Wild boar *(Sus scrofa)* meat quality

A study of the homogeneity of wild boar meat quality

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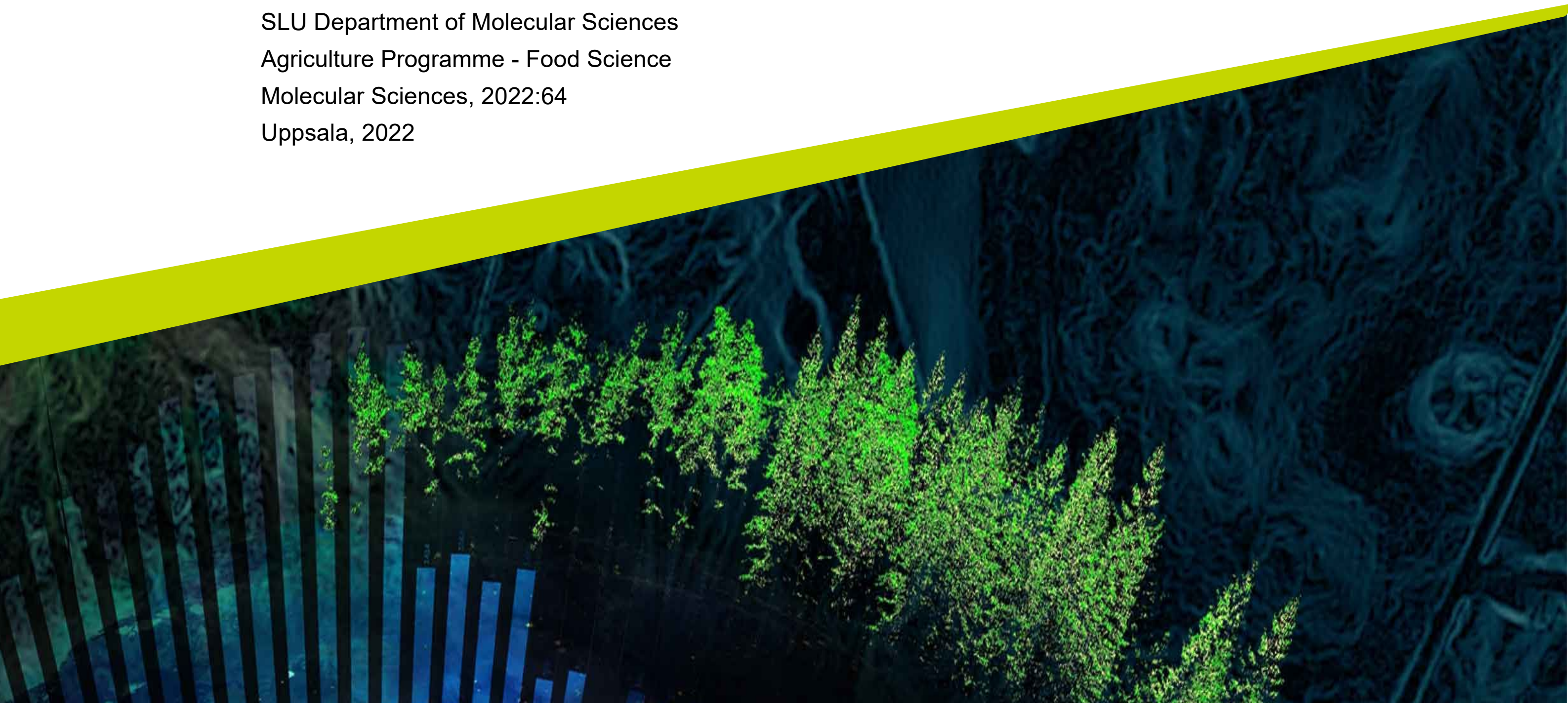

Wild boar (*Sus scrofa*) meat quality.
A study of the homogeneity of wild boar meat quality.

Undersökning av köttkvalitet på vildsvin (Sus scrofa).
En studie av homogeniteten för köttkvalitet hos vildsvin

Maja Jonsson

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Abstract

The food industry is constantly adapting and is to a large extent shaped by the desires of its consumers. Consumer food desires are dictated by a variety of reasons such as nutrition or taste. We have to consider the impact that our production methods and food choices have on the climate and must collectively attempt to reduce our climate footprint. In this study, the current issue of the increasing Swedish wild boar population was assessed, and the quality of the meat was examined. The Swedish wild boar population has increased rapidly in recent years, reaching numbers of around 200,000 in 2018 (Svenska Jägareförbundet 2018). The uncontrolled wild boar population is problematic for several reasons. One reason is that they roam around crop fields, consequently trampling and destroying crops that are for human consumption. Their damage contributes to large amounts of food waste. Additionally, the uncontrollable population have become road hazards and caused traffic accidents.

Since the Swedish wild boar population must be controlled, it is essential to know whether we can utilise their meat. By controlling the population by hunting for example, we can reduce traffic accidents and crop damage and benefit from their meat. It is, therefore, important to investigate the quality of the Swedish wild boar meat as it may be an additional food source to satisfy consumer needs. Wild boar meat has a low climate footprint, is nutritious and has higher contents of omega-3 fatty acids in comparison to pork (Barbani et al. 2011). Wild boar meat may, therefore, serve as a useful alternative to pork.

In this study, wild boar meat quality was investigated and compared to meat from commercially bred pigs. The wild boar meat was obtained from a game handling facility in Skåne called Skånska vilt and the commercial pork from Lövsta abattoir in Uppsala. To assess meat quality, colour, pH value, fat content and fatty acid composition was measured from meat samples of the shoulder muscle. A sensory evaluation with an untrained tasting panel was carried out to test for possible variation in taste and aroma between wild boar meat and pork.

The results showed that meat from the wild boar had a higher ultimate pH value in comparison to meat from domestic pigs ($p = 0.004$). There was a significant colour difference between pork and wild boar meat where meat from wild boar was darker and had more intense red colour compared to the meat from pigs. No colour difference between male and wild boar sow was detected. No significant difference in the fat content between male and wild boar sow meat or between the wild boar meat and pork meat was found. There was also no difference in fatty acid composition between the male and sow meat of the wild boar.

Keywords: Wild boar, Sus scrofa, meat quality, diet, lipid composition, Sweden, pork

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Abbreviations

DFD	Dark firm dry
FA	Fatty acid
GC	Gas chromatography
MUFA	Monounsaturated fatty acids
PUFA	Polyunsaturated fatty acids
PSE	Pale soft exudative
SFA	Saturated fatty acids
TLC	Thin-layer chromatography
WHC	Water holding capacity
LD	Longissimus dorsi

1. Introduction

The opportunity to be able to consume what grows and lives in the forest is fantastic. Today's consumer has less knowledge about and understanding of the primary sources for food production, and even know less about what grows wild in the nature. One of these wild animals of interest as human food, is the wild boar. The number of wild boars in Sweden has increased rapidly over the past 30 years (Viltdata 2022). There is historically documentation that wild boar was present in southern Sweden from as early as about 2300 years before our time, i.e., during the Neolithic time (Svenska Jägareförbundet 2018). However, the wild boar was completely extinct from Swedish forests during the early 18th century and has been so until the mid-1950s when the wild boar was kept in enclosures. Different opinions prevail about how, but wild boars managed to escape from fenced areas and thereby established themselves in Sweden again. In 2020 158,809 wild boars were estimated to be shot, a sharp increase as 58,527 individuals were shot ten years earlier (*Viltdata* 2022). Even though it is difficult to know exactly how large the tribe is, it is estimated that there are as many as about 300,000 individuals 2022.

Today's challenge is that there is a very large number of individuals that do great damage to fields as well as areas close to the city (Svenska Jägareförbundet 2018). Furthermore, in 2020, 7,217 traffic accidents occurred where wild boar was involved (Nationella Viltolycksrådet 2022). Unfortunately, traffic accidents related to wild boar and other wild animals often occur (Länstyrelsen Östergötland 2022). One effective solution would be to increase shooting of wild boar, thereby creating a balance in the ecosystem. Increased shooting results greater supply of wild boar meat.

There are strict laws regarding the sale of wild boar meat, which makes it difficult for private individuals to buy wild boar meat (Jägareförbundet 2022). Wild boar must always pass a game handling facility before being sold.

In April 2020, a major initiative was started by the Government called the *Wild Boar Package*, in which the Swedish Board of Agriculture, the National Food Agency, the county administrative boards and the Swedish Veterinary Institute, SVA, are involved (SVA 2022). The purpose of the *Wild Boar Package* is to give consumers greater access to and supply of wild boar as food and is part of the national food strategy's action plan (Regeringskansliet 2020). The project is planned to run between 2020–2025 and several projects have been started. Some examples of projects are "Wild boar meat - climate and communication" by Hushållningssällskapet Halland, "More wild boar meat in the Örebro region" by Agro Öst, and "Eklandskapsgrisen - Sweden's own Eberico" by the Ek(o) network for a living countryside around Rengen (Jordbruksverket 2022).

2. Background

2.1 Diet and habitat of the wild boar

Wild boar, (*Sus scrofa)* is a species in the ungulate family of pigs (NE.se 2022). The animal can be up to 185 cm long and up to 100 cm tall. However, it is more common for the animals to be slightly smaller. The coat is, especially during the winter, ragged and grey black/black-brown. During its first year, the young are bright with longitudinal stripes. A large head and a thick, muscular neck are a shared trait among all wild boars. Wild boars are very shy animals. The males live alone while the sow live in small groups with other sows and their piglets (usually 3-8) mainly in deciduous and mixed forests and around fields.
The wild boar population is widespread over most of the world. Oak, beech, hazel, and roots are staple foods for wild boars (Schley & Roper 2003). They also eat "human food". The wild boar is often found foraging in fields, in doing so, they uproot large amounts of crops which are destroyed. However, wild boars roaming the forest in their search for food is positive as it promotes forest regeneration. Support feeding is widely used with three main purposes: to increase the growth rate and density of wild boar, as bait for efficient hunting and to distract animals from agricultural fields (Magnusson 2010). Sex and age, as well as feed availability largely impact the weight variation of the wild boar (Groot Bruinderink et al. 1994). According to E. Hazebroek (1994), juveniles seemed to suffer most and decreased in bodyweight during autumn and winter, compared to the adults. A high-density population also decreased the body weight, especially between the autumn and winter seasons.

2.2 Hunting techniques and stress levels

The choice of hunting method should primarily be chosen based on the density of the wild boar population and the area for hunting should be carried out under controlled conditions (Naturvårdsverket 2020). Collaboration between landowners and hunters is of great importance as those who own a little land can have difficulty influencing the development of the wild boar population and are dependent on those who own a lot of land. During the growing season for agricultural crops, it is important to target hunting in the fields to reduce the damage caused by wild boars that roost in the fields. The hunt is planned strategically and is carried out in the form of stealth or vigilant hunting, which is a calm hunting method that does not create stress for the wild boar. Another so-called calm hunting method that does not create stress for the wild boars is when you sit hidden for example in a stand and wait for the animal to bypass. This method of hunting is effective at most of the year. In the autumn, driven hunt is the most common and effective hunting method. Driven hunt involves dog handlers using their dogs to track and drive the animals towards pass shooters deployed in strategic places. When hunting with a dog, it is important that the dogs are not too aggressive and sharp as the dogs can attack the wild animals and in the worst case kill the wild animals.

Hunting sometimes leads to the animals becoming stressed and cortisol levels increase, which in turn has negative effects, especially for longer periods of time for the animal's well-being (Güldenpfennig et al. 2022). According to a study by J. Güldenpfennig et. al. (2022) where blood from wild boar hunted on driven hunts was analysed, it was clear that all animals had increased cortisol levels, however, with variations between age groups and sex. The hypothalamic-pituitary-adrenal axis (HPA) is activated in response to stress, which in turn activates secretion of glucocorticoids, primarily the hormone cortisol. The secretion of cortisol affects functions such as energy release, immune activity, development, growth, and the reproductive ability. Glucocorticoids are beneficial for short-term survival, but prolonged release can lead to metabolic, immune, and physiological dysfunction. Elevated cortisol levels are something that also affects pigs in domestication due to stress (Becker et al. 1985).

2.3 Field damages by wild boars

During the last six years, the number of game damages has doubled according to the game damage survey (Jordbruksverket 2020). In 2012, 88,300 tonnes of grain harvest were destroyed and in 2020, 164,600 tonnes of the harvest were destroyed by wild animals. The wild boar is the dominant wild animal that causes damage to the crops. This applies to all crops except spring rapeseed where fallow deer are dominant. Wild boar caused damage to fields corresponding to a loss of 85,400 tonnes of grain in 2020. According to the Swedish Board of Agriculture's survey from 2020, about half of the farmers suffer from game damage. In southern Sweden even 70% of the farmers suffer from this problem. At the national level, the proportion was 54%. Ley is the crop that is grown the most calculated in area. Game damage was discovered on 138,930 hectares, which corresponds to 17% of the total cultivated area in 2020, whereas in 2014 only 8% were affected by damage.

The farmers state in the survey that which wild animals are on the ground influences the choice of crop (Jordbruksverket 2020). Those who have a lot of wild boars on their land refrain to grow peas and oats to a greater extent. But autumn rapeseed and winter wheat are also often affected by game damage. Game damage is more common in organic farms as these areas are often found in forest areas or in the parts of the countryside. An example of this is in Götaland's southern plains, where in 2020 the crop loss was 1.9% for organic farming and 0.6% in total. In Svealand, the loss was 7.5% in organic farming and 2.8% total loss.

2.4 Game slaughterhouse and possible risk factors with wild boar meat

For game meat to be sold on the European market, it must have been handled via a game handling facility, i.e., facilities approved by the National Food Agency for game slaughter (Livsmedelsverket 2022a). The game must be delivered by the hunter unscathed and with the red organs left, so that a veterinarian employed by the National Food Agency can inspect the animal for maximum food safety. Wild boar (and bear) should be examined for trichinae and deer from enclosures should be checked for tuberculosis. Animals that have died or been killed in connection with a traffic accident may not be left at a game handling facility.

In 2018, there were 200 approved game handling facilities registered with the National Food Agency, of which 64 facilities handled wild boar (Livsmedelsverket 2018). In 2017, there were 154 establishments, of which 71 received wild boar, which shows that the number of establishments increased, but not the number of establishments that receive wild boar. The game handling facilities are primarily located in Skåne, Blekinge, Västra Götaland and Södermanland. The facilities usually receive small volumes of animals and only a dozen of the 64 facilities account for just over 80% of the total quantity. According to the National Food Agency's database, a total of 15,161 wild boars were handled via game handling facilities in 2018, which corresponds to 14% of the total number of slaughtered wild boars, which in turn corresponds to 3,000 tonnes meat with bones. It is of great importance that hunting, and slaughter of wild boar takes place in a hygienically good and controlled manner by people who have knowledge and understanding of the hazards that are present during handling. For example, toxin-producing bacteria are found in the game and in the environment where the game is handled, including the hunter's hands. From the shot to the meat on the plate, it should always be seen as food and handled with great care.

Trichinella is a food-borne agent causing *trichinellosis* in humans (Nöckler et al. 2006). *Trichinella spiralis* is the species most common in domestic animals and *T. spiralis*, *T. nativa*, *T. britovi* and *T. pseudospiralis* are most spread between wildlife carnivores. Trichinella are small worms of the roundworm type (nematodes) that can infect humans and other carnivorous mammals (Kocięcka 2000). Infection in humans is uncommon, but serious. The larvae are millimetres long and are encapsulated in the animal's muscles and are thus spread when consuming the meat. The larvae develop in the stomach of the person who has eaten the meat into sexually mature worms, which in turn multiply. The new larvae drill through the intestinal wall and spread via the blood to the muscles and are encapsulated to be spread again. If a person consumes meat infected with trichinae, symptoms such as abdominal pain, fever, and nausea after 1-2 days. By heating Trichinella to 60-65°C it dies. From 1 July 2021, it is possible for laboratories to apply for subsidies from the National Food Agency for analyses of wild boar meat to find trichinae and cesium-137 (Livsmedelsverket 2021c). The purpose of the subsidies is to increase the consumption of wild boar meat that is safe to eat in Sweden and is part of the work that is done to make it easier for hunters to consume the meat. During the year 2020, 161,072 wild boars were tested and only 9 of these had Trichinella, which corresponds to 0.006% (SVA 2020b).

It is possible that wild boar can be infected with salmonella, and not everyone who carries it always gets sick (Livsmedelsverket 2021c). *Salmonella Choleraesuis* is a salmonella type found in domestic pigs, which was detected in 2020 in some cases in wild boar. It is allowed to eat meat from wild boar affected by salmonella if the meat is cooked well. However, meat should never be eaten from animals that are noticeably ill.

Meat from wild boar shot with lead bullets can pose a health risk if ingested (Malmsten et al. 2021). To remove meat around the shot-damaged area with approx. 10 cm safety zone reduces the risk of ingesting lead and the risk can be completely avoided by using lead-free ammunition as an alternative. A survey by the National Food Agency in 2020 shows that 15% of the samples of meat from VHA contain levels of lead above the limit value for beef[1] (Livsmedelsverket 2020).

Wild boar meat can also contain the parasite toxoplasma, which can be harmful to pregnant women (Richomme et al. 2009). Toxoplasma is eliminated by heating (at least 71° C) or by freezing.

In areas affected by radioactive fallout from the 1986 Chernobyl accident, high levels of caesium are common in wild boar, higher than in other game species (Strålsäkerhetsmyndigheten 2021). Caesium levels decrease very slowly and the problem with wild boar is that levels decrease slower than for deer and moose, for

[1] There is currently no limit value for lead content in beef in 2021-12-22.

example. The Swedish Radiation Safety Authority collaborates with hunters and performs measurements of wild boar meat to investigate and improve knowledge about levels of Cs-137 in Swedish wild boar. The measurement results indicate that the levels there is seasonal variation, the average value for one year for January-April was in Heby, Uppsala 4500 Bq / kg and the average value for September-October was 570 Bq/kg. The levels are not necessarily higher in older animals but are affected by the feed they eat; studies show that in some cases the levels are highest in young animals (Nemoto et al. 2018). From 1 July 2021, the Government has decided to introduce subsidies to test the caesium-137 levels in wild boar meat from affected areas with the aim of maintaining food safety (Regeringskansliet 2021).

2.5 Boar taint

In Sweden, all male pigs are neutered before sexual maturity, either physically or chemically, to avoid them developing bad taste and aroma (Zamaratskaia & Squires 2009). This odour called boar taint occurs mainly during heating and is caused by the naturally occurring components skatole and androstenone during puberty. The smell of androstenone can often be likened to a urine- or sweat-like odour, while skatole is often described as faecal smell. Androstenone is synthesized in the testicles at puberty and is released into the bloodstream and the adipose tissue (Fischer & Wüst 2012). Skatole is formed by microbial degradation of tryptophan in the pig's intestine and then enriched in adipose tissue.

It is not possible to castrate wild boar, therefore boar odour can occur in these male animals. The wild boar sow can go into heat all year round, but is usually in autumn and winter (Fischer & Wüst 2012). During the sow's heat, testosterone and androstenone levels up to ten times higher than normal in semen plasma occur.

According to a study by Fischer and Wüst (2012) on boars older than 10 months (sexually mature), androsterone was found in high concentrations, which resulted in mean values of 3329 ng androstenone/g meat. Skatole, on the other hand, was only detectable in 50% of the boars, and then in negligibly low values.

2.6 African swine fever

African swine fever is a viral disease caused by an asphyxia virus and affects pigs and wild boar (De la Torre et al. 2015). The serious viral disease originated in Africa and thus got its name. In recent years, the viral disease has spread sharply in the Caucasus and Russia, among others, as well as in several EU countries. In China, the first cases of African swine fever were discovered in 2018 and quickly spread to Southeast Asia. Sweden has not yet received any detected cases of the infection.

Wild boar and domestic pigs suffer from similar symptoms, which is initially high fever and impaired general condition (SVA 2020a). Difficulty breathing, vomiting, bleeding from the mouth and rectum as well as uncoordinated gait are also common symptoms. The onset of the disease usually becomes so severe that the animals die within a week. Direct contact between the animals is a major cause of the spread of infection. The infection can also be spread via tools, transport vehicles, or food as the virus survives refrigeration and freezing for several years.

2.7 Meat quality

Colour

The colour of the meat is determined by two main factors, which are the concentration and chemical state of the heme pigments myoglobin (Mb) and hemoglobin (Hb) as well as the muscle structure of the meat (MacDougall 1994). The redness of the meat is experienced by the total concentration of pigment and can be measured by a colourimeter or spectrophotometer. The amount of iron in the feed affects the colour (Warriss 2000). Colour of meat can be described both subjectively and objectively. However, it is difficult to describe the colour of meat subjectively as the individual has their own perceptions and it is difficult to get a reliable result.

One way colour is measured is by using the CIELAB-system (Warriss 2000). The tristimulus L*, a* and b* values from CIE-system are the coordinates on the colour sphere; L* represents the lightness component or value from black to white, a* represents red to greenness and b* represents yellow to blueness colour. Minolta Chroma Meter (Minolta (UK) Limited, Milton Keynes, UK) is a common measuring instrument for measuring the colour of meat in L*, a* and b* values. It is important that the piece of meat is thick enough for the best measurement results, preferably 2.5 cm. Another important parameter in colour measurement is that the meat has been exposed to oxygen long enough for the surface pigment to have oxygenated, i.e., 'blooming'. Recommended time for this is one hour but is temperature dependent. The reflectance of light is affected by the structural properties of the muscle which is very pH dependent.

According to a comparison of wild boar meat and domestic pig meat by Marchiori et al. (2003), did wild boar meat had lower L* (brightness) and b* (yellow colour intensity) value and higher a* (red colour intensity) compared to pork (Marchiori 2003).

pH and PSE

The postmortem process when the animal's living muscles undergo transformation to edible meat through acidification of the muscle is essential for meat quality

(Warriss 2000). The extent and speed of the acidification process is essential for the colour and water holding capacity (WHC) of the meat and is measured by the pH value in the meat. The final pH and the speed of the pH-fall thus provides basic information that predicts the meats final quality, including a predictor for the deviating meat qualities PSE (Pale, Soft and Exudative) and DFD (Dark, Firm, Dry). PSE has a higher risk in pig meat and DFD in beef. PSE occurs when the meat temperature is still high, and the pH fall is rapid immediately after death. pH measurement on the whole muscle can be difficult to perform for an exact result and the electrode is fragile and easily contaminated by proteins and fats. Therefore, an electrode adapted specifically for meat, an ion-sensitive field effect transistor (ISFETS), has been developed.

Marchiori et al. (2003) reported a decrease in pH from 6.09 one hour after slaughter, to pH 5.32 48h after slaughter for pig Longissimus dorsi (LD). For wild boar, the drop was from 6.18 (1h after slaughter) to 5.46 (48h after slaughter) in LD (Marchiori & Eduardo de Felício 2003).

WHC, water holding capacity

Lean meat consists of about three quarters of water, of which about 10% is chemically bound to the muscle proteins and the rest of the water extracellular (Warriss 2000) in the space between the thin and thick filaments of the myofibrils. During rigor mortis, the water is squeezed out into the extracellular space. Drip loss is affected by the WHC of the meat and consists of a diluted solution of the sarcoplasmic proteins and contributes to lower meat yield (Huff-Lonergan 2009). Drip loss is also affected by the muscle acidification process in the muscle. A high final pH results in low drip loss and a rapid acidification process leads to increased drip loss. The freezing process and thawing affect drip loss and WHC, but also the history of pH changes during rigor mortis and whether it has been cut in the meat (Ngapo et al. 1999). The literature disagrees on how much the various factors affect and what is optimal.

2.8 Nutritional compounds in wild boar meat

Protein

According to the National Food Agency's food database, wild boar meat contains 23% protein (Livsmedelsverket 2022b). This value is supported by a study of Strazdina et. Al (2014) where the protein content was determined from 19.55% to 23.18% with an average protein content 20.88 ± 2.99%, and by a study by M. Paleari et al. (2003) where the protein content was determined to 21.9±0.65%. The quality of the protein depends on its amino acid composition and digestibility (Strazdina et al. 2014). According to FAO/WHO the recommended intake of essential amino acids is 83.5 mg per kg body weight and day (FAO 2013). Wild boar meat is evaluated as source of protein with high nutritional value.

Fatty acids

Fat is a vital part of the diet for the body to function normally, build and repair cells and produce and regulate hormones (Livsmedelsverket 2021a). The essential fatty acids, as the polyunsaturated fats omega-3 and omega-6, are further important to ingest through the diet as they affect functions in the body such as blood pressure and immune system. Vitamins A, D, E and K are fat-soluble and therefore need fat from the diet to be absorbed by the body.

In general, game meat has a low fat content compared to domestic pigs (Razmaite et al. 2012). However, this can vary during the season and vary depending on gender, age, and physiological conditions. According to Razmaite et. al (2012), the same fatty acids were found in meat from both young wild boars and adult domestic pigs. However, the composition varied considerably between the animals. The intramuscular fat in the wild boar increases with increasing age. Among the saturated fatty acids (SFA), C16:0 and C18:0 are most common. According to the study by Razmaite et. al (2012), weight of the animal did not play a role in the proportions of SFA and total polyunsaturated fatty acids (PUFA). When the fatty acid composition between domestic pigs and wild boar was compared in that study, it was concluded that no correlations could be found between different wild boars and their fatty acid composition.

There are clear variations in the amount of fat and the lipid composition during the year and in some cases between the sexes (Razmaite et al. 2012). According to Russo et. al. (2020), sex only influenced C16:1(n7), which was found in larger quantities in wild boar sows compared to males (Russo et al. 2017). The study also shows that which month of the year the hunt was carried out, either October-November or December-January, had a major impact on the fatty acid composition. This was shown by marked differences in the ratio MUFA, PUFA, PUFA / SFA and n6/n3.

Minerals

Red meat is an important source of mainly the minerals Fe and Zn (Babicz & Kasprzyk 2019). Minerals are important for maintaining the basic functions of the body as building materials for bones, skin, teeth, and hair. Macro- and microelements are also important for the metabolic process in the body and regulation of water and electrolyte metabolism. The advantage of the minerals being taken from animal products instead of from plants is that they are more bioavailable and easier for the body to absorb.

Youths, women, and the elderly are the ones most easily affected by a lack of macro- and micronutrients (Livsmedelsverket 2021b). The content of nutrients in meat is affected by factors as species, age, sex and especially nutrition and the environment regarding wild animals such as wild boar whose diet is based mainly on grass, cereals, herbs, and mushrooms. The content of minerals in meat from domestic animals can to a greater extent be regulated and controlled by the producer.

3. Purpose and aim

*The aim o*f this study was to investigate eventual differences of meat quality between wild boar from South Sweden, and commercial pigs. Also, to investigate whether variations in taste and other sensory aspects could be found. The results from this report can later be used as a basis for food producers in their work with the development of wild boar meat products.

Hypothesis

Wild boar meat from South Sweden and meat from commercial pigs has no differences regarding pH, colour, lipid content and lipid composition. Pigs are the domesticated variety of wild boar, so they are of the same species. It is therefore interesting to see how, or if, they differ. It can both be genetic differences and individual differences based on the living conditions and diet of the wild boar.

Limitations

This study will not examine an eventual link between hunting method and meat quality. The hunting method will be considered as an influencing factor in the discussion. Also, the age of the animals is not considered in this study.

4. Material and method

4.1 Sample collection

The meat used in this study was from the shoulder of 20 wild boars from the game handling facility Skånska vilt in Skåne and 3 domestic pigs from Lövsta abattoir, Uppsala. The wild boar used for pH, colour and lipid analysis were hunted at the end of October 2021 and the wild boar meat used for the sensory evaluation by a consumer panel was hunted in January 2022. From the time the meat was cut, it was stored at -20°C until it was used for analysis. The wild boars were both sows and males of varying ages, randomly selected from what was hunted the week before the sample collection. The meat used for the sensory evaluation was shoulder from one wild boar male, one wild boar sow, one wild boar gilt and one domestic slaughter pig. The carcasses from the pigs and wild boars were weighed at the slaughterhouse and the game handling facility respectively.

4.2 pH and colour measurement

The pH was measured in wild boar and pig shoulder muscle at three places after thawed at 4°C for 24 hours, followed by one hour at room temperature (340 WTW, Weilheim, Germany). Calibration of the instrument was performed with standard pH buffers of 4.00 and 7.00 at 20°C.

The meat was let to bloom at room temperature for one hour before the colour was measured. The colour was measured on the surface of the meat and measurement was performed in triplicates using a chroma meter (CR-300 Chroma Meter, Minolta, Japan) according to the method of Honikel (Honikel 1998). The instrument was calibrated before each measurement against a white tile ($L* = 93.30$, $a* = 0.32$ and $b* = 0.33$).

4.3 Lipid extraction and determination of fatty acid composition by GC

Lipid extraction

For lipid analysis, the shoulder from 17 wild boars (8 sow, 9 wild boar male) and 3 commercial pigs were used. The entire shoulder from each animal was grounded, and 1 g was used for lipid extraction, according to Pickova et al (Pickova et al. 1997).

An Ultra Turray was used to homogenize 1g sample with 8ml Hexane/ Isopropanol (HIP) (3: 2; v: v) in a glass tube to disrupt the cells. The Ultra Turray nozzle and the glass tube were washed with 4ml HIP in connection with the solution being transferred to a teflon tube. 4ml 6.67% Na_2SO_4 solution was added to the solution and vortexed well to then centrifuge at 4000 RPM for five minutes. The upper phase was transferred to a pre-weighed glass tube and 1ml hexane was added to the sample. The sample was vortexed and centrifuged once again and the upper phase transferred to the pre-weighted glass tube (repeated twice). The collected upper phase was evaporated with N_2 and then the fat content determined gravimetrically and calculated. The lipid content was determined in duplicates. One ml hexan was added to the samples and they were stored in -20°C until further use for gas chromatography.

Gas Chromatography

The extracted lipid samples were methylated according to Pickova et al (Pickova et al. 1997). When the stored lipid sample was thawed, the lipids were diluted with hexane. The amount hexane was adjusted according to the amount lipids, to reach a concentration of 5mg/ml lipids. 2 ml SeccoSolv dried methanol was added, and the sample was put in to heating block (60°C) for 10 minutes. 3ml BF_3 reagent was added, and the samples were put in to heating block again for 10 minutes and then the tubes were let cool down in ice and water bath. 2ml 20% NaCl (200g/L) and 2ml hexane was added to the samples followed by vortex and putted in the fridge for 30 minutes to let the phases separate.

The upper phase was transferred into a second glass tube and the extraction was repeated by adding 1ml hexane, vortex and let the phase separate in the fridge. The collected upper phase was evaporated with N_2 followed by dissolving with 0.5ml hexane and transferred to a vial.

The methylated lipid samples were run on thin layer chromatography (TLC) plates against the standard 18-4 [5 ug/ul] for controlling that the methylation was performed correctly.

The Fatty acid methyl esters (FAME) were analysed as described by Pickova et al (Pickova et al. 1997) by using a gas chromatograph (CP3800, Varian AB, Stockholm, Sweden), equipped with an Flame ionization detector (FID) detector and a BPX 70 column (SGE, Austin Texas) with 50 m length, id 0.22 mm and a film thickness of 0.25 µm. Fatty acids were identified by comparison with a standard mixture (GLC- 68D, Nu-Chek Prep, Elysian, USA).

4.4 Consumer panel

The sensory evaluation was carried out with the aim of investigating whether there was a difference between pork from commercial slaughter pigs and meat from wild boars off both sexes in colour, aroma, taste, tenderness, and juiciness and an overall accept-ability using a scale of 7 points; 1 to 7. 1 point correspond to "dislike", and 7 points correspond to "like most" (Terry et al. 2005). The panel consisted of ten random invited persons from staff and students at the department of Molecular Science at the Swedish University of Agricultural Sciences (SLU) Ultuna, Uppsala.

For the sensory test, shoulder meat from pigs and wild boars were minced, no salt or flavour were added, vacuum-packed, and heated in water bath at 70°C until the core temperature was 67°C (Honikel 1998). The samples were served to the panellists on paper plates. Crackers and water were available to clean the palette. The tasting scheme is shown in Appendix 1.

4.5 Statistical analysis

Data from all carcass attributes tests (pH, colour, lipid content) were analysed with one-way ANOVA. Tukey's test was used to make pairwise comparisons with a difference considered significant if $P<0.05$ (MiniTab n.d.).

The sensory test was analysed with one-way ANOVA and General Linear Model. Also, in this case Tukey's test was used to make pairwise comparisons with a difference considered significant if $P<0.05$ was used.

Minitab version 19.2020.2.0 was used for all analyses.

5. Result and discussion

5.1 Carcass characteristics

There was a weight difference of the carcasses between the pigs and the wild boar, where the pigs were larger (Table 1). There was no difference in carcass weight between the sexes of the wild boars (Table 2). The carcass weight for the wild boar varied from 15.9 kg to 50.7 kg. The reason for the large variation in weight for wild boar can be due to factors as age, sexual maturity, heat, availability of feed, season, and individual variations. The pigs, on the other hand, are produced under controlled conditions, were of the same breed and were slaughtered at about the same age and weight, which gives a more homogeneous carcass weight.

Table 1. Technological traits for pork and wild boar meat quality

Trait	Wild boar (n=17)	Pig (n=3)	p-value
Carcass weight (kg)	31.8 ± 2.80	92.7 ± 0.60	<0.0001
Final pH	5.70 ± 0.09	5.50 ± 0.02	0.004
L*	31.7 ± 2.80	47.2 ± 0.60	<0.0001
a*	15.3 ± 2.22	2.36 ± 0.65	<0.0001
b*	19.0 ± 1.94	22.7 ± 0.58	0.007

Least squares means and standard deviation for carcass weight, pH, and colour measurement of wild boar and pig shoulder muscle.

Table 2. Technological traits for wild boar meat quality.

Trait	Entire wild boar male (n=9)	Wild boar sow (n=8)	p-value
Carcass weight (kg)	32.0 ± 9.58	31.7 ± 11.0	0.962
Final pH	5.70 ± 0.10	5.64 ± 0.06	0.208
L*	32.3 ± 3.4	31.3 ± 2.41	0.536
a*	15.2 ± 2.67	15.4 ± 2.01	0.873
b*	19.3 ± 2.40	18.9 ± 1.68	0.736

Least squares means and standard deviation for carcass weight, pH, and colour measurement of wild boar shoulder muscle.

5.2 pH measurement

There was a difference in final pH in shoulder muscle from wild boar and pig. The final pH of wild boar varied from 5.55 to 5.87, with an average of pH 5.67. The average final pH value for the entire wild boar males was 5.70 ± 0.10 and for the wild boar sow 5.64 ± 0.06. The final pH of pork meat ranged from 5.48 to 5.52 with an average pH of 5.5 ± 0.0201. The pH values of the samples are shown in table 1 and 2.

The final pH of the meat has a great impact on the water holding capacity and is thus important for the meat quality. When the animal is slaughtered and the muscle becomes meat, a natural pH decrease occurs due to lactic acid formation from anaerobic metabolism of glycogen in the muscle. In this study, the final pH was measured on meat that has been slaughtered/shot, hung for 48 hours, cut, frozen and finally measured on thawed meat. Therefore, it is not entirely relevant to compare the pH values from this study directly with those from measurements done at slaughterhouses directly after slaughter.

According to (Marchiori & Eduardo de Felício 2003), pH 48h after slaughter was 5.47 ± 0.15 for wild boar and 5.34 ± 0.10 for pig. The pH measured in the study was lower than the pH of the meat that has been frozen, but not significant at $p<0.05$ level for both domestic pigs and wild boar.

5.3 Colour measurement

Colour values of shoulder muscles from wild boars (n=17) and pigs (n=3), measured after thawing and after 1h blooming time, are shown in tables 1 and 2. Meat colour was measured as lightness (L*), redness (a*) and yellowness (b*) did show differences between the wild boars and pigs. The mean value for L* for wild boar was 31.7 and for pig 47.2 with a significant difference. The mean value for a* for wild boar was 15.283 and for pig 2.36 with a significant difference. The mean value for b* for wild boar was 19.039 and for pig 22.67 with a significant difference. The pork had a much lighter and pink colour compared to the wild boar meat, which was dark red like beef, which the results clearly show.

No differences were found between sows and male wild boar (See Tab. 2). The fact that there was no colour difference in the meat between the sexes of wild boar is an advantage seen from a food production perspective where individual variations are undesirable. The fact that no difference was detected indicates homogeneity of the meat quality in the meat from the group of wild boars studied. In the industrial processing of a raw material, in this case wild boar meat, there are often standards and requirements that the raw material must meet. To facilitate food production, it is good if the raw material always has the same properties. One example isthat the colour of the meat does not differ between individuals, which it does not in this study.

5.4 Lipid extraction and determination of lipid class composition

There was no difference in fat content in shoulder muscle neither between wild boar and pig, or between different sex for wild boar. The average lipid content for wild boar was 4.71% and 2.92% in pig shoulder (Table 3). The fatty acids C17:0, C20:2(n-6), C20:5(n-3), C22:5(n-3) were detected in wild boar meat but not in pork. There was significantly higher amount of the fatty acids C16:1(n-7), C18:1(n-9) in pigs than in wild boar meat. Higher proportions of C18: 2 (n-6), C18: 2(n-3), C20:2(n-6), C20:5(n-3) and C22:5(n-3) were found in wild boar compared to pigs. Proportions of MUFA, n-6, n-3, and the ratio n-6 / n-3 were higher in wild boars compared to pigs. No significant difference was detected for PUFA.

Table 3. Average total lipid content in percentage and lipid class composition for wild boar and pigs g per 100g meat.

Fatty acid	Wild boar (%) (n=17)	Pig (%) (n=3)	p-value
Total lipid	4.71 ± 1.91	2.92 ± 0.23	0.129
C14:0	1.19 ± 0.41	1.22 ± 0.20	0.905
C16:0	23.6 ± 1.47	25.3 ± 1.57	0.083
C16:1(n-9)	0.43 ± 0.29	0.31 ± 0.27	0.504
C16:1(n-7)	2.56 ± 0.83	4.13 ± 0.20	0.005
C17:0	0.22 ± 0.24	0	0.124
C18:0	10.3 ± 1.08	10.7 ± 1.05	0.524
C18:1(n-9)	35.9 ± 4.70	42.2 ± 0.17	0.036
C18:1(n-7)	3.98 ± 0.49	4.38 ± 0.29	0.196
C18:2(n-6)	16.1 ± 3.32	8.69 ± 0.82	0.001
C18:3(n-3)	0.98 ± 0.36	0.31 ± 0.29	0.007
C20:1(n-9)	0.46 ± 0.36	0.52 ± 0.07	0.762
C20:2(n-6)	0.40 ± 0.40	0	0.012
C20:3(n-6)	0.29 ± 0.36	0.17 ± 0.29	0.555
C20:4(n-6)	2.83 ± 1.71	2.12 ± 0.42	0.489
C20:5(n-3)	0.36 ± 0.27	0	0.034
C22:5(n-3)	0.47 ± 0.40	0	0.06
SFA	24.8 ± 1.74	26.5 ± 1.50	0.125
MUFA	43.3 ± 4.40	51.5 ± 0.65	0.006
PUFA	4.96 ± 2.38	2.60 ± 0.46	0.111
n-6	19.6 ± 5.11	11.0 ± 0.91	0.011
n-3	1.82 ± 0.63	0.31 ± 0.29	0.001
n-6/n-3	11.9 ± 5.79	23.5 ± 4.81	0.015

No difference was detected for any of the fatty acids when comparing wild boar sows and males. See Table 4 for comprehensive results. The fatty acid composition is greatly affected by the diet of monogastric animals. Wild boar sows and males have lived in similar environment and eaten the same feed and digested the feed in the same way. The fact that there was no significant difference in fatty acid composition between the sexes can be seen as positive from a food processing aspect.

Table 4. Average total lipid content in percentage and lipid class composition for wild boar and pigs g per 100g meat. wild boar male and wild boar sow.

Fatty acid	Male wild boar (%) (n=9)	Wild boar sow (%) (n=8)	p-value
Total lipid	5.42 ± 1.67	4.08 ± 1.98	0.156
C14:0	1.11 ± 0.50	1.30 ± 0.26	0.346
C16:0	23.1 ± 1.81	24.1 ± 0.81	0.213
C16:1(n-9)	0.40 ± 0.40	0.47 ± 0.47	0.626
C16:1(n-7)	2.35 ± 0.96	2.81 ± 0.63	0.274
C17:0	0.18 ± 0.27	0.28 ± 0.21	0.433
C18:0	10.3 ± 1.21	10.3 ± 1.00	0.980
C18:1(n-9)	35.0 ± 6.16	36.9 ± 2.16	0.403
C18:1(n-7)	4.14 ± 0.40	3.81 ± 0.56	0.185
C18:2(n-6)	16.8 ± 4.16	15.2 ± 2.00	0.354
C18:3(n-3)	0.90 ± 0.35	1.07 ± 0.37	0.341
C20:1(n-9)	0.58 ± 0.36	0.34 ± 0.24	0.137
C20:2(n-6)	0.47 ± 0.25	0.33 ± 0.24	0.271
C20:3(n-6)	0.33 ± 0.44	0.26 ± 0.26	0.722
C20:4(n-6)	3.37 ± 2.20	2.24 ± 0.66	0.179
C20:5(n-3)	0.44 ± 0.30	0.28 ± 0.22	0.247
C22:5(n-3)	0.61 ± 0.45	0.33 ± 0.31	0.151
SFA	24.3 ± 2.16	25.4 ± 0.95	0.203
MUFA	42.3 ± 5.72	44.4 ± 2.04	0.335
PUFA	5.66 ± 3.03	4.18 ± 1.10	0.213
n-6	21.0 ± 6.46	18.1 ± 2.64	0.259
n-3	1.96 ± 0.80	1.68 ± 0.39	0.395
n-6/n-3	12.7 ± 8.00	10.9 ± 1.32	0.538

5.5 Consumer panel

Table 5. Sensory test of pork and different types of wild boar meat by untrained panelist (n=10).

	Pork	Wild boar male	Wild boar sow	Wild boar gilt	p-value
Overall liking	3.9 ± 1.6^{b}	4.3 ± 2.0^{b}	4.8 ± 1.14^{ab}	5.9 ± 1.2^{a}	0.031
Colour	0.1 ± 0.3^{a}	1.4 ± 0.8^{b}	1.0 ± 0.9^{b}	2.3 ± 0.5^{c}	<0.0001
Aroma	1.2 ± 1.0^{a}	0.5 ± 0.9^{a}	0.7 ± 0.8^{a}	0.6 ± 0.7^{a}	0.287
Taste	0.6 ± 0.7^{a}	1.6 ± 1.2^{a}	0.7 ± 0.8^{a}	1.8 ± 1.3^{a}	0.025
Tenderness	0.9 ± 1.0^{a}	0.7 ± 0.7^{a}	0.9 ± 0.7^{a}	1.0 ± 0.8^{a}	0.869
Juiciness	1.6 ± 1.2^{a}	0.9 ± 0.6^{a}	0.9 ± 0.6^{a}	1.0 ± 1.1^{a}	0.245

Overall liking of pork and wild boar meat in points on a scale of 1 - 7, where 1 is lowest and 7 is highest. For the parameters colour, aroma, taste, tenderness, juiciness, all samples were set against each other in pairs of two and the score is an average of how many times the sample was preferred over the compared sample.
$^{a, b, c}$ means that do not share a letter are significantly different.

There was a difference in overall score between the four meat samples (table 5). Wild boar gilt received the highest grade with a mean value of 5.9 ± 1.2. The pork sample with the lowest grade of 3.9 ± 1.6. The panellists were also allowed to comment on the samples. The pork sample received three comments that it was dry and pale, which can be perceived as negative or unappetizing properties. The sample of entire wild boar male meat received no comments suggesting off flavours of boar taint.

Table 6. Sensory test of pork and wild boar meat by untrained panelist (n=10).

	Wild boar meat (n=30)	Pork (n=10)	p-value
Overall liking	5.0 ± 0.6^a	3.9 ± 1.6^a	0.064
Colour	1.6 ± 1.0^a	0.1 ± 0.3^b	<0.0001
Aroma	0.6 ± 0.7^a	1.2 ± 1.0^a	0.058
Taste	1.4 ± 1.2^a	0.6 ± 0.7^a	0.062
Tenderness	0.9 ± 0.7^a	0.9 ± 1.0^a	0.91
Juiciness	0.9 ± 0.7^a	1.6 ± 1.2^b	0.041

Overall liking of pork and wild boar meat in points on a scale of 1 - 7, where 1 is lowest and 7 is highest. For the parameters colour, aroma, taste, tenderness, juiciness, all samples were set against each other in pairs of two and the score is an average of how many times the sample was preferred over the compared sample.
$^{a, b}$ means that do not share a letter are significantly different.

Table 6 shows a comparison from the sensory test with an average value for all wild boar samples (n=30) compared to the pork (n=10). For the general impression, wild boar gilt received the highest score, but not significantly. Significant difference was shown for colour and juiciness where wild boar meat was preferred over pork for colour and pork was preferred before wild boar for juiciness.

5.5.1 Methodological considerations

The design of the sensory test was created to answer the question of the report and test the hypothesis and not performed exactly according to an existing method from a previous study. The requirement to participate in the survey was that the person should eat pork on a frequent basis. How often pork was consumed was not a specification.

I wanted to compare all samples against each other to see which sample was most preferred. Other methods could have been used instead, such as a triangle test could also have been applied to see if any of the sample's A-D differed from the group. But in this case, the chosen method suited well based on answering the research question, amount of meat available, number of panels lists and available resources. Had there been more meat available, the test panel could have consisted of more people, which would have contributed to a greater variation and more results. In this case, only one shoulder from an animal could be used for the taste panel, which was a limitation.

One factor that could also have affected the result is the requirements placed on the taste panel. The only requirement was that the panellists eat meat. Had this requirement been specified, for example, that the panellist would consume pork once a week, it would have been other people who participated, which would have given a different result. But I chose not to be too specific in who would test as I wanted a general result from the "ordinary consumer".

After the tasting, I was informed by some panellists that it was too "heavy" a tasting with a lot of meat to try at the same time. For the next time, the session could have been divided into two occasions. When the meat was served in small pieces, it cooled down quickly, which may have affected the panel lists depending on how quickly they tasted.

The colour of the meat is also an influencing factor. Wild boar meat was darker than the pork, which can affect the panellists' judgment. Blind testing could have been carried out but had required more staff and been demanding on staff and logistics.

As the panel is untrained, the scale 1-7 can be interpreted in different ways individually.

5.6 Conclusion

In this study, shoulder meat from commercial slaughtered pigs and wild boars was compared in terms of pH, colour, fat content, fatty acid composition, and by sensory evaluation. Pork was compared to wild boar meat, and the groups wild boar sow and wild boar males were also compared to each other. In terms of pH, colour and fatty acid composition, there were difference between wild boar meat and pork, for example, the wild boar meat had more of n-3 fatty acids than pork. No difference was found for fat content between the wild boar meat and the pork. From the test panel, the colour of the wild boar meat was preferred compared to the pork, and for juiciness, the pork was preferred to the wild boar meat. Pork and wild boar meat did not differ significantly in taste, aroma, or tenderness.

The properties that are considered advantageous for a raw material are individual and vary depending on the purpose and in which process it is to be used. It is difficult to say that something is right or wrong, as long as the raw material meets the requirements for food safety. The wild boar meat had a distinctly darker red colour than the pork. This can be a beneficial property for the wild boar meat since pork often become bleached and get a grey colour when cooked. Final pH was higher for wild boar than for pigs, but not with a large standard deviation and the values from this study were comparable to other studies. No signs of PSE were detected that could have a negative impact on meat quality such as WHC and shelf life. Overall, the characteristics of the wild boar evaluated in this report can be seen as positive for food production and a show an opportunity to create a product with added value from wild boar meat.

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Popular science summary

In this study, wild boar meat was examined and compared with pork, and meat from wild boar males and wild boar sow was compared against each other. There was also a tasting performed by an untrained consumer panel who got to taste and compare meat from pork and wild boar meat from different age and sex against each other. Regarding pH, colour, and fatty acid composition, there were differences. No difference was found for fat content between the wild boar meat and the pork. From the consumer panel, the only noticeable difference between the samples was colour and juiciness. Pork and wild boar meat did not differ regarding taste, aroma, or tenderness. The tests were performed on meat from wild boar and pigs, raised and produced in Sweden.

For hunters, wild boar meat has long been part of the diet, but in step with the increasing number of wild boars in Sweden, it has become more common and more accessible to consumers. In my opinion, the large population should be seen as an opportunity for consumers to take part in a Swedish-produced high-quality protein source, instead of focusing on the high population as a problem.

The focus of the food industry should be to introduce wild boar meat to consumers, to make it easily accessible, create more semi-finished products or products that just need to be fried. Examples of this can be meatballs, sausages, or slowly cooked meat like pulled proc. This could contribute to the consumption of wild boar meat becoming part of everyday life and not just happening on the weekend in the form of a steak. The possibility of making a slowly cooked product from wild boar was inspiration for the choice of muscle to investigate in this work.

Populärvetenskaplig summering

I denna studie har vildsvinskött undersökts och ställts mot griskött, samt har kött från vildsvinshanar och honor ställts mot varandra i jämförelserna. Det genomfördes även en provsmakning av en otränad konsumentpanel som fick smaka och jämföra olika köttprover mot varandra. Av undersökningarna framkom ingen signifikant skillnad inom gruppen vildsvin. Gällande pH, färg, och fettsyrasammansättning fanns det skillnad mellan griskött och vildsvin, till exempel har vildsvin mer omega 3-fettsyror. Ingen signifikant skillnad konstaterades för fetthalten mellan vildsvinsköttet och grisköttet. Från testpanelen var den enda märkbara skillnaden mellan proverna att färgen på vildsvinköttet var mer uppskattad och saftigheten var bäst i fläskköttet. Testerna gjordes på kött från bog av vildsvin och gris, uppvuxna och producerade i Sverige.

För jägare har vildsvinskött länge varit en del av kosten, men i takt med det ökade antalet vildsvin i Sverige har det blivit vanligare och mer lättillgängligt för konsumenter. Det bör i min mening ses som en möjlighet för konsumenter att ta del av en svenskproducerad högklassig proteinkälla, i stället för att lägga fokus på den höga populationen som ett problem.

Fokus från livsmedelsföretagen bör ligga i att introducera vildsvinkött till konsument genom att göra det lättillgängligt, skapa fler halvfabrikat eller produkter som bara ska stekas på. Exempel på detta kan vara köttbullar, korvar eller långsamt tillagat kött likt pulled prok. Detta skulle kunna bidra till att konsumtionen av vildsvinskött blir en del av vardagen och inte bara sker på helgen i form av en stek. Möjligheten att tillverka en långsamt tillagad produkt av vildsvin var inspiration till val av muskel att undersöka i detta arbete.

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Appendix 1

Tasting session

Instructions:

Today you will get to try meat. On the one hand, samples will be compared against each other, and assessed individually. Read the entire form and ask me before you start the tasting if you have any questions.

The test is divided into two parts.

First, two samples will be compared against each other, and you should state which of the two you prefer for each category, e.g., colour, aroma, etc. Write the sample code in the box, alternatively "E" (equal) if you do not feel any difference. See example.

Example:

Sample code		Colour	Aroma	Taste	Tenderness	Juiciness
Xa	Xb	E	Xa	Xb	E	Xb

Step two is an individual assessment of each sample where you will tick a box with the number 1-7 that corresponds to your overall impression of the sample. 1 is the lowest score and 7 is the highest. There is also a field under where you can write a comment if you notice something distinctive you want to mention regarding taste, aroma, etc.

The meat is not flavoured with either salt or other spice.

Water and crackers are available between tastings to cleanse the palette.

Explanation of assessment criteria:

Colour and aroma = Look and smell at the pieces of meat, compare them against each other and choose the one that appeals to you the most.

Taste = Taste the pieces of meat, compare them against each other and choose the one that appeals to you the most.

Tenderness = When you taste the meat, choose the sample that is easiest to chew here.

Juiciness= When you taste the meat, choose the sample that is juiciest here.

Tasting form

Personal information

Gender Sow____ Male____ non-binary____

Age <30____ 30-40____ 40-50____ 50<____

How often do you consume read meat? 1/week___1/month___ 1/6month___ 1/year___ never____ Don't know____

How often do you consume wild boar meat? 1/week___1/month___ 1/6month___ 1/year____never____ Don't know____

Comparing test

Choose between the two samples. Write the **code** of the preferred sample for each category. If no difference is noticed, write "**E**" (equal). Compare 1a against 1b and so on. Repeat this procedure for all six pairs.

Sample code		Colour	Smell	Taste	Tenderness	Juiciness
1a	1b					
2a	2b					
3a	3b					
4a	4b					
5a	5b					
6a	6b					

Overall preference test

A Dislike ☐ ☐ ☐ ☐ ☐ ☐ ☐ Like

1 2 3 4 5 6 7

Note:

B Dislike ☐ ☐ ☐ ☐ ☐ ☐ ☐ Like

1 2 3 4 5 6 7

Note:

C Dislike ☐ ☐ ☐ ☐ ☐ ☐ ☐ Like

1 2 3 4 5 6 7

Note:

D Dislike ☐ ☐ ☐ ☐ ☐ ☐ ☐ Like

1 2 3 4 5 6 7

Note:

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