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Composition of venison and game meat for its processability to meat product

Bachelor Thesis

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Statement

I declare that I worked out this bachelor thesis titled „ Composition of venison and game meat for its processability to meat product“ alone and that I used only literature that is cited and mentioned in references. I agree with storing this thesis in the library of CULS Prague and enabling it for study use.

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Pavlína Pěstová

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Abstract

This thesis summarizes a revision of literature findings on theinfluence of physical and chemical properties of the game meat on processability and production of meat products. Processed tabularized overview of the physical and chemical properties of game, rated by raw meat products focused on samples coming mostly on hunted game (red deer, fallow deer, wild boar, African ungulates). To allow comparison with captive bred animals, the livestock was included. The most freguently assessed physical properties was the water activity and pH and chemical properties was the composition and sensory characteristics of meat. The controlled effects were stress before cropping, region, species/breed, age, and gender on the quality of meat and meat products. Most published studies were on evaluation of the game, deer and wild boars. It has been shown that the initial quality of deer and wild boar meat directly affects the chemical and physical quality of the final products (ham, sausage, mould-ripened salami, chorizo sausages, dried salami, cecinas, saucisson). The importance of research on game rising in recent years, as evidenced by an increase in the number of scientific publications related to this area.

Key words: game meat, chemical composition, physical properties, processability, venison

Abstrakt

Tato bakalářská práce shrnuje na základě revize literatury, poznatky o vlivu vlastností zvěřiny na zpracovatelnost a výrobu masných produktů. Cílem práce je porovnat fyzikální a chemické vlastnosti zvěřiny a masa. Zpracovaný tabularizovaný přehled fyzikálních a chemických vlastností zvěřiny a masa z hospodářských zvířat, hodnocený v syrovém stavu a v masných výrobcích, byl zaměřen na vzorky pocházející z řízených odstřelů zvěře (jelen evropský, daněk evropský, divoké prase, africké druhy kopytníků). Nejčastější hodnocenou fyzikální vlastností byla vaznost vody a pH a chemickou vlastností bylo složení masa a organoleptické vlastnosti (a zkoumání vlivu stresu před usmrcením, oblasti, věku a pohlaví na konečnou kvalitu masa). Nejčastěji publikovanými studiemi bylo hodnocení zvěřiny pocházející z jelení a černé zvěře. Bylo prokázáno, že vstupní kvalita jeleního a kančího masa přímo ovlivňuje chemickou a fyzikální kvalitu konečných výrobků (šunky, klobásy, zrající salámy s plísní, chorizo klobásy, sušené salámy, klobásy cecinas, salámy saucisson). Význam výzkumu zvěřiny v posledních letech stoupá, což dokládá zvýšení počtu odborných pubikací, týkající se této oblasti.

Klíčová slova: fyzikální vlastnosti, chemické složení, maso daňka, maso jelena, zpracovatelnost, zvěřina

Content

List of the shortcuts used in this Thesis

TBARS – Thiobarbituric-reactive substances

FA – fatty acids

LAB – lactic acid bacteria

BA – biogenic amines

1. Introduction

Venison and game meat has been traditionally part of human diet since rising of huntering and gatherging societies in paleolithic times (Curtis, 2001). Lawrie and Ledward (2006) presents, that hunting of animals by our ancestors for gaining of meat and other products was important change in human evolution in comparison with domestication, which is closely connected with beginnings of agriculture in about 7000 BC. Nowadays game meat production is not only secured by hunting, but also by severe extensive or intensive farming systems throughout the world and especially in rich countries consumer demand about game meat is increasing (Hoffman and Wiklund, 2006).

Game meat is ranging as specific group next to meat kinds of the most common farm animals. Wild game species spectrum is diverse - Belitz *et al.* (2009) divide henceforth game into further groups, such as deer, wild boars, other wild animals and also birds of fowl etc .

Belitz *et al.* (2009) also refer the main characteristics of the game meat. The wild game meat consists of fragile meat fibers, which have firm consistency. Its color remains red to red-brown and usually darker than meat from domestic species. This meat has low amounts of connective and adipose tissues. Taste and flavor of each type of wild meat is characteristic. Aging of this meat requires a longer time than meat from domestic animals because of the thick and compact muscle tissue structure. Wild game meat after aging becomes dark-brown to black-red. Generally nutritional value of game meat can be considered higher in comparison of farm animal meat (Hoffman, 2008).

Hoffman and Wiklund (2006) pointed especially on desirable low fat content and positively low content of saturated fatty-acid. Cordain *et al*. (2002) state, that game meat can have due to its favourable fat content composition important usage in nutrition for prevention and cure of chronic diseases like arteriosclerosis. Arihara (2006) also present, that increasing concerns about human health are closely connected with eaten meat products and that there are several ways how to develop healthier meat and meat products, functional products including.

2. Bibliographic Research

2.1. Comparison of game meat with beef

Game has a number of characteristics due to which could be classified the most valuable dietetic foods among other the others. With very low fat and high protein content game meat, surpasses the meat of most kinds of farm animals. Proteins of the game has are rich in essential amino acids, what significantly increase their biological and nutritional value (Lawrie and Ledward, 2006).

As a result of extremely low proportion of fat game meat, especially venison (game meat from deer species) contains very little cholesterol, what is in terms of modern nutrition assessed as priority (Vodňanský *et al*., 2010). But it has relatively large amount of unsaturated fatty acids and poly unsaturated fatty acids, which have been shown a positive effect on the multifaceted human organism, e. g. in prevention of chronical diseases. The fat contained in the muscle is generally considered to be carriers of flavours, and to achieve the desired effect just proportion of weight around 1-2%. It is this minimal representation of fat that game has is totally inadequate to ensure its excellent taste (Cordain et al., 2001, Purchas, 2005).

Taste and smell of game meat is specific for each species specific. The game meat color is dark red with significantly saturated shade than the meat of farm animals.

Game meat also have more muscle pigments (myoglobin), higher vitamin content and there is also some difference in structure of muscle fibres in comparison with farm animals. (Lawrie and Ledward, 2006).

2.1.1. The composition of proteins

Game is characterized by the high content of essential amino acids. For the human body is receiving these building components of protein is very important, because you can´t in its metabolism to create itself (Steinhauser, 1995). The highest proportion of essential amino acids has a muscle of boars and hares (Pipek, 1998). Meat of wild boars is of 11.7% higher amino acid content than meat of domestic pigs. Also venison of deer species contains more amino acids than beef cattle such as muscle (Lawrie and Leward, 2006).

The concentration of proteins in lean meat does not vary widely, and the variation that does exist, what can often be explained based on differences in levels of intramuscular fat. With higher levels of fat are associated slightly lower percentages of protein (Pipek, 1998). Venison generally has low fat levels so the protein percentage tends to be correspondingly higher than meats containing more fat (Seman and McKenzie-Parnell, 1989).

Generally the proteins that make up muscles of all mammals are very similar, but there are differences between species that can be detected by simple electrophoresis techniques (Skrokki and Hormi, 1994). There will be some differences in proteins between muscles and between species due to differences in the proportions of the various muscle fibre types that differ in their metabolisms (Purchas, 2005).

2.1.2. The composition of fats

Major building components of fat are fatty acids, which are divided according to the chemical composition of a few basic groups. One of them is called saturated fatty acids that are present in increased quantities, especially in some animal fats. The human body fat in these components requires a certain amount, should be content in their diet is limited, with higher income may cause increases in blood cholesterol levels and therefore higher risk of cardiovascular disease (Purchas, 2005).

The second so-called unsaturated fatty acids are represented mainly in vegetable, seafood and venison. They have on the human organism versatile positive effect. It is disputes especially of essential fatty acids omega-6 and omega-3, which the human body cannot produce itself and therefore has to cover their need by food (Vodňanský *et al.*, 2010). Unsaturated fatty acids help lower blood cholesterol and play an important role in the prevention of cardiovascular diseases. In addition, they demonstrated a beneficial effect on nervous system function and development of the immune abilities of the organism. An important dietetic properties of fat contained in the game is particularly high proportion of unsaturated fatty acids (Cordain *et al.*, 2001; Purchas, 2005)

The percentage of fat present is almost always the most variable composition characteristic of any meat product, and even though this review focuses on lean venison with a subcutaneous and separable fat, fat percent will remain an important source of variation because of the intramuscular fat (Uherová *et al.*, 1992). Intramuscular fat is the fat found within a muscle either between or within individual muscle fibres. It is commonly referred to fat it is invisible, and should not be confused with intermuscular fat in the scams between muscles (Uherová *et al*., 1992).

The level of fat in meat is a very important characteristic because higher levels of fat are associated with more energy. The nature of fat in terms of its fatty-acid composition is also very important. These two characteristics are related because as the concentration of fat increases the proportion of that fat that is found in fat cells between the muscle fibre. Fat in the fat cells contains mainly saturated fatty acids, the overall proportion of saturated fatty acids in meat increases as the level of intramuscular fat increases. By venison would be expected to have a lower concentration of the saturated fatty acids (Sinclair and O´Dea, 1997).

Cholesterol levels in venison and other meats are of importance because cholesterol intake by humans is to some extent associated with plasma cholesterol levels and therefore with the risk of heart disease in reviewing this area noted that cholesterol intake is a less potent regulator of plasma cholesterol than dietary fatty acids, and that responses to dietary cholesterol varies widely between people (Rule *et al*., 2002). Cholesterol levels in lean meat does not change significantly with the increase in intramuscular fat levels because it is present in cell membranes of fat cells, as well as those of muscle fibres. The level of cholesterol in the game is no different from those that are clearly outside of the meat of deer species. Game meat is to be an attractive choice for those concerned about their plasma cholesterol levels, because of its low level of intramuscular fat (Rule *et al*., 2002).

2.1.3. Vitamins

The content of vitamin in the meat of each animal species is often very different. Game animals such as deer contains more thiamine, riboflavin and pantothenic acid than beef. The meat of wild boar is found more vitamin B6 and riboflavin in meat than domestic pig. Muscle of domestic pig in turn has a higher content of thiamine and pantothenic acid than venison of wild boar (Vodňanský *et al*., 2010).

Meat is an important source of vitamins. This is particularly the B vitamins that are found in large quantities both in the muscle, and internal organs. A significant content of vitamin B12, which is found exclusively in foodstuffs of animal origin. Lipophilic vitamins are found in adipose tissue and liver. The negligible amount of vitamin C is present, higher levels of this vitamin is only in the liver and fresh blood. The meat is getting into the body at the same time consumers vitamins with protein, which is important in the construction of certain enzymes (Chan *et al*., 1995).

Vitamin content is much higher in liver than in muscle and differences should be found between species, especially among ruminants and non-ruminants. These differences are caused by different vitamin intake of these animal groups. In ruminants the activity of microflora in the gizzards original content in the feed increased vitamin, or vitamins are consumed. Therefore, meat of polygastric animals is relatively stable in content of vitamins compared to meat of monogastric animals, which varies greatly depending on their content in the feed (Okabe *et al*., 2002).

Many vitamins are relatively resistant to physic-chemical effects, but in some there is destruction: for example, spreads heat thiamine, vitamins A and B6 are sensitive to oxidation, especially the influence of light, etc. When cooking in water moving part (10 to 15 %) water-soluble vitamins into the broth, turning the meat loses (Rule *et al*., 2002).

2.1.4. The structure of meat

Carcass consists of lean meat, fat and bone, together with connective tissue. The fat can be subcutaneous (lying under the skin of the animal), intermuscular (lying between individual muscles) or intramuscular (occurring within the body of the muscle). Subcutaneous fat is relatively easy to trim to produce leaner-looking meat; intermuscular fat is more difficult to remove simply. Intermuscular fat is also referred to as marbling fat because when abundant it gives a marbled appearance to the lean (Warriss, 2000).

2.1.5. Structure of muscle

Muscle of game species has finer muscle fibres in comparison to the muscle of domestic livestock which is the main reason for the "softness" of venison (Paulsen *et al.*, 2011).Higher digestibility of venison meat has resulted in a small amount of connective tissue. In addition, the fibrous part of the muscle is often stored in fat increased. Highly significant differences has been found between muscle of domestic and wild boar (Purchas, 2005). While the domestic pig meat contents of predominantly white muscle fibres, muscle of wild boar contains more red fibres. In addition, the average ofwhite muscle fibres in domestic pigs are significantly greater than in wild boar.

2.2. Characteristics of meat

2.2.1. Water binding capacity

The ability of meat to bind water – binding capacity - is one of the most important technological properties, it significantly affects the quality of meat products. It depends on the severity and economy of production, in particular loss of water during production, storage and cooking. Binding capacity can influence both the treatment of meat and various additives (Gracey *et al*., 1999).

2.2.1.1. Influences on binding capacity

The ability of meat to bind water depends on many factors like pH, salt concentration (ionic strength), the contents of some ions, intravital influences the post-mortem changes, grinding structure of meat. Many of these factors can influence the technology, thereby achieving the desired high esteem (Gracey *et al*., 1999).

Binding capacity depends on the intravital influences, different binding capacity is usually found between animals of different sex, age, importance and method of animal husbandry. Binding capacity changes significantly depending on the post-mortem changes, when the first drops due to acidification and create a solid structure (rigor mortis) that is then increased again during ripening (Huff-Lonergan and Lonergan, 2005).

Binding capacity is influenced by fat content in the salami - keep the fat particles in dilute protein (loose) network structure. This network is maintained even after heating more water than is possible in the absence of fat (Gracey *et al*., 1999).

2.2.1.2. pH

Post mortem muscle acidification is one of the fundamental changes in their conversion to meat. Change speed and extent of acidification significantly affects the color of meat. Acidification is measured in terms of pH in the muscle. PH measurements can thus provide information on potential quality of the meat (Yndgaard, 1973).

When the pH value of isoelectric point (approximately 5.0) is significantly low esteem. By adjusting the pH of muscle (acidification) causes a change in dissociation of functional groups of proteins. Changes taking place in the distribution of positive and negative charges on the protein molecule. Split so some lateral electrostatic binding and leads to delays in peptide chains. In the space between immobilizes them more water (Paulsen *et al*., 2011). Changes in meat pH occurr post-mortem, but also in some technological operations, when the pH is deliberately modified. The meat and meat products range from 4 to 7 of pH values (Pipek, 1998).

2.2.1.3. Defects of meat

2.2.1.3.1 PSE

PSE = pale, soft, exudative, with this defect is encountered mainly in pigs bred for high meat yield (Aalhus *et al*., 1991). After the defeat of the converts glycogen due to stress on the lactic acid that remains in the muscle tissue. This results in a decrease in pH below 5, 8 and an increase in muscle temperature above 42 ° C. Thanks to decrease of pH muscle proteins come closer to its isoelectric point. Be partially denatured proteins, a violation of the structure of muscle fibres and leads to release of meat juices, change color and consistency of muscle to change. The meat becomes pale, soft and exudative. This defect is associated with susceptibility of pigs to stress (Belitz *et al*., 2009)

2.2.1.3.2 DFD

DFD (dark, firm, dry) this defect is encountered mainly in cattle (Koubková and Nový, 1997). This defect is not genetic and there is a contingent of animals being exhausted before slaughter. During transport or during exertion before slaughter muscle during work deplete all muscle glycogen stores. Glycogen is the main source of lactic acid. Lactic acid has a lot to defeat the rise in meat is not needed to acidification. Its pH is above 6, 2. The meat is then easy to spoil, is dark, tough and dry (Belitz *et al.*, 2009).

2.2.1.3.3 Hampshire factor

PSE is a variant of the problem and is also linked to the pig breeding conformation. Some pig breeds, specifically the Hampshire breed, have increased muscle glycogen content. This causes more rapid course post-mortem glycogenolysis and reaches a pH near the isoelectric point of proteins. Hampshire factor is derived from the value of pH after 24 h less than 5.4. This is accompanied by impaired binding capacity and lighter meat color, more pronounced than in the PSE defects (Ingr, 2003).

2.2.1.3.4 Effect of salt on the binding capacity

Effect of salt on the binding capacity is a result of the influence of anions and cations. There is a bond strength of individual ions. The effect of salt on the hydratation of powdered meat works by reacting salt ions and protein ions. The result of this reaction is the densification of the structure and decrease protein binding capacity. As stronger the anion is bonded, the stronger the dehydrating effect of salt is (Pipek, 1995).

When salt is added to the meat, the amount of water absorbed by proteins is increased, which is in a muscle or above pH 6 by reducing the isoelectric point. This causes the dissemination component of muscle cells due to electrostatic repulsion, allowing more water to be bonded inside the muscle fibres and cells, reduces fluid loss during cooking (Huff-Lonergan and Lonergan, 2005).

2.2.1.4. Intravital influences

Meat quality and high performance in the production of animals for slaughter are affected by many factors, which affect the lives of animals during the fattening period, during transport, at a time before slaughter and processing (Brennan, 2006). Effects on the quality and production of meat may have species, breed, sex, age, castration, feeding methods, levels of nutrition, disease, drug use, fatigue, starvation conditions during transport and stress (Ingr, 2011). These effects must technologist in the meat industry not only count, but to some extent they should know how to reduce the negative impacts or eliminate their consequences (Brennan, 2006).

2.2.1.5. Animal species

Individual species have different chemical composition and proportions in the carcass tissues and consequently vary the characteristics of meat of different animals. The difference is particularly in fat content, the ratio of muscle and connective tissues, meat tenderness, color (the content of haem pigments) and binding capacity, different is the specific flavour and aroma (Brennan, 2006).

Binding capacity of meat is different in individual animals for slaughter, it is related to protein and fat, muscle structure and course of post-mortem changes. Binding capacity is often heavily influenced by muscular anomalies like PSE and DFD (Chan et al., 1995).

Meat color is mainly related with the content of haem pigments. At higher content of haem pigments is lower clearance, and therefore darker meat. Is especially the case for animals and muscles, where the in vivo intense muscle activity, or is necessary to ensure a sufficient supply of oxygen. Due to the many other influences are intravital haem pigments content in a particular case very different. Large differences associated with bleeding animals, applies in particular game (Dedek and Steineck, 1994)

2.2.1.6. Influence of sex

The influence of sex is due to the different temperaments and different intensity of metabolic processes in males and females. Female body metabolizes efficiently and saves energy as part of the fat reserve for future development of the fetus and to the survival of adverse conditions. Meat of females therefore generally contains more fat than meat of males (Gracey *et al*., 1999) the influence of sex on meat quality of animals which include the effect of estrus and pregnancy in females. Effect of pregnancy is generally small in the first half, but the further course of the muscle of impoverished nutritionally significant ingredients and contains more water. Inadequately fed females during this period have the meat quality continues to deteriorating (Gracey *et al*., 1999).

In connection with the influence of gender should also consider the influence castration, which is practiced only in males. Uncastrated males grow faster, better use of feed and have a greater slaughter yield, less fat and more edible parts. In castrates any disadvantages arising from differences in temperament and sexual behavior occur like they are not aggressive, not tend to have unwanted sexual odor and thus not have reduced quality of meat. With regard to the creation and storage of fat, are neuters between the male and female gender (Chan *et al*., 1995).

2.2.1.7. Influence of age

With age, the animal is changing the chemical composition and growth dynamics of individual tissues. The fastest growing and the first bone, followed by growth of muscle and adipose tissue developes. Muscle growth is the most intense during adolescence. Growth gradually decreases with the age and particularly stops after reaching adulthood, however, fat storage increases, which then formes the greater part of the increment (Brennan, 2006).

Until adulthood reduces the amount of water, then water again slightly increasing. Mineral content increases disproportionately with progressive ossification of the bones. Protein content shows regular growth. The content of functional (not depot) fat grows very quickly and after a certain age, its growth stopped. In adult animals, however, is growing, according to nutritional status, the content of depot fat. For most animals, body fat storage depot increases before winter. Most animals are slaughtered at the time the carcass maturity. It is the age (or live weight), when the animal is approaching its physical development of the adult animal, the development of the muscle ends and begins in increased production of fat depot (Gracey *et al*., 1999).

2.2.2. Meat tenderness

Meat tenderness is determined by its structure, status and chemical composition. To achieve the fragility of the meat should be long enough to let mature to release rigor mortis (Thompson, 2002). Meat tenderness depends significantly on the content of connective tissue, collagen content, and other somatic proteins that firm texture of meat. Their release is a change in enzyme maturation meat. Taste long-term treatment by heating in the presence of water means the transfer of collagen and gelatine to soften meat. Meat tenderness is also influenced by the content of intramuscular fat. Meat with a higher content of this fat is more fragile (Mulley *et al*., 2006).

2.3. Processability of meat

Meat product is technologically created from meat by many processes or their combinations, such as grinding, heating, smoking etc. These processes are to change meat into product with its typical structure, composition and flavour.

2.3.1. Emulsification

Emulsified meat products are widely consumed, Toldrá (2010) defines them in this way: ”*Emulsified meat products are generally defined according to their appearance: meat particles are so fine, that they are not visually distinguishable on the smooth product surface.“*

Emulsification step is always followed by heat treatment, which aims to stabilize multiphase batter and achieve sensory properties (Karakaya *et al*., 2005).

2.3.1.1. Comminuted meat is classified in two classes.

Cold emulsions

Cold emulsions are raw-cooked, it means that the components of product are raw before they are finally cominutted. The cominnuted result is submitted to heat treatment (Toldrá, 2010).

Hot emulsions

Hot emulsions are pre-cooked products in two stages of heat treatment. The first step is carried out on raw material at a temperature adjustment to 80 °C. The second step of the heat treatment is final cooking of the product (Toldrá, 2010).

2.3.1.2. Aims of Emulsification

Emulsification has three specific objectives. Firstly, to ensure the physical stability of the product emulsification determines the characteristic texture of the dough, which significantly affects the separation of fat and moisture from the product during cooking (Sebranek, 2003).

Toldrá (2010): “*Secondly, it creates a typical sensory properties such as appearance, texture, flavour, or noise. Finely comminuted preparations are defined by* *their smooth surface. Generally, the "cold emulsion" gives sliceable products, while "hot emulsion" gives spreadable products.”*

Thirdly, it is a means to create value added meat, including which is less acceptable due to the high content of connective tissue or fat (Sebránek 2003).

Emulsification is also the side effect improves retention and safety in use of ingredients such as salt, and heat treatment. It is also a means to improve the nutritional properties of products. Relevant properties are obtained horough suitable combinations of ingredients and manufacturing processes (Toldrá, 2010).

2.3.2. Cooling

Refrigeration is an important process for prolonged preservation of fresh meat. Cooling is important also in terms of water evaporation and thus the weight and quality losses (Belitz *et al*., 2009)

If cooling takes place slowly, the moisture from the surface of meat products intensively evaporates. Evaporation leads to undesirable weight loss. With sausage or salami of smaller calibres it can also result in deterioration of - shrinkage and wrinkling the surface (Kerry and Ledward., 2002).

The rate and extent of these adverse changes are influenced by the temperature difference between surface and dew point temperature of air, the proportion by volume and surface of the product, cooling time and air velocity. Products must be intensively cooled, it is easiest to shower with cold drinking water, while also possibly to remove adhering dirt from the smokehouse (soot, tar, etc). It can be cool and moist air flowing (Cassens, 1994).

2.3.3. Drying

Drying is the technology used in the production of meat sausages and durable piece products. It is a traditional preservative treatment, the reduction of water activity below a certain limit is reduced or stopped the activity of microorganisms (Ingr, 1993). Only a small number of microorganisms are killed by drying, however, so they can survive and stay as pathogenic germs. In addition, the drying helps to achieve the required shelf-life and a number of complementary interventions, which are variously combined with drying.

This is particularly the salting, the use of reduced temperature, heat treatment, smoking, addition of nitrite, etc. Suitable packaging protects product against recontamination, or from moisture and dust, allowing long-term shelf life (Toldrá, 2010).

Drying is used as a preservation method in the production of durable sausages (both fermented, and heat treated), dried hams, some types of dried meat and fish processing. In addition to preserving its own drying effect has some influence on sensory properties of dried meat and sausages (Cassens, 1994).

2.3.4. Salt and Pickle Curing

The addition of salt, curing compounds and other ingredients added products flavour, aroma and other sensory and technological properties (Toldrá, 2010). The purpose of salting was originally to achieve shelf-life of meat, than highlight the flavour, salting is now particularly important from a technological point of view - to increase the solubility of myofibrillar proteins, thereby creating the structure of meat products. Some mixture of curing ingredients (such as nitrite, ascorbic acid, polyphosphates etc.) has more specific effects (Belitz *et al.*, 2009).

To enhance taste, sodium chloride is used in most of the meat products by adding of 2 to 3% of total product weight. In fermented sausages and raw hams are typically higher. Recently, appears (among other things, from a health point of view) tendency use less salt, which achieves smoother taste (Pipek, 1998).

2.3.5. Smoking

Smoking is a method of food treatment, when the product passes from smoking media products of pyrolysis of wood. Their effect is partially preserved meat, while gaining the typical taste after smoking and golden brown (Toldrá, 2010).

Kerry and Ledward (2002) mentioned, that in addition to its own chemical action of smoke components on the preservative effect and physical phenomena involved. These processes occur in parallel with smoking. They are heat (pasteurization), reduced water activity (drying surface), or lowering the pH and fermentation (cold smoke during the smoking process).

During smoking, also weight decreases which is partly due to evaporation of water, some fat is lost by dripping out of product. For products with a higher fat content has smoked antioxidant effect, thereby limiting the rancidity. Smoking has no effect on digestibility (Cassens, 1994).

2.3.5.1. Methods of smoking

While smoking is necessary to achieve the desired flavor, color surface of the product required, and usually such a heat treatment to ensure adequate shelf life (Chicester, Mrak, 1984).

According to the smoke temperature can distinguish three types of smoke

• Cold Smoke: heat treatment does not act, only provides chemical components and contributes to drying. In this way produce fermented meat products, smoke exposure time is several days (for varying lengths of intervals).

• Warm Smoke: used for smoking large pieces of muscle meat and

• Hot smoke: used for most meat products. Along with the smoking and heat treatment takes place, ensuring shelf life (Pipek, 1998).

2.3.6. Heat treatment

Heat treatment of meat and meat products is especially important to achieve their shelf-life. During this process, change the digestibility of meat, its consistency and sensory properties. Shelf-life is ensured by direct heat, but also other factors which, when cooking at the same time it operates. It is used so as to reduce the activity of water on the surface during baking (Tornberg, 2005).

2.3.6.1. Changes by heat treatment

The structure of meat products is stabilized by heating, and there are changes in sensory properties (color, taste and consistency), digestibility and technological properties of meat. These changes are caused by changes in components of the meat during heating (Pipek, 1998) When denatured by heating, no significant improvement in digestibility, because the proteins in meat are generally digested in the raw state. Long time heating at a temperature higher than 100 ° C may lead to deterioration in protein digestibility (Toldrá, 2010).

2.3.6.2. Denaturation of proteins

During cooking, the structure of proteins excreted in their natural configuration. Warming increases the thermal motion of molecules, peptide chains and hydrogen bonds are released. This leads to changes in the structure of protein molecules. Interaction between carboxyl groups (aspartic acid, glutamic acid), and amino groups (lysine, arginine) is almost dissolved. This change disulfide bonds of cystine. After cooling are oriented as before heating, and the structure of protein molecules is broken. To release the hydrogen bond is required the presence of water. If there is insufficient of water, causing denaturation temperature above 100 ° C (Pipek, 1998).

The degree of denaturation varies according to how many hydrogen bonds will be destroyed. Construction of new binding sites between the peptide chain leads to a reduction in the number of hydrophilic centres of blocking polar groups. Reducing the increase in hydrophilic and hydrophobic properties of protein molecules is accompanied by decreasing hydratation (Cassens, 1994).

The result is to increase the sensitivity of denaturation of globular proteins to proteolytic enzymes. Other consequences are color change (denaturation of haem pigments), chipping of sulphur compounds (mainly sulphide) and inorganic phosphate.

2.3.6.3. Mass loss during heat treatment

Heat treatment of meat leads to weight loss, such as water evaporation, extraction of water-soluble compounds of meat in case of boiling in water and also water loss bonded in muscle proteins (Tornberg, 2005). The mass loss increases with increasing temperature in the core. At lower temperatures are mainly due to evaporation of water. At higher temperatures, the losses of co-flowing juice. In the temperature range 45 to 75 ° C denaturation of proteins leads to the release of meat juice. The degree of heating at 55 ° C has a growing importance of collagen shrinkage. Thermal processing (e. g. smoker) occurs and the loss of fat by dripping but not more than 1% of the total weight of the product (Pipek, 1998).

Releasing state is caused by deformation of protein structures and reducing the total volume. Volume reduction can be up to 43% of original value and you may lose 68% of water content. Loss of water by heating over, allow better interaction of proteins (Tornberg, 2005).

Losses extract, which results in a depletion of sensory and nutritionally valuable components can be limited by the fact that the meat is not cooked in pure water, but the broth from the previous production lots. The problem here may be contamination of microorganisms that proliferate in the broth. Another problem is the degradation of some of the excluded components and increased oxidation of fats in the extract (Pipek, 1998).

2.3.7. Fermentation

Fermentation helps shelf-life of meat products. Fermented meat products are not subjected to heat treatment, is here to reduce the pH and water activity (Roca and Incze, 1990).

Reducing the pH usually occurs in the action of lactic acid bacteria during ripening contributes to the acidification of fat hydrolysis (formation of fatty acids). Acidification is important especially in rapidly ripening of sausages. By reducing the pH is reduced and the reproduction of Salmonella.

The pH of the fermented sausages rang between 5.0 and 5.3. The long dry salami is usually higher than 6; contrary to quickly matured salamies is less than 5 (Pipek, 1998). Water activity is reduced by salting and drying of the product. To reduce its value may also contribute to higher fat content and sacharids (Katsara and Burdas, 1992). To ensure adequate shelf-life, at the beginning of the ripening of fermented sausages, the salt of 3% of total product weight should be added.

During ripening and drying water activity gradually decreases and reaches values eliminating the growth of microorganisms. Water activity is also important for sprouting mold surface of the sausages. Reducing the water activity can take place at minced meat products (due to the rapid salinity) relatively quickly, while the individual products (raw ham) are a matter of many months (Pipek, 1988).

The shelf-life of fermented products, however, must also contribute to the careful selection of raw materials and the overall hygiene of production, to a greater extent than other products (Roca and Incze, 1990).

3. Aims of the Thesis

The main task of this work is to summary and evaluate effect of game meat and venison to technological processability, into meat products. Secondary task is to assess the influence of physical and chemical characteristics of meat on the final quality of meat products

4. Materials and Methods

While writing this thesis, I have used literature sources of books sourcing of: Agricultural and Food Library, Prague, Information and Library Studies Centre of the Czech University of Life Sciences in Prague, Google Books. During the work I used information from online internet full text databases and of Google Scholar databases thorough Study and Information Centre of the Czech University of Life Sciences in Prague - 360 Search, Web of Knowledge, Web of Science, ScienceDirect, BioOne, EBSCO, Ovid, ProQuest, Scopus PMC - where I was searched using a keywords: game meat, chemical composition, physical properties, processability, venison and I cited necessary information. When searched for scientific publications (papers), I used keywords: game meat, chemical composition, physical properties, processability, venison. I quoted according citation standards of Methodical Manual for the BSc and MSc Theses Realised at the DASFPTS (2013) issued by Faculty of Tropical AgriSciences.

5. Results and Discussion

Total processed 52 research articles. Of these articles were created two summary tables. The tables were divided to the physical and chemical properties of meat and meat products. The tables have been divided into seven columns. The columns property type, animal species, the definition of input variables, the consequential effects, researched the product and observed value. The last column shows the citation source of articles that were used.

Table no. 1 shows with the physical properties of meat and meat products. Table no. 2 shows chemical characteristics of meat and meat products. Because of limited literature on game species and to allow comparison the table was extend of domestic species namely (cattle, goat, horse, pig).

Table no. 1 : List of physical properties of meat and meat products

type	species	definition	effect on	product	observed value	references
physical	cattle (*Bos primigenius*)	fermentation technology	water acivity, pH	bresaola	higher pH and lower water capacity	(Paleari *et al.* , 2002)
physical	goat (*Capra aegagrus hircus*)	fermentation technology	water acivity, pH	bresaola	higher pH and lower water capacity	(Paleari *et al.* , 2002)
physical	horse (*Equus ferus caballus*)	fermentation technology	water acivity, pH	bresaola	lower pH and lower water activity	(Paleari *et al.* , 2002)
physical	red deer (*Cervus elephus*)	fermentation technology	water acivity, pH	bresaola	higher pH and lower water capacity	(Paleari *et al.* , 2002)
physical	wild boar *(Sus scrofa*)	fermentation technology	water acivity, pH	bresaola	higher pH and lower water capacity	(Paleari *et al.* , 2002)
physical	red deer (*Cervus elaphus*), wild boar (*Sus scrofa*)	other species	water activity	chorizo , saucisson	all samples presented similar values for aw 0.802–0.918	(Vioque *et al* ., 2003)
physical	red deer (*Cervus elaphus*)	ripening	density of proteins	chorizo sausage	Ripening conditions influenced the relative density of many proteins at the end of ripening.	(García Ruiz *et al.* , 2007)
physical	red deer (*Cervus elaphus*), wild boar (*Sus scrofa*)	other species	pH	chorizo, saucisson	all samples presented similar values for pH 4.96–6.03	(Vioque *et al* ., 2003)
physical	wild boar (*Sus scrofa*), pork (*Sus scrofa* var. *domesticus*)	starter cultures	sensory eval., TBARS, BA	mould-ripened salami	starter cultures improve sensory evalution of product, Peroxide value, TBARS and BA lower	(Paulsen et al., 2011)
physical	wild boar (*Sus scrofa*)	hunting season	meat quality	sausage	Sausages made from meat of wild boars shot in the autumn winter season presented higher textural values and were juicier compared to wild boar shot in the spring-summer season	(Lachowicz *et al* ., 2008)
physical	wild boar (*Sus scrofa*), pork (*Sus scrofa* var. *domesticus*),	other species	meat quality	sausage	wild boar sausages as less juicy and gummy, and more springy, than pork sausages.	(Lachowicz *et al* ., 2008)
physical	impala *(Aepyceros melampus)*	night-cropped	meat quality	raw meat	does not have a negative effect on meat quality	(Hoffman , 2000a)
physical	ostrich (*Struthio camelus* var. *domesticus*)	pH	binding capacity, colour of meat	raw meat	changes in colour and appearance	(Botha *et al.*, 2006)

type	species	definition	effect on	product	observed value	references
physical	ostrich (*Struthio camelus* var. *domesticus*)	pH	binding capacity, colour of meat	raw meat	changes in colour and appearance	(Botha *et al.,* 2006)
physical	red deer (*Cervus elaphus*)	effects of feeding regimen	carcass characteristics, meat colour and lipid stability	raw meat	The pellet-fed deer had significantly higher live weight, carcass weight, dressing yield and fat content than the pasture group.	(Wiklund *et al*., 2005)
physical	buffalo (*Bubalus arnee f. bubalis*)	age	physical properties of meat	raw meat	young male buffalo is more suitable for proccessing in chunks.Females and old buffalos is more reliable to proccesing in smaller particles	(Kandeepan *et al.*, 2009)
physical	reindeer (*Rangifer tarandus tarandus*)	pH (24)	proteolysis, tenderness	raw meat	difference in sarcomere length	(Wiklund *et al.*, 1997).
physical	buffalo (*Bubalus arnee f. bubalis*)	age	water activity, pH	raw meat	pH is the same, the water activity is higher in spent females	(Kandeepan *et al*., 2009)
physical	grey duiker (*Sylvicapra grimmia*)	night-cropped	pH	raw meat	does not adversely affect meat quality, in terms of the rate of pH decline	(Hoffman and Ferreira, 2000)
physical	red deer (*Cervus elaphus*)	rigor temperature	tenderness	raw meat	tenderness can be improved via the manipulation of rigor temperature	(Bekhit *et al*., 2006)
physical	red deer (*Cervus elaphus*)	pH	tenderness	raw meat	significant effects on venison tenderness and colour stability	(Wiklund *et al.,* 2010)
physical	springbok (*Antidorcas marsupialis*)	pH	tenderness	raw meat	low muscle pH would be beneficial towards meat tenderness	(Hoffman *et al,* 2007).
physical	springbok (Antidorcas marsupialis)	region	organoleptic properties	raw meat	Caledon springbok have meat with higher colour saturation	(Hoffman et al., 2007)
physical	fallow deer (Dama dama)	age	colour of meat	raw meat	older bucks(36 month) have darker meat than younger (18-24 months)	(Hutchison et al., 2010)
physical	fallow deer (Dama dama)	sex	colour of meat	raw meat	difference of colour between sexes	(Hutchison et al., 2010)

Table no.1 describes the effect of age, meat processing, feeding animals, pH, hunting and wildlife species on the physical characteristics of meat and meat products.

In researching the effect of age of buffalo (*Bubalus arnee f. bubalis*), there were no differences in pH for raw meat only older females were found to have higher water activity (Kandeepan *et al*., 2009). From the economical point of view to process buffalo, young males are more suitable cuts of larger pieces (quarter, half) compared to older males and females, which are more suitable for cuts of smaller pieces (Kandeepan *et al*., 2009). Time of cropping in grey duikers (*Sylvicapra grimmia*) (night cropped) does not adversely affect the quality of meat (Hoffman and Ferreira, 2000). Research has shown ostriches (*Struthio camelus* var. *domesticus*), water holding capacity and meat color is directly dependent on pH (Botha *et al*., 2006).

The research of red deer (*Cervus elaphus*) found the most impact on meat quality. Deer fed by pellets showed a higher fat content and had higher, live and also slaughter weight than free ranging ones (Wiklund *et al*., 2005). Method of meat ripening directly affects the content of various proteins in the final products (chorizo sausages) (García Ruiz *et al*., 2007). pH has a direct impact on the tenderness and the color of deer meat (Wiklund *et al*., 2010), manipulation with rigor temperature can be achieved by better binding properties of meat (Bekhit *et al*., 2006). Fermentation has a direct impact on increasing the pH and water activity in Bresaola (Paleari *et al*., 2002), same is true for cattle (*Bos primigenius*), goat (*Capra aegagrus hircus*), wild boar (*Sus scrofa*). Only horse (*Equus ferus caballus*) have pH and water activity in raw meat and final product lower values than other species (Paleari *et al*., 2002). When I compared pH and water activity in products (chorizo, saucisson) from red deer and wild boar, red deers have higher water acivity in chorizo and lower water activity in saucisson than wild boar. (Vioque *et al*., 2003). pH of the wild boars and red deers on this products are similar (Viouque *et al*., 2003).

Fallow deer (*Dama dama*) males over 36 months have darker colour of raw meat and as one of the sample was found to influence of gender on the colour of raw meat (Hutchinson *et al*., 2010). Reindeer (*Rangifer tarandus tarandus*) have changes in sarcomere length after pH (24) (Wiklund *et al*., 1997). Springbok (*Antidorcas marsupialis*) from Caledon region demonstrated a greater saturation of the color of raw meat over springbok bred in other regions (Hoffman *et al*., 2007).

When compared to products produced from a wild boar and domestic pig was found that the sausage made from wild boar meat is less juicy, gummy and more springy (Lachowicz *et al*., 2008). Sausages made from meat of wild boars shot in the autumn andwinter season presented higher textural values and were juicier compared to wild boar shot in the spring-and summer season (Lachowicz *et al*., 2008). Fermented products of wild boar meat affect higher pH and lower the water activity of the final products (Bresaola) (Paleari *et al*., 2002).

Table no.2 : List of chemical properties of venison

type	species	definition	effect on	product	observed value	references
chemical	ostrich (*Struthio camelus* var. *domesticus*)	addition of phosphates	water absorption	ham and sausage	addition of phosphates does not increase the water absorption of meat	(Fisher *et al* ., 1999)
chemical	red deer (*Cervus elaphus*), cattle (*Bos primigenius*), horse (*Equus ferus caballus*), goat (*Capra aegagrus hircus*)	technology/meat composition	volatile compounds	cecinas	venison - highest level of volatile compounds from lipid oxidation; microbial degradation only horse, bovine - smoking, venison - spices	(Hierro et al.,2004)
chemical	not specified	content of water	texture and quality	sausage	decrease of water activity ensure the shelf life	(Chevallier *et al.* , 2010)
chemical	blesbok (*Damaliscus dorcas phillipsi)* , springbok (*Antidorcas marsupialis*)	content of fat	shelf life	salami	is extended by organic acids	(Todorov *et al.* , 2007)
chemical	springbok (*Antidorcas marsupialis*), gemsbok (*Oryx gazella*), kudu (*Tragelaphus strepsiceros*), zebra (*Equus burchelli*)	other species	Physico-chemical, microbiological, textural and sensory attributes	salami	Springbok salami having the highest mean pH value, game flavour was not perceived as a strong attribute during the sensory analyses, Gemsbok salami was strongly associated with the attribute colour, springbok salami scored the lowest for both colour and taste, salami produced from gemsbok, kudu and zebra were superior to springbok salami	(Van Schalkwyk *et al* ., 2010)
chemical	pork meat (*Sus scrofa* var. *domesticus*), pork lard	ripening	physicochemical, microbiological, and textural properties	low-acid sausages	pH values were similar, small increase of Micrococcaceae, sausages showed low hardness and cohesiveness	(Spaziani *et al.* , 2008)
chemical	red deer (*Cervus elaphus*)	controlled ripening	organoleptic properties	chorizo sausage	more perceptible aroma, greater taste intensity, more pungency and flavour, aftertaste and greater hardness than naturally-ripened batches.	(García Ruiz *et al* ., 2010)
chemical	red deer *(Cervus elaphus)* , wild boar (*Sus scrofa*)	other species	chemical composition	dry sausage	protein nitrogen and phosphorus content were higher in products made with wild boar.	(Soriano *et al* ., 2005)
chemical	wild boar (*Sus scrofa*), pork (*Sus scrofa* var. *domesticus*)	fermentation	chemical composition	mould-ripened salami	protein content was slightly lower, and concentrations of hydroxyproline and biogenic amines (histamine, putrescine and cadaverine) significantly higher	(Paulsen *et al* ., 2011),

type	species	definition	effect on	product	observed value	references
chemical	cattle (*Bos primigenius*), wild boar *(Sus scrofa),* red deer (*Cervus elaphus*), goat (*Capra aegagrus hircus)*, horse (*Equus ferus caballus)*	other species	chemical composition	cured products	The cured meat of the horse and wild boar had low saturated fatty acid levels. The free amino acids content in the cured deer, wild boar and goat meat was more elevated, than in beef and horse cured meat.	(Paleari *et al*., 2002)
chemical	wild boar (*Sus scrofa*), cattle (*Bos primigenius*)	other species	chemical composition	bresaola	wild boar product has lower moisture content and the total proportion of saturated fatty acids, higher content of protein, amino acids and total cholesterol and proportion of unsaturated fatty acids, and the like fat and share monounsaturated fatty acids	(Paleari *et al*., 2003)
chemical	red deer (*Cervus elaphus*)	protein content	degradability	chorizo sausage	no significant variations in nitrogen fractions	(Chevallier *et a* l., 2006)
chemical	red deer (*Cervus elaphus*), wild boar (*Sus scrofa*)	other species	content of fat	chorizo , saucisson	products made with deer meat had a higher fat content than those prepared with wild boar meat	(Soriano *et al*., 2005)
chemical	kudu *(Tragelaphus strepsiceros*)	age	organoleptic properties	raw meat	insignificant differences in chemical composition	(Mostert and Hoffman, 2007)
physical	llama (*Lama glama*) and alpaca (*Lama pacos*)	location of breeding	physical properties of carcass	raw meat	Location of breeding directly affects the size of carcass. Llama and alpaca slauhtered at 25 monts. Llama carcass was significantly bigger than alpaca	(Cristofanelli *et al*., 2004)
chemical	ostrich (*Struthio camelus)*	age	organoleptic properties	raw meat	at higher age increased the intermuscular fat content	(Hoffman and Fisher, 2001)
chemical	reindeer (*Rangifer tarandus tarandus L.)*	age	organoleptic properties	raw meat	no significant differences	(Sampels *et al*., 2005)
chemical	springbok *(Antidorcas marsupialis)*	gender,age	organoleptic properties	raw meat	no significant differences (gender, age)	(Hoffman *et al*., 2007)
chemical	red deer *(Cervus elaphus)*	sex	organoleptic properties	raw meat	no significant differences, a little more fat in females	(Purchas *et al*., 2010)
chemical	impala *(Aepyceros melampus)*	sex	organoleptic properties	raw meat	no significant differences	(Hoffman *et al.,* 2005)
chemical	impala *(Aepyceros melampus)*	sex	organoleptic properties	raw meat	no significant differences	(Hoffman *et al*., 2007)

type	species	definition	effect on	product	observed value	references
chemical	impala (*Aepyceros melampus)*	sex	organoleptic properties	raw meat	no significant differences	(Hoffman, 2000a)
chemical	llama *(Llama glama)*	sex, age	organoleptic properties	raw meat	no significant differences	(Peréz *et al.* , 1999)
chemical	not specified	age	organleptic prepertiess	raw meat	no significant differences	(Hoffman *et al.* , 2007).
chemical	cattle (*Bos primigenius*), wild boar (*Sus scrofa*), red deer (*Cervus elaphus*), goat (*Capra aegagrus hircus*), horse (*Equus ferus caballus*)	fermentation technology	microbiology counts	raw meat	increase in LAB, dissapereance of coliforms and pathogenic staphylococci	(Paleari *et al* ., 2002)
chemical	reindeer *(Rangifer tarandus tarandus*) and red deer (*Cervus elaphus*)	location of breeding	meat quality and compositional/nutritional characteristics	raw meat	Location breeding directly affects the quality of meat and compositional/nutritional characteristics	(Triumf *et al* ., 2012)
chemical	springbok (*Antidorcas marsupialis*)	production region	meat quality	raw meat	production region influenced the game meat aroma, initial juiciness, sustained juiciness and residual tissue ratings of the meat	(Hoffman *et al* ., 2007)
chemical	springbok *(Antidorcas marsupialis*)	age, gender	meat quality	raw meat	the influence of age and gender were negligible	(Hoffman *et al* ., 2007)
chemical	kudu (*Tragelaphus strepsiceros*)	sex	chemical composition	raw meat	female had a higher fat and myoglobin content than males	(Hoffman *et al* ., 2009)
chemical	impala (*Aepyceros melampus*)	sex	chemical composition	raw meat	The females had a higher total lipid content than males	(Hoffman, 2000b)
chemical	red deer (*Cervus elephus*)	effects of feeding regimen	chemical composition	raw meat	no differences were found in ultimate pH values and muscle glycogen content, meat from pasture-fed deer showed a high content of the fatty acid	(Wiklund *et al.*, 2003)
chemical	red hartebeest (*Alcelaphus buselaphus caama*)	region and sex	chemical composition	raw meat	Differences in concentrations of individual fatty acids, amino acids and minerals were minor and of no practical value. The animals obtained from the Qua-Qua region had the highest lipid content compared to hartebeest sampled in other regions.	(Hoffman *et al* ., 2010)

type	species	definition	effect on	product	observed value	references
chemical	reindeer (*Rangifer tarandus tarandus)*	smoking or drying	fatty acids, vitamins	raw meat	increased free fatty acids, decreasing retinol and tocopherol	(Sampels *et al.,* 2004)
chemical	wild boar (*Sus scofa*)	feral wild boars	fatty acids, vitamins	raw meat	variable FA profile, lower then pork, high vit E	(Quaresma *et al* ., 2011)
chemical	red deer (*Cervus elaphus*)	composition of fat	degradability	sausage	myofibrillar protein content was decreased	(García Ruiz *et al.,* 2007)
chemical	nile crocodiles (*Crocodylus niloticus*)	chemical composition	content of minerals	raw meat	Crocodile meat have a lower iron, magnesium and sodium content than either beef or chicken	(Hoffman *et al* ., 2000)
chemical	tegu (*Tupinambis sp.*)	composition of meat	content of lipid	raw meat	very low lipid content (18,2mg/100g)	(Hoffman, 2008)
chemical	buffalo (*Bubalus arnee f. bubalis*)	age	content of fat	raw meat	the fat content is higher of older females	(Kandeepan *et al* ., 2009)
chemical	oryx (*Oryx beisa*), zebra (*Equus burchellii*), kongoni (*Alcelaphus buselaphus*)	other species	composition of meat	raw meat	Myoglobin content was highest in zebra meat and lowest in oryx meat, Zebra meat was darker and had less cooking loss compared to meat from the other species, Oryx meat had the highest lightness, and chromaticity values	(Onyango *et al* ., 1998)
chemical	wild boar (*Sus scrofa*), pork *(Sus scrofa* var. *domesticus*)	other species	composition of meat	raw meat	wild boars present a higher degree of carcass fatness and larger loin areas, darker, less tender and leaner meat	(Sales and Kotrba, 2013)

Table no.2 describes the influence of age, gender, type and method of processing on the chemical properties of meat.

In most cases, there were detectable effects of age and sex on meat quality. The table shows slight differences in the effects of individual animals. Examination of impala (*Aepyceros melampus*) (Hoffman *et al*., 2005; Hoffman, 2000a), kudu (*Tragelaphus strepsiceros*) (Mostert and Hoffman, 2007), llamas (*Llama glama*) (Peréz *et al*., 1999) and reindeer (Sampels *et al*., 2005) did not affect the examined variables on the quality of the meat.

The research on ostrich (*Struthio camelus* var. *domesticus*) confirms higher content of intermuscular fat when elderly (Hoffman and Fisher, 2001). Adding phosphate to ostrich meat does not have effect water absoption increase in meat (Fisher *et al*., 1999). Buffalo females have higher content of fat than males (Kandeepan *et al*., 2009).

The results from study on springbok have not found effects of age and sex on meat quality (Hoffman *et al*., 2007) but pointed out the interesting finding that meat quality depends on the place animal´s production (Hoffman *et al*., 2007).

Location of breeding has directly effect on the quality of meat and compositional/nutritional characteristics of norwegian reindeer and farmed red deer from New Zealand. Reindeer muscles had higher antioxidant capacity, shorter sarcomeres, smaller muscle fibre diameters, higher ratios of fatty acids in the intramuscular fat (Triumf *et al*., 2012).

When I compared meat products from springbok, gemsbok (*Oryx gazella*), kudu and zebra (*Equus burchelli*), springbok salami having the highest mean pH value, game flavour was not perceived as a strong attribute during the sensory analyses. Gemsbok salami was strongly associated with the attribute colour, springbok salami scored the lowest for both colour and taste, salami produced from gemsbok, kudu and zebra were superior to springbok salami (Van Schalkwyk *et al*., 2010).

Comparison between oryx (*Oryx beisa*), zebra and kongoni (*Alcelaphus buselaphus*) showed the following results. Myoglobin content was highest in zebra meat and lowest in oryx meat, Zebra meat was darker and had less cooking loss compared to meat from the other species, Oryx meat had the highest lightness, and chromaticity values (Onyango *et al*., 1998).

The research of blesbok (*Damaliscus dorcas phillipsi*), and springbok shows direct effect of the fat content of meat on the shelf-life, which extends the content of organic acids (Todorov *et al.*, 2007). When analyzing buffalo meat was found to influence of age, with older female buffaloes have shown a higher fat content than males (Kandeepan *et al*., 2009). The effect of gender was demonstrated in the impala and kudu. The impala female had higher total lipid content (Hoffman, 2000b), kudu female had a higher fat and myoglobin in meat than males of both species (Hoffman *et al*., 2009).

Smoked and dried reindeer meat can achieve a higher content of free fatty acids and reduce levels of retinol and tocopherol in meat (Sampels *et al*., 2004). Meat from horses and wild boars had low content of saturated fatty acids in the blood. The free amino acids content in the cured deer, wild boar and goat meat was more elevated, than in beef and horse cured meat (Paleari *et al*., 2002). Wild boar products has lower moisture content and the total proportion of saturated fatty acids, higher content of protein, amino acids and total cholesterol than cattle (Paleari *et al*., 2003).

Research on red deer showed the most specific chemical properties that influence meat quality. The deer females have been shown to contain more fat than males, regardless of age (Purchas *et al*., 2010). Controlled ripening positively influences more perceptible aroma, greater taste intensity, more pungency and flavour, aftertaste and greater hardness than naturally-ripened batches (García Ruiz *et al*., 2010). Animals from free-range (pasture) have a higher fat content in the meat (Wiklund *et al*., 2005). Fat content has influence on the amount of myofibrillar protein is lower in the final product (sausage) (García Ruiz *et al*., 2007). A comparison of dry sausages of deer and wild boar meat has been demonstrated that the products of wild boar meat have a higher proportion of nitrogen and phosphorus than sausages deer (Soriano *et al*., 2005), but on the other hand deer sausage showed a higher fat content (Soriano *et al*., 2005).

The research of wild boar has been shown that the fermentation affects the protein content and the concentration of hydroxyproline and biogenic amines (histamine, putrescine, cadaverine) (Paulsen *et al*., 2011). In wild boars were found variable fatty acid profile and higher vitamin E content than domestic pigs (Queresma *et al*., 2011). Wild boars showed a higher degree of fatness of the carcass body, darker, less binding and leaner meat (Sales and Kotrba, 2013).

6. Conclusions

Thesis compares inflence of various effects on physical properties and chemical characteristic on the quality of game meatand its products age, sex, region of origin, processing method.The determinet final meat products were curred ham, sausage, mould-ripened salami, chorizo sausages, dried salami, cecinas and saucisson. Processed tabularized summary is based mainly on me meat from culled red deer, fallow deer, wild boar and African ungulates. To some extent comparison to farm animals of cattle, goat, horse and pig was done. Interest of use of game and exotic species in the food industry increased in recent years, so in favour of the consumers the summarized good composition of game meat would serve to also enhance quality of products made from them.

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