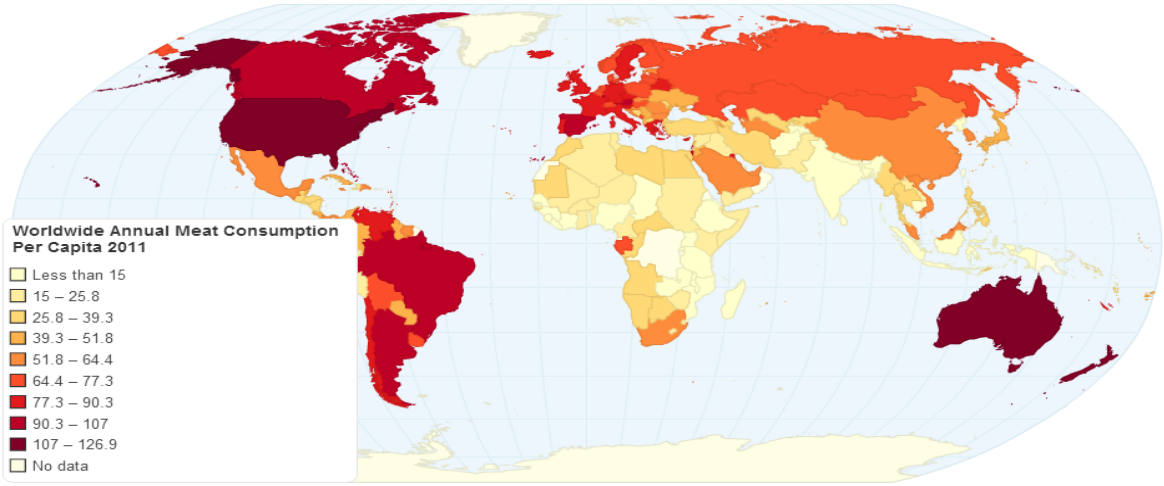


Figure 2: Worldwide Annual Meat Consumption Per Capita 2011 (FAO,2011).

#### 4.1.2.1. The importance of meat in tropics and subtropics

Meat consumption in developing countries has been continuously increasing from a modest average annual per capita consumption of 10 kg in the 1960s to 26 kg in 2000 and will reach 37 kg at end the year 2030 according to FAO projections (Heinz and Hautzinger, 2007).

Meat is held in high esteem in most communities. It has prestige value, it is often regarded as the central food round which meals are planned, various type of meat is sometimes made the basis of festive and celebratory occasions, and from the

popular as well as the scientific point of view, it is regarded as a food of high nutritive value. In the former where meat is in short supply it can be taken as a measure of the nutritional quality of the diet as a whole (Bender, 1992).

### 4.1.3 Chemical properties of meat

Meat is nutritionally very value source of full protein, vitamins (especially B group), unsaturated fatty acids and mineral substances. Law is therefore regarded as an irreplaceable component of nutrition, althought it is possible (difficult) to ensure full value (Pipek, 1998).

Table 1: The elementary composition of lean muscle meat (Pipek, 1995b)

| Content | Ingredient meat |
|---|---|
| **70- 75%** | Water |
| **18-22%** | Protein |
| **2-3%** | Fat |
| **1-1,5%** | Minerals and vitamins |

#### 4.1.3.1. Water

The moisture content of muscle and consequently meat plays a vital role in muscle food palatability, functionality, and shelf-life as muscle is composed of approximately 75% water (Kerth and Chris, 2013).

#### 4.1.3.2. Protein

Proteins are the major component of meat from a nutritional and technological point of view. Their content in meat is very high. Meat protein is complete protein, containing all essential amino acids for the body. The lean meat average 18-22 % protein. Nutrient composition of meat varies depending on the location on the body meat. Typically lean back and lean thigh section contains the highest protein content,

probably because this component of the animal body more activities to other parts (Bender, 1992).

The main nutritional value of meat is protein sources. It was found 30 amino acids in nature, including 20 kinds of amino acid commonly found in most proteins in meat. All amino acids can not replace easily threads found in muscle tissue so the meat has a high biological value. They give flesh color and characteristic odor (Kerth and Chris, 2013). According Pipek (1998), proteins in the meat are divided into groups according to their solubility in water and in salt solutions.

Proteins are divided into three groups:

a) Sarcoplasmic proteins
b) Myofibrillar proteins
c) Stroma proteins

#### 4.1.3.3. Lipid

In meat, lipid represented as the largest part as fat, up to 5% of muscle tissue. Fat energy supply by 2.25 times compared with glucide, protein. On the surface of the meat fats help protect the meat from drying out during storage and during cooking. Also fat in meat helps the meat softer, making meat easier to chew. Fat is the main source of meat flavor, increase the sense of meat, great importance to taste. Lipids can be broadly defined as organic compounds (mostly consisting of hydrogen, carbon, nitrogen, oxygen, and phosphorus). That are virtually insoluble in aqueous solutions but highly soluble in organic solvents, meat commonly, dichloromethane, chloroform, hexane and diethyl ether (Kerth and Chris, 2013).

#### 4.1.3.4. Vitamins and minerals

Meat and meat products are important sources of all the B-complex vitamins including thiamin, riboflavin (B2), niacin (B12), biotin, and some folate. Particularly in the liver and several other organs are rich in vitamins A, D, E and K. Meat is an excellent source of several minerals such as iron, copper, zinc, manganese,

phosphorus, and play an important role in the prevention of zinc deficiency, iron deficiency and especially that is common in developing countries growth (Bender, 1992).

### 4.2. Meat spoilage

There are three main mechanisms for meat and meat products spoilage after slaughtering and during processing and storage:

1) Microbial spoilage
2) Lipid oxidation
3) Autolytic enzymatic spoilage

### 4.2.1 Microbial spoilage

Microbial spoilage is the most significant changes occurring in foods during processing and storage occurs. Dave (2011) reported that, microbial spoilage causes pH change, slime formation, structural components degradation, off odors and appearance change. Meat is the appropriate environment for many microbes because water activity in meat, rich in nutrients especially protein, fat, minerals. So when fresh meat stored at improper conditions, the meat will be metamorphosed and lead to rancidity, damaged sensory status, or even the formation of harmful substances of human health.

According to Jay et al., (2005) meat and meat products provide excellent growth media for a variety of microflora (bacteria, Yeats and molds), some of them are pathogens.

#### 4.2.1.1. Bacteria

Bacteria have many different shapes. The majority of rod-shaped, spherical or spiral. Bacteria can grow in fresh food, such as meat, milk, vegetables. *Pseudomonas* is one of the commonest and most important spoilage bacteria found on meat. Pathogenic bacteria may cause disease -through infection, such as *Salmonella* and

*Yersinia*, or through producing toxins, such as *Clostridium* and *Staphylococcus*, or may be both infectious and produce toxins, such as *Streptococcus* (Warriss, 2000).

#### 4.2.1.2. Molds

We can only recognize the presence of the molds on the surface of the meat with the naked eye when they have formed large colonies. We can not see whiskers the hyphae that form threadlike vegetative parts of molds in meat. Molds colonies does not include a separate body which is a network of interconnected hyphae called fibers. Mold species include *Cladosporium, Sporotrichum, Geotrichum, Penicilluim* and *Mucor* (Garcia-Lopez *et al.,* 1998). Mold grows in meat makes the meat has a musty smell, viscosity and color change.

#### 4.2.1.3. Yeasts

There are two types of yeast. By fermentation, the yeast species *Saccharomyces cerevisiae* converts carbohydrates to carbon dioxide and alcohols–for thousands of years the carbon dioxide has been used in baking and the alcohol in alcoholic beverage (Legras et al., 2007).

The second type of yeast is very common yeast in medium rich in sugar materials. The growth of yeast in the product is usually seen on the surface of vegetables or meat, cheese. Other species of yeast *Candida Albicans* as pathogens that can cause infections in humans (Dave, 2011).

### 4.2.2. Lipid oxidation

The oxidave changes can have negative effects on the quality of meat and meat products, causing changes in sensory and nutritional properties (Shah, 2014).

Autoxidation of lipids and the production of free radicals are natural processes which affect fatty acids and lead to oxidative deterioration of meat and off flavours development (Dave, 2011). After slaughtering of animals, the fatty acids in tissue undergo oxidation when the blood circulation stops and metabolic processes are

blocked (Gray and Pearson, 1994; Linares et al., 2007). Lipid oxidation is the reaction of oxygen with double bonds of fatty acids (Hultin, 1994). At ordinary temperatures with oxygen to oxidize unsaturated fatty acids, and while at higher temperatures, leads to auto-oxidation of saturated fatty acids. Autoxidation hydrocarbon chain takes place by radical chain reactions consisting of three basic steps (initiation, propagation and termination).

**Initation:** The first stage is to initiate a radical mechanism, which involves homolytic cleavage of covalent C-H bonds. The energy required to split the binding molecule of fatty acids may be obtained from various sources: irradiating with ultraviolet rays, visible light, due to heat and metal ions of Fe, Cu… (Velíšek and Hajšlová, 2009a).

**Propagation**: During the propagation stage, the peroxyl radicals react with other lipid molecules to form hydroperoxides and new free radicals (Fraser and Sumar, 1998; Hultin, 1994): formation peroxyl radical and formation hydroperoxide. The sequence of these two reactions propagation step can be repeated several times. Therefore, autoxidation called chain reaction.

**Termination:** When the concentration of free radicals in the reaction system is high enough, it is likely that the two free radicals react to form not a radical, comparatively stable product and this reaction chain ends (Velíšek a Hajšlová, 2009). These lipid oxidation products can cause loss of color and nutritive value due to sever effects on lipids, pigments, proteins, carbohydrates and vitamins (Simitzis and Deligeorgis, 2010) and are directly related to carcinogenic and mutagenic processes (Liu et al., 1995).

Additives antioxidant often are added to meat and meat products fresh and processed to prevent lipid oxidation (decomposition), prevent degraded tastes, and improve color stability. However, is off set by some risk. Short-term adverse effect of sulfur dioxide, for example, main manifest in some particularly sensitive individual by gastric irritation, nause, diarrhoea asthma attacks and skin rashes (Velišek, 2013). Many herbal spices are known as excellent sources of natural antioxidants. Phenolic compounds are the primary antioxidants present in spices and there is a linear

relationship between the total phenolic content and the antioxidant properties of spices (Peter, 2004).

### 4.2.3. Autolytic enzymatic spoilage

Enzymatic actions are natural process in the muscle cells of the animals after they have been slaughtered and are the leading cause of meat deterioration. The enzymes have the ability to combine chemically with other organic compounds and work as catalysts for chemical reactions that finally end up in meat self deterioration (Tauro et al., 1986).

In the autolysis process, the complex compounds (carbohydrates, fats and protein) of the tissues are broken down into simpler ones resulting in softening and greenish discoloration of the meat. These autolysis changes include proteolysis and fat hydrolysis which are prerequisite for microbial decomposition. Excessive autolysis is termed “souring” (Tauro et al., 1986). Postmortem breakdown of polypeptides are the result of tissue proteases and is responsible for flavor and is textural changes in meat (Toldra and Flores, 2000).

## 4.3 Preservatives

For thousands of years, people around the world have used meat or fish preservatives by adding salt or sugar to foods for prolonged use. Due to the increasing demand for food preservation methods against the rapidly growing spread of microorganisms from bacteria or fungi, mold disease causes (Roller, 2003). Producers began to gradually replace the chemical preservatives. In the legislation of the European Union (European commission, 2008) food additive is “any substance not normally consumed as a food itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation treatment, packing, packaging, transport or holding of such food results, or may be reasonably expected to result, (directly or indirectly) in it or its by-products

becoming a component of or otherwise affecting the characteristics of such foods. The term does not include contaminants, or substances added to food for maintaining or improving nutritional qualities, or sodium chloride".

However, reports of occasional allergic reactions in sensitive indiduals and the formation of potentially carcinogenic by-products (e.g. nitrosamines from nitrite) have raised concerns about the potential detrimental effects of preservatives on health (Roller, 2003). Consequently, in recent years, consumer demand for natural preservatives has increased tremendously. Food producers are gradually replacing them with other safer preservation methods (Peter, 2004).

### 4.3.1. Plant extract as the preservatives

Meat is prone to both microbial and oxidative spoilage and therefore it is important to use a preservative with both antioxidant and antimicrobial properties (Kanatt et al., 2008).

For a long time, the plant kingdom is recognized as a huge source of compounds with applications in the food, cosmetic and drug industries. However, relatively little effort has been devoted to the development of plant-derived compounds as substitutes for synthetic fungicides (Roller, 2003). Natural plants are considered an important target to investigace in order to provide a new source of natural antioxidants and/or antimicrobial agents from a safety view point. Consequently, there is a practical need for the screening and selection of natural antioxidants as effective alternatives in the prevention of food deterioration (Kikuzaki and Nakatani, 1993). These natural antioxidants from plants, in the form of extracts, have been obtained from different sources such as fruit (grapes, pomerante), vegetables (brocoli, potato), herbs and spices (tea, rosemary, oregano, cinnamon, sage, thyme, mint, ginger, clove) and investiged to derease the lipid oxidation. These antioxidants are extracted from various plant parts such as leaves, roots, trunks, seeds, seeds and bark (Shal et al., 2014).

#### 4.3.1.1. Herb and spices

In ancient times spices and herbs were considered to be the basic ingredients of incense, perfume, ointment, cosmetics or medicine. Spices and herbs have also been used a bit in the preparation of cooking. It is then used in flavors and beverages (Ravindran and Geetha, 2004).

The terms "herb" and "spice" have more than one definition. Herbs are plants, some of which contain essential oils useful in foods, pharmaceuticals and/or cosmetics. They grow both in the wild and under cultivation. Herbs do not develop persistent wood tissue. Spices are generally derived from woody plants that grow in tropical areas. In most parts of the world, herbs are grown mainly as field crops or a small scale as a catch-crop among vegetables and ornamentals (Peter, 2012).

In the course of time the spices and herbs have been proven to be helpful not only to make delicious food (Ravindran and Geetha, 2004). But also the use of herbs and spices as natural preservatives to improve the shelf life of meat products is a promising technology because many herbs and spices have proven both antioxidant and antimicrobial properties (Ahn et al., 2004).

Spices can be used fresh or dried or in the form of extracts such as oil and oleoresin. Herbs are usually traded as dried products. Fresh herbs and frozen herbs have become available with modern preservation methods but the industry is still dominated by the sale of dried products (Petr, 2004).

### 4.3.2 Plants with the antioxidant properties

Oxidative change can have a negative effect on the quality of meat and meat products, causing sensory and nutritional properties (Shah, et al., 2014). Antioxidants are used to help prevent or minimize the oxidative change of meat and meat products (Shah, et al., 2014). Antioxidants can prevent lipid peroxidation by using mechanisms: preventing chain inhibition by scavenging initiating radicals, breaking chain reaction, decomposing peroxides, decreasing localized oxygen concentrations and binding chain initiating catalysts, such as metal ions (Dorman et al., 2003) and therefore the

antioxidant is intentionally added to food, help to preserve food from oxidation and deterioration and to increase their shelf life (Chung et al., 1997).

There is a large number of compounds already proposed for antioxidant activity, but only a few can be used in food products. The antioxidants can be of synthetic or natural origin (Shah, 2014). Synthetic antioxidants such as butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT), propyl gallate (PG) and tert-butyl hydroquinone (TBHQ) are the commonly used synthetic antioxidants (Shylaja and Peter, 2004). However, the demand for natural antioxidants, especially of plant origin has increased in recent years due to the growing consumer concern about synthetic antioxidants that have had potential toxicological effects (Juntachote et al., 2006). The natural antioxidants that have been studied in meat include a huge number of plant sources: vegetables, fruits, and seeds of various plants, some cereals, wine, tea, coffee, fruit juices and many spices (Shahidi and Zhong, 2010).

Spices and herbs are recognized as sources of natural antioxidants and consumption of fresh herbs in the diet may therefore contribute to the daily antioxidant intake (Shylaja and Petr, 2004). The rhizome of the popular ginger species, *Zinger officinale*, is widely used as a spice and food seasoning due to it sweet aroma and pungent taste. It is well known to have antioxidant activity (Jitoe et al., 1992; Zia-ur-Rehman et al., 2003) and effective antimicrobial agents. A ginger rhizome extract exhibited the highest antioxidanty activity (Mansour and Khalil, 2000) due to the effect of its total phenols (Stoilova et al., 2007) and these extract are rich in phenol will be a good substituent for synthetic antioxidants.

Phenolic compounds in plant antioxidanty were suggested to act against oxidation-induced damage of myofi brillar protein by two mechanisms: metal chelation (leading to inactivation of nonheme iron prooxidant effect) and radical scavenging (they could be scavengers of iron and lipid-mediated reactive oxidant species (Estévez et al., 2008). The most common natural antioxidants are phenols, phenolic acids, flavonoids, lignans and diterpenes and quinones. The source of polyphenolic compounds is also tea leaves (*Camelia sinensis).* The most interesting group of tea polyphenols includes catechins and phenolic acids (see Table 2). Rosemary, marjoram,

thyme and garlic are also often used in different substrates of model systems and meat processing (Marzanna, 2017).

Herb and spices, due to their long tradition of safe consumption and the content of antioxidant substances in appropriate proportions for humans, may be useful in the prevention of degenerative diseases (Dauchet et al., 2009; Vainio & Weiderpass, 2006). By reducing the amount of lipid oxidation products, they can also shape the nutritional value of meat products, e.g. reduce the loss of vitamin B1 or the nutritional value of proteins.

There are many researchers who have studied the extracts from plants that preserve the meat. Green tea leaves, rosemary and sweer red pepper extracts were applied to grand pork meat (Wojciak et al., 2011). Pomegranate *(Punica granatum*) peel extract was applied to ground goat and nugets (Devatkal et al., 2012). Ginger (*Zingiber officinale*), onion (*Allium cepa*) and garlic (*Allium sativum*) extract were applied to stewed pork (Cao et al., 2013). Naveena et al., (2013) used carnosic acid extracted from rosemary (*Rosmarinus officinalis*) leaves in buffalo meat patties. Rosemary (*Rosmarinus officinalis*), nettle (*Urtica dioica*) and lemon balm (*Melissa officinalis*) leaf extract was investigated in beef patties (Akarpat et al., 2008).

TABLE 2: Antioxidants isolated from herbs, spices and teas (Marzanna Hęś, 2017).

| **Species (systematic names)** | **Constituents** |
|---|---|
| Rosemary (*Rosemarinus officinallis*) | Carnosis acid, carnosol, rosmarinic |
| Oregano (*Origanum vulgare*) | Flavonoids, tocopherols |
| Thyme (*Thymus vulgaris*) | Biphenyls, flavonoids |
| Garlic (*Allium sativum*) | Containing compounds |
| Majoram (*Majorana hortensis*) | Flavonoids |
| Ginger (*Zingiber officinale*) | Gingerol-related compounds |
| Black pepper (*Piper nigrum*) | Phenolic amides, flavonoids |
| Turmeric (*Cucurma domestica*) | Curcumins |
| Green tea (*Camelia sinensis*) | Catechins |

### 4.3.3 Plants with the antimicrobial properties

Although the antimicrobial properties of herbs and spices have been long recognized, recent researches in naturally-derived antimicrobials have led to a renewed scientific interest in these substances. A possible alternative to synthetic antimicrobials is the use of plants and their products, together with essential oils which are thought to be generally effective for food safety and preservation (Lanciotti et al., 2004). There is growing interest in using natural antibacterial compounds, such as extracts of tea, spices and herbs, for food preservation (Smid and Gorris 1999).

Countries with hot climate use multipe spices on a regular basis, compared with coutries with cooler climate. The obvious reason for this being that foods in warmer zones are more susceptible to spoilage than foods in cooler areas. Addition of many spices produced synergistic effect together with displayed increased antibacterial activity when used in combination than when used alone (Billing and Sherman, 1998).

Spices and herbs which possess antimicrobial activity include those containing simple phenols and phenolic acids (Dorman and Deans, 2000), alkaloids coumarins, and terpenoids (Cowan, 1999). Those which demonstrated antimicrobial activities were incorporated into food preparation for their antimicrobial properties rather than for purely organoleptic purposes. The antimicrobial action of plant extracts or their essential oils in model food systems or in real food is well-documented in the literature (Holley, 2005).

Table 3: Antimicrobial activity of herbal spices (Peter, 2004)

| Spice | Mode of application | Activity against bacteria | Activity against fungus |
|---|---|---|---|
| **Basil** | Essential oil | | *Ascophaera apis* |
| **Basil** | Methyl chavicol | *Aeromonas hydrophylla, Pseudomonas fluorescens* | |
| **Coriander** | Essential oil | | Ascophaera apis |
| **Fenugreek** | Seed saponins | | Fusarium oxysporum f. sp. Lycopersici |

Table 3 (Continued)

| | | | |
|---|---|---|---|
| **Fenugreek** | Essential oil | *Bordetella bronchiseptica, Bacillus cereus, Bacillus pumilus, Bacillus subtilis, Micrococcus flavus, Staphylococcus aureus, Sarcina lutea, Escheriachia coli, Proteus vulgaris* | |
| **Cumin** | Essential oil | | *Penicillium notatum, Aspergillus niger, Aspergillus fumigatus, Microsporum canis* |
| **Fennel** | Essential oil | *Staphylococcus aureus, Bacillus subtilis* | |
| **Ajowan** | Seed extracts | | *Pythium aphanidematum, Macrophomia phaseolia, Rhizactonia solani* |
| **Allspcie** | Plant extract | | *Fusarium spp., Cladosporium spp, and Alternania spp.* |
| **Oregano, coriander and basil** | Essential oil | *Listeria monocytogenes*, *Staphylococcus aureus, Pseudomonas aeruginosa, Lactobacillus plantarum, Escherichia coli, Yersinia enterocolitica* | *Apsergillus niger* |
| **Pepper mint, thyme, caraway** | Essential oil | *Agrobacterium tumefaciens, Ralstonia solanacearum, Erwinia carotovora* | |
| **Spearmint, basil, parsley** | Essential oil | *Staphylococcus aureus, Escherichia coli* | *Candida albicans, Aspergillus niger* |
| **Oregano and mint** | Essential oil | | *Aspergillus ochraceus* |
| **Oregano** | Essential oil or carvacrol | | *Candida albicans* |
| **Oregano, thyme** | Essential oil or carvacrol | *Streptococcus pneumonia R36 A, Bacillus cereus* | |
| ***Anerthum graveolens,* coriander** | Seed diffusates | | *Alternaria alternate, Fusarium solani, Macrophomia phaseolina* |

### 4.4 Study area basic fact and biodiversity


Figure3: Map of Vietnam (Lonelyplanet, 1999)

Vietnam has an area of 32931.4 km2, is located in the east of the Indochina peninsula between Laos and Cambodia in Southeast Asia, Asia. Vietnam's territory is long and narrow. The total length of Vietnam's coastline is 3,260 km with thousands of large and small islands on the coast and off the high seas. Vietnam is a country located in the tropical monsoon climate. Due to geographic location, Vietnam has a great diversity of terrain with three quarters of land being hilly, land, landscape and especially each area has its own unique climate. According to statistics, Vietnam is one of twenty-five countries with a high level of biodiversity. It is ranked 16th worldwide in biological diversity (16% of the world’s spices) and 15,986 species of plants, including 4,528 species of non-vascular plants and 11,458 species of vascular plants, of which 10% are endemic. In agricultivary, Vietnam is one of the twelve centers of plant genetic resources in the world. Currently, Vietnam National Gene Bank preserves

12,300 varieties of 115 plant species (National environmental report in Vietnam, 2005).

### 4.4.1 Typical plants with antioxidant and antimicrobial effect used in Vietnam

#### 4.4.1.1. Allium fistulosum – hành lá

Figure 4: Green Onion (Ho Dinh Hai, 2013)

*Allium fistolosum*, commonly called green onion, spring onion or scallion. *Allium fistulosum* is a perennial herb having narrowly ellipsoid onion with many secondary onions, forming a clump consisting of several dozen bulbs. These spices probably come from the Altai and is widespread in Siberia, China, Japan and Mongolian (Valíček, 2009).

At present, *Allium fistolosum* is an important spice in Asian cuisine, especially in Southeast Asia. Spring onion contains 0.1-0.25% oil, phytoncids, vitamin B and vitamin C, fatty acids, choline, falovonoids, sulfur compounds, minerals, and other valuable compounds are allyl, mucilages, flovonoids and volatile and nonvolatile phytoncids. Especially silica effectively suppresses some yeasts and bacteria, especially *Staphylococcus* and *Streptococcu*s. It was found that phytoncids inter alia, positively affects the enzymatic system of the organism (Valíček, 2009). In Vietnam, green onion

is an indispensable spice in dishes such as fried, fried, noodles, meat porridge. Onions increase the taste of food and lose the smell of fishy.

#### 4.4.1.2. Allium sativum – Tỏi

Figure 5: Garlic (Ho Dinh Hai, 2012)

*Allium sativum*, commonly known as garlic, has been used as spices, foods and medicine for over 4,000 years (Ali et al., 2000). A perennial herb with onion flattened oval to spherical, composed of several egg-shaped fleshy bulbs, called cloves. The garlic plant's bulb is the most commonly used part of the plant. The leaves and flowers (bulbils) are sometimes eaten. *Allium sativumm* probably comes from Central Asia, from Tan-shan, where, thanks to the nomadic Mongols spread to China and other parts of the world (Valíček, 2009). Garlic is one of the easy-growing spices, growing well in a hot and humid environment. In Vietnam there are many famous garlic growing areas such as Ly Son, Phan Rang and Bac Giang.

Garlic has been known to posses various biological functions, including antioxidation and antimicrobial activities (Dillon et al.,2013). Garlic is one of the most commonly used ingredients as a flavor enhancement for sausage. In addition to flavoring the foods, garlic is appreciated for its medicinal properties. Garlic has a wide spectrum of actions; not only antibacterial, antiviral, antifungal and antiprotozoal, but also has beneficial effects on the cardiovascular and immune systems (Harris, Cottrell, Plummer, & Lloyd, 2001). Garlic-rich organosulfur compounds and their precursors

(allicin, diallyl sulfide and diallyl trisulfide) are believed to play a key role in these biological effects (Ankri & Mirelman, 1999; Kumar & Berwal, 1998). According to research by (Sallam et al., 2004), it has been pointed out that fresh garlic, garlic powder and garlic oil provide antioxidant and antimicrobial benefits to raw chicken sausage during cold storage (3°C). Addition of fresh garlic at 30 g/kg or garlic powder at 9 g/kg, did not result in a strong flavor and, at the same time, they produced significant antioxidant and antimicrobial effects and extended the shelf-life of the product up to 21 days.

#### 4.4.1.3. Alpinia officinarum – Riềng

Figure 6: Galangal (Ho Dinh Hai, 2012)

*Alpinia officinarum*, known as lesser galangal, is a perennial herb, belonging to family Zingiberaceae, originated in China and mainly cultivated in Southeast Asia (Bruneton, 1995). Various pharmacological properties have been found to be associated with *Alpinia officinarum* which include anti-inflammatory, antibacterial, antifungal, antiviral, diuretic, and anticancer properties (Lee, et al., 2009).

Young rhizome is a spice and is used to flavour various dishes in Malaysia, Thailand, Indonesia and Vietnam. For example, in Vietnam, people often take fresh galangal to collect water and use it to marinate meat, especially pork. Extract from galangal is a way to preserve meat for a long time and taste better (Ho Dinh Hai, 2012).

*Alpinia officinarum* rhizome contains 0.5-5% essential oil represented mainly 1,8 cineol, eugenol, present are flavonoids quercetin and kaempherol, galangin and isorhamnetin. Furthermore, the present resin is about 5%, 1% tannic acid and about 33% starch (Valíček, 2009).

#### 4.4.1.4. Camellia sinensis – Trà xanh

Figure 7: Green (Cayhoacanh, 2000)

*Camellia sinensis* is a plant whose leaves and leaf buds are used for tea production. The plants come from Southeast Asia, but is now cultivated in tropical and subtropical regions of all continents. The main active ingredient is an alkaloid caffeine, which comprises 2-4% tea, theobromine (0.1%), and theophylline (0.03%). They are represented tannic acid (9.3%) polyphenols, especially flavonols (often also referred to as tea catechins-an antioxidant) (Valíček, 2009).

Tea from the leaves of plant *Camellia Sinensis*, next to water, is one of the most widely consumed drinks in the world use everyday because of its pleasant taste and its use as a drug with medici effect (Yongjin hu, et al., 2008). Chan (et al., 1997) reported on the basis of extensive animal experiments and some epidemiological data, tea has been attributed the properties of being anti-inflammatory, antioxidative and anticarcinogenic. Tea extracts have been shown to have several useful antimicrobial

effects. The basis and neutral metanol extract of Camellia inhibited the growth of food-borne pathogens in microbiological media and food (Kim, et al., 2001).

Yongjin hu, et al. (2008) found that the antimicrobial extract of green tea can extend the life of lamb up to 4 days at 7±1C without adversely affected affecting its physicals, chemicial and organoleptic parameters.

#### 4.4.1.5. Cinnamomum loureiroi – Quế thanh

Figure 8: Cinnamon (Kalyx, 2000)

Cinnamon is a popular spice that has long been used around the world and for many uses in food, pharmaceuticals and cosmetics. It is obtained from the dried inner bark of tropical evergreen trees of the genus Cinnamomum (Jayatilaka et al., 1995). The genus Cinnamomum has 250 species and *Saigon Cinnamon* (*Cinnamomum loureiroi*), as know as Vietnamese cinnamion is indigenous to mainland Southeast Asia. Cinnamomum bark and shoots contain 2% cinnamic aldehyde silica (75-90%), especially polysaccharides, further mucilage, tannins (2-3%), calcium oxalate ( 1.3%), biotin, diterpenes cinncassioly, coumarins (0.9%) (Valíček, 2009).

The bark oil is anti-fungal and anti-bacterial, slowing meat spoilage, so its use as a spice for meat dishes in warmer climates is sensible. Jayathilakan et al. (2007) applied ascorbic acid (5 mg/kg), cloves (25 mg/kg), and cinnamon (25 mg/kg) to treat precooked sheep, beef and pork, and reported that after storage at 6 °C for 6 days, the

production of warmed-over-flavor (WOF, expressed as n-hexanal formation) was suppressed by more than 50%, and the inhibition was highly correlated with antioxidant potential of these plant extracts.

#### 4.4.1.6. Curcuma longa – Zingiberaceae – Nghệ

Figure 9: Turmeric (Do Tat Loi, 2004)

Turmeric is a perennial herb plant (*Curcuma longa*) of the ginger family, Zingiberaceae. It is a grass with a height of 0.6 m to 1 m. The bulb is cylindrical or slightly flat. The oval leaves are slender at both ends, up to 45 cm long and 18 cm wide. Inflorescence growing from the middle of the leaves, petals outside the greenish-yellow color (Do Tat Loi, 2004).

Turmeric comes from South and Southeast Asia, which is also known as "yellow curtains". It is grown mainly in India, as in China, Vietnam, Bangladesh, Indonesia, but also in South America and the Caribbean (Valíček, 2009).

*Curcuma longa* is a widely cultivated ginger plant with pungent rhizomes that produce turmeric, a popular spice for curries, food flavouring, and colouring. Curcumin, the active component of turmeric, is known to have a wide array of bioactivity including antioxidant, anti-inflammatory, anti-cancer, and cardio-protective

properties. The aromatic leaves of *C. longa* are used for flavouring steamed and baked fish (Larsen et al., 1999).

Phenolic content and radical–scavenging activity were significantly higher in rhizomes than in leaves of *C. longa*, but metal ion-chelating ability was higher in leaves (Chan et al., 2008). Khanna (1999) recorded that the antioxidant property of turmeric was effective in preventing peroxide developments in foods. Turmeric contains curcumin that acts as a scavenger of oxygen free radicals. The antioxidant mechanism of curcumin is attributed to its unique conjugated structure, which shows typical radical-trapping ability as a chain-breaking antioxidant (Chattopadhyay et al., 2004).

Maurya et al. (2010) observed that turmeric showed a significant effect in controlling oxidative rancidity of fat of carabeef pastirma. Tayyem et al. (2006) analysed various commercial turmeric and curry powders and reported that pure turmeric powder had the highest curcumin concentration, averaging 3.14% by weight.

#### 4.4.1.7. Cymbopogon citratus – Poaceae – Så

Figure 10: Lemon grass (Giaoduc, 2013)

*Cymbopogon citratus*, commonly known as lemon grass or oil grass, is a perennial plant which yields aromatic oil from South Asia and Southeast Asia. The name lemongrass is derived from the typical lemon-like odour of the essential oil

present in the shoot (Skaria, 2006). Lemongrass is a herbaceous plant, usually growing in dust about 1-1.5m high. The body is white or slightly violet, with lots of burning. Lemongrass is a type of root, growing deep in the soil, roots thrive when the soil is porous. Long narrow leaves. Leaf hugged each other very firmly, mastering a fake (which we often call the bulb). Lemongrass shoots in the armpit of leaves forming as branches of rice. With this way of reproduction from an early branch, they will later multiply into clusters of lemongrass (like rice dust) (Do Dinh Hai, 2012).

*Cymbopogon citratus* has a delicate lemon flavor, it is used fresh (very popular) or dried, powdered. The main chemical components of lemon essential oil are geraniol and citronellol. Moreover, lemongrass contains flavonoids that have antioxidant activity (Do Tat Loi, 2004).

Also according to Do Dinh Hai (2012), lemongrass is grown for use as a spice, also grown to extract essential oils in food, medicine, pesticides and cosmetics.

Especially lemongrass has been grown for many years for various medical purposes in countries around the world. The use of *Cymbopogon citratus* has been found as a folk remedy for cough, malaria, pneumonia and vascular disorders. Researchers have discovered that lemongrass contains antidepressants, antioxidants, antiseptics, bactericides, fungicides, neurotoxins and tranquilizers (Mohd Irfan Naik et al., 2010).

Further, many workers had reported about the antibacterial activity of lemongrass oil against a diverse range of harmful organisms, yeast and fungi (Shigeharu et al., 2001).

#### 4.4.1.8. Piper Nigrum – Hạt tiêu đen

Figure 11: Black Pepper (Do Dinh Hai, 2001)

*Piper Nigrum* (Black pepper) is a flowering vine in the family Piperacea, obtained from mature fruit, which is usually dried and used as a spice. According to Ravindran (2001), black pepper is said to be king in all seasonings. It is the most important, most popular and most widely used spice in the world. Together with other spices, pepper helped to improve flavor and preservation of food became easier. *Piper Nigrum* has been also used as a traditional medicine. For example for aiding in digestion, in curing the common cold or as a carminative and febrifuge.

Perennial climbing plant growing to 10-12 m. The stem is woody at the base, the top of the gnarled and flexible with air adventive roots. Leaves are petiolate, blades broadly ovate or on top sharpened, shiny and leathery with marked venation. In the leaf axils grow herringbone with both genital and genital single flowers that are bland, small, pale yellow or cream. Fruit is a berry with a thin fleshy pericarp, that is the time ripe red to yellow-red. In each ear is formed from 20 to 30 berries (Valíček, 2010).

Black pepper is native to south India and is extensively cultivated there and elsewhere in tropical zones such as the Asia Pacific region, mainly India, Indonesia, Malaysia, Sri Lanka, Thailand, China, Viet Nam and Cambodia (Ravindran, 2001). According the Worldatlas (2017) Vietnam is the world leader in production of black

pepper, producing 16, 3000 tons which are about 34% of the world's production. The plant is a traditional cash crop in the country, and 95% of the black pepper produced is an export primarily to the US, India, Netherlands, and Germany. Black pepper is widely used in Western and Eastern dishes, both vegetarian and non-vegetarian. Black pepper contributes to taste, taste, antifungal, antimicrobial and antioxidant properties, so black pepper is a multi-functional spice. *Piper nigrum* is of great importance also in the canning industry and the production of spice mixtures. Piperonal has an aroma as vanilla, and used in perfumery (Valíček, 2009)

Pepper has antioxidant activity which is attributed to the tocopherol and polyphenol contents in pepper. Supercritical carbon dioxide extracts of ground black pepper have been found superior in reducing lipid oxidation of cooked ground pork (Tipsrisukond et al. 1998). Nakatani et al. (1986) identified black pepper have five phenolic ammonia as having good antioxidant properties, even higher than synthetic antioxidants such as butylated hydroxy toluene and butylated hydroxy anisole.

Thanks to the antibacterial pepper, adding this spice to food increases the quality of their keeping and prevents their deterioration. The essential oil of pepper is found to be inhibitory to *Staphylococcus albus, Clostridium diphthereae, Streptomyces faecalis*, etc. Pepper leaf oil also exhibits antifungal activity (Ravindran, 2007).

#### 4.4.1.9. Syzygium nervosum - Vối nếp

Figure 12: *Syzygium nervosum* (Do Dinh Hai, 2012)

Do Tat Loi (2001) reported that *Syzygium nervosum* is a species of Myrtaceae family native to northern Australia and in tropical countries in Asia. The tree is about 5-6m high. *Syzygium nervosum* is a medium-sized tree with a dark brown bark and longitudinal crack. Oval leaves, small white flowers and flowers often hatched into the beam. Leaves, branches and flower buds are pleasant aromatic. Grows wild and is planted everywhere. In the leaves there are tannins, some minerals, vitamins and about 4% of essential oils. Especially, leaves at all stages of development have a significant antibiotic effect, especially those harvested in winter. Leaf antibiotics are effective against many types of bacteria such as *Streptococcus, Staphylococcus, Daphnia, Salmomella, Bacillus subtilis.* This active antibiotic is water soluble and is a common organic solvent, stable with temperature and not toxic to the body. As long as green tea leaves, Syzygium buds and leaves are raw materials used to make people drink water every day and also for postpartum women. *Syzygium nervosum* has long been used as a folk remedy such as for the treatment of sore throats, dermatitis and intestinal diseases. Below are illustrations of leaves and buds after being harvested, washed and dried.

Figure 13: *Syzygium nervosum* after being dried (Ho Dinh Hai, 2003)

#### 4.4.1.10. Zingiber officinale - Gừng

FIgure 14: Ginger (Ho Dinh Hai, 2002)

The spice ginger is obtained from the underground stems or rhizomes of *Zingiber officinale*, a herbaceous tropical perennial belonging to the family Zingiberaceae, to which also belong turmeric *(Curcuma longa*), and galangal, is widely used as a spice or a folk medicine (Peter, 2001). Ginger is grown throughout the tropics, although most areas are in India, China, Southeast Asia and West Africa, but also in Jamaica (Valíček, 2010).

Ginger has been used as spice for over 2,000 years. The water extract of ginger exhibits 6-gingerol and its derivatives which is mostly found in the rhizome at concentrations of 130 to 7138 ppm (Voravuthikunchai, 2011).

Ginger has excellent antioxidant properties, as well as their more established role in preserving lipid-based foods. Studies include the role of components such as gingerol in inhibiting linoleic acid autoxidation (Kikuzaki and Nakatani, 1993), extending the shelf-life of meat (Ziauddin et al., 1995), dehydrated pork (Fuijo et al., 1969) and fermented meat sausage (Al-Jalay et al., 1987). The antimicrobial properties found in ginger have also been shown in studies, such as those related to *Acillus subtillis* and *E. coli* (Yamada et al., 1992) and *Mycobacterium* (Hiserodt et al., 1998). In addition to its aromatic contribution to foods, ginger tea has been used to improve

circulation, aid digestion, and treat nausea from motion sickness, pregnancy or chemotherapy (Ernst and Pittler, 2000).

## 5. Conclusion

Literature sources and electronic information sources to analyze the composition of the meat, processing of meat products, and research on plants which could serve as preservative to prevent or reduce the risk of proliferation of microorganisms to a minimum and to prolong the shelf life of meat and meat product was investigated in the study. Collection of information on the topic was conducted from specific internet databases such as ScienceDirect, Web of Knowledge and Google Scholar. The most searched keywords were: „preservation “, „ herb and spices “, and „ food spoilage “. Use of plant extract to extend the shelf life of meat is a very reasonable method for sustainable development because it is a natural substance that does not have adverse effects on human health and also does not pollute the environment. This method is particularly suitable in the tropics and subtropics, where many poor countries do not have refrigerators and even no electricity available to use. The work brings a complete a general overview of the possibilities of using various plant extracts for the preservation of meat in the tropics and subtropics in Southeast Asia, particularly in Vietnam.

In addition to the work I have made a small survey on the use of plant extracts to preserve meat in Vietnam. Questionnaire with the title: “Questionnaire on plant extract used as meat preservation media in Vietnam” and evaluation of questionnaire see in Annex A, B and C.

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## ANNEX A

Questionnaire with the title: “Questionnaire on plant extract used as meat preservation media in Vietnam” was set up from the 15th of March until 9th of April 2017. The purpose of the questionnaire was to figure out the contemporary daily tendencies of Vietnamese people in meat preservation. The questionnaire was created online through Google Docs, because of high effectivity, the results are immediately visible and the survey sample is very wide. The questionnaire was sent personally to acquaintances of author through social media sites. Based on good practice of questionnaire survey the representative sample of respondents wasn’t chosen well, but the questionnaire and the results can serve as a pilot version of first step towards future research. The questionnaire was created in Vietnamese language, hence limiting to only Vietnamese people living either in Vietnam or in foreign countries. Total number of respondents was 68. Annex B and Annex C show the questionnaire survey form in Vietnamese and English, respectively.

The age range of respondents was 21-30 (77.9%) and 67.5% respondents already worked. Only 5 respondents lived in foreign countries (Czech Republic and Germany) the rest lived in Vietnam: 32 respondents in the capital city of Hanoi and 11 respondents in Ho Chi Minh City, also know as Saigon. 70% of all respondents finished tertiary education and 16 respondents had high school as their highest education. Only one third of the respondents were male and only one tenth of respondents worked in rural areas. As the best way of meat preservation, Vietnamese people generally preferred the natural way, which means keeping it in cold stage (44 answers), marinating it with herb and spices (22 answers) or pack of the food in banana leaves (2 answers from Hanoi). Most respondents didn’t have deep knowledge about herb and spices. 85% of respondents did not realize which parts of herb is used as plant extract for prolonging shelf life of meat. 60% of respondents get their information from their family. Most people had stigma against chemical preservation-reasoning it as a negative influence of their health, that is lacks certification or even that it changes the flavour and texture of meat. Only 4 respondents had positive or netural view on chemical preservation. The herbs that were well known between the respondents were garlic (38%), green tea (32%), ginger (31%), green onion (27%) and lemongrass (27%).

## ANNEX B

# Nghiên cứu về chiết xuất từ thực vật bảo quản thịt ở Việt Nam

**Nghề nghiệp của bạn**

- Học sinh, sinh viên
- Công nhân, viên chức
- Nông dân
- Nghỉ hưu
- Thất nghiệp

1) Bạn sống ở thành phố nào:

2) Tuổi của bạn
   - Dưới 20 tuổi
   - Từ 21- 30 tuổi
   - Từ 31-40 tuổi
   - Từ 41- 50 tuổi
   - Từ 51 tuổi trở lên

3) Trình độ học vấn
   - Trung học cơ sở
   - Trung học phổ thông
   - Đại học và sau đại học

4) Giới tính
   - Nam
   - Nữ

5) Bạn làm việc ở đâu
   - Thành phố
   - Làng quê

6) Trong trường hợp bạn muốn bảo quản thịt , bạn sử dụng phương pháp nào?
   - Tự nhiên ( đề nghị nêu tên cụ thể)
   - Tổng hợp, hóa học

7) Bạn ưu tiên phương pháp nào?

- Chiết xuất từ tự nhiên
- Chiết xuất hóa học

8) Bạn biết chiết xuất từ loại cây nào có tác dụng bảo quản thịt không?
   - Biết
   - Không biết
   - Bạn có biết bộ phận nào của cây được sử dụng bảo quản thịt không?.....
   - Bạn có biết vùng nào trồng nhiều cây có tính chất bảo quản thịt ở nhà không?.....

9) Bạn có trồng cây nào có tính chất bảo quản thịt ở nhà không?
   - Có
   - Không trồng

10) Bạn có kiến thức về các loại cây có chiết xuất bảo quản thịt từ đâu?
   - Từ gia đình
   - Từ nhà trường
   - Từ thực hành
   - Nghe từ một ai đó
   - Từ sách vở
   - Từ một trường hợp khác

11) Bạn có một công thức gia truyền nào về các loại cây có chiết xuất bảo quản thịt không?
   - Không
   - Có

12) Bạn có sẵn sàng chia sẻ một công thức mà bạn hoặc gia đình bạn sử dụng chiết xuất từ thực vật để bảo quản thịt không?
   -Không
   -Có (cụ thể là công thức gì) / …

13) Bạn nghĩ gì về việc sử dụng các loại chiết xuất từ thực vật để bảo quản thịt với sức khỏe?.....

14) Bạn nghĩ gì về việc sử dụng các chất tổng hợp ( hóa học) để bảo quản thịt

.....
.....

15) Nếu bạn muốn chia sẻ thêm thông tin về việc bảo quản thịt bằng phương pháp tự nhiên, xin vui lòng bạn chia sẻ tại đây :

……
……..

16) Bạn có biết cây nào có chiết xuất bảo quản thịt nào ở danh sách dưới đây không ?

| No | Tên thực vật ( plants species) | Họ (family) | Tên tiếng địa phương (vernacular name) | Bộ phận thực vật sử dụng (plants part use) | Có biết hoặc không biết |
|---|---|---|---|---|---|
| 1 | Allium fistulosum | Alliaceae | Hành hoa | củ (bulbs) | |
| 2 | Allium sativum | Alliaceae | Tỏi | củ (bulbs) | |
| 3 | Alpinia officinarum | Zingiberales | Riềng | thân ngầm (rhizome) | |
| 4 | Bruguiera gymnorrhiza | Rhizophoraceae | Sú vẹt | vỏ, lá (phloem, leaves) | |
| 5 | Camellia sinensis | Theaceae | Trà xanh | Lá (leaves) | |
| 6 | Capsicum annuum | Solanaceae | Ớt tiêu | quả (fruit) | |
| 7 | Cinnamomum loureiroi | Lauraceae | Quế thanh | vỏ, lá (phloem, leaves) | |
| 8 | Curcuma longa | Zingiberaceae | Nghệ | thân ngầm (rhizome) | |
| 9 | Cymbopogon citratus | Poaceae | Sả | thân, lá (rhizome) | |
| 10 | Hemerocallis fulva | Hemerocallidaceae | Hoa hiên | Hoa (flower) | |
| 11 | Laurus nobilis | Lauraceae | Nguyệt quế | lá, vỏ, hoa (leaves, phloem, flower) | |
| 12 | Piper nigrum | Piperaceae | Hạt tiêu đen | quả (fruit) | |
| 13 | Syzygium aromaticum | Myrtaceae | Đinh hương | Hoa (flower) | |
| 14 | Syzygium nervosum | Myrtaceae | Vối nếp | vỏ, lá, nụ (phloem, leaves, flower buds) | |
| 15 | Zingiber officinale | Zingiberaceae | Gừng | thân ngầm (rhizome) | |

## ANNEX C

# Research on plant extract preservation meat

# in Vietnam

1) Your job?
   - Student
   - Manual or administration job
   - Farmer
   - Already retired
   - Unemployed
2) Town, that you are living in ?.....
3) Your age?
   - Under 20
   - 21-30
   - 31-40
   - 41-50
   - 51 and more
4) Your highest education level
   - Middle school
   - High school
   - College/university
5) Gender
   - Man
   - Woman
6) Your working location
   - Urban areas
   - Rural areas

7) What process do you usually use to preserve food?
   - Traditional with natural ingredients (please name it)
   - Chemical or combined (please name it)
8) Which way is your prefered one?
   - Natural additives
   - Chemical additives

9) Do you know any plants extract that have the preservation effects?
   - Yes
   - No
   - Which parts of plants is normally used for the preservation?.....
   - Which region is known for growing those plants?.....

10) Do you grow those plants yourself at home?
   - Yes
   - No
11) Where do you gain knowledge about plants extract for meat preservation from?
   - Home
   - School
   - From real life
   - Overheard from people
   - From books
   - Other
12) Do you have any herbal/plants home recipe for meat preservation?
   - Yes
   - No
13) Could you share any share with us?.....
14) What do you think about usage of plant extracts for meat preservation?.....
15) What do you think about synthetic preservation extracts?.....
16) Any additional infos about natural additives for meat preservation?.....
17) Do you know any of those plants extract used for meat preservation?

| No | Plants species | Family | Vernacular name | Plants part use | Know/don't know |
|---|---|---|---|---|---|
| 1 | Allium fistulosum | Alliaceae | Hành hoa | bulbs | |
| 2 | Allium sativum | Alliaceae | Tỏi | bulbs | |
| 3 | Alpiniaofficinarum | Zingiberales | Riềng | rhizome | |
| 4 | Bruguiera gymnorrhiza | Rhizophoraceae | Sú vẹt | phloem, leaves | |
| 5 | Camellia sinensis | Theaceae | Trà xanh | leaves | |
| 6 | Capsicum annuum | Solanaceae | Ớt tiêu | fruit | |
| 7 | Cinnamomum loureiroi | Lauraceae | Quế thanh | phloem, leaves | |
| 8 | Curcuma longa | Zingiberaceae | Nghệ | rhizome | |
| 9 | Cymbopogon citratus | Poaceae | Sả | rhizome | |
| 10 | Hemerocallis fulva | Hemerocallidaceae | Hoa hiên | flower | |
| 11 | Laurus nobilis | Lauraceae | Nguyệt quế | Leaves, phloem, flower | |
| 12 | Piper nigrum | Piperaceae | Hạt tiêu đen | fruit | |
| 13 | Syzygium aromaticum | Myrtaceae | Đinh hương | flower | |
| 14 | Syzygium nervosum | Myrtaceae | Vối nếp | phloem, leaves, flower | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | buds | |
| 15 | Zingiber officinale | Zingiberaceae | Gừng | rhizome | |
| | | | | | |