Fermented sausage

– Product development at Lindell's Gårdsslakteri

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ABSTRACT

Product development is a risky business; many products never yield profit, but it is also necessary for a company's survival in a competitive business where the costumers change their requests constantly. Consumer-led product development is developed from the wish to fill the consumer's needs and expectations and thereby be more likely to succeed. Lindell's Gårdsslakteri AB is a local slaughter and meat processor in Västergötland. They wish to expand their meat product assortment with a new product that fits into their otherwise traditional and quality oriented supply. A market survey led into the idea of developing a fermented sausage. The manufacturing of fermented sausage is complex with many parameters to consider producing a tasteful, visually attractive and safe sausage. Typical for all fermented sausages are the combination of lactic acid, salting and drying. A "medvurst" is a type of fast fermented sausage that is produced and ready to be sold within a few days. The manufacturing process started with the mixing of pork and beef meat with seasonings, starter culture and curing salt. When a paste was formed frozen pork fat was mixed in. After filling into semipermeable casings the sausage was left for tempering. The fermentation started in the smoke chamber followed by smoking and heat treatment to 47°C. The sausage was then left in the chilling room to mature for 2 days. After two test trials the desired sausage was created. Following was the labeling and part of a risk analysis concerning EHEC. After the end of the project Lindell´s continued with the risk analysis, durability tests and launching. The resulting product is a locally produced "medvurst". Consumer's interest in extrinsic factors has created a whole new market with many new possibilities for product development. Meat product ingredients have gained an extra interest from the consumers in the last couple of years, especially the additives. Lindell´s like many other companies are getting more questions and phone calls about this and a deepened knowledge is desired to be able to fill the consumer needs.

Keywords: meat product, fermented sausage, food additive, food product development

SAMMANFATTNING

Produktutveckling utgör en ekonomisk risk men är också en nödvändighet för ett företags framgång i den hårt konkurrensutsatta livsmedelsbranschen där konsumenternas önskemål ständigt skiftar. Konsumentinriktad produktutveckling utvecklades för att öka möjligheterna för en lyckad produktutveckling genom att fylla konsumenternas behov och förväntningar. Lindell's Gårdsslakteri är en lokal slakteri- och processanläggning i Västergötland. De skulle vilja utveckla sitt traditionella och kvalitetsinriktade charksortiment med ytterligare produkter. Genom en marknadsundersökning kom idén upp att utveckla en fermenterad korv av medvursttyp. Att producera en fermenterad korv är komplext, många parametrar ska kontrolleras och justeras för att få en korv som smakar gott, ser bra ut och är säker. Typiskt for all fermenterad korv är kombinationen av mjölksyra, saltning och torkning. En medvurst är en snabbfermenterad korv som produceras på ett par dygn. Produktionsprocessen startar med att fläsk- och nötköttet mixas med kryddor, bakteriekulturer och nitritsalt. När en smet har bildats blandas det frusna späcket i. Efter stoppningen i semipermeabla korvskinn lämnas korvarna att tempereras. Fermenteringen startar sedan i rökskåpet och följs av rökning och upphettning till 47°C. Korven lämnas sedan i kylen i 2 dygn för att mogna. Efter två testkörningar hade en smakrik, lagom syrad korv utvecklats och processen följdes av en genomgång av märkningsdirektiven samt en del av riskanalysen rörande EHEC. Efter projektets slut fortsatte Lindell's med riskanalysen, hållbarhetstester och lansering. Resultatet är en lokalt producerad medvurst. Konsumentintresset för produkters yttre egenskaper (som lokalproducerat) har öppnat en helt ny marknad med många nya produktutvecklingsmöjligheter. Ett ökat intresse från konsumenterna kring ingredienserna i charkprodukter har setts de senaste åren, särskilt kring tillsatserna. Lindell's har precis som många andra företag märkt av ett ökat antal telefonsamtal och frågor kring detta. För att kunna uppfylla konsumenternas behov krävs en fördjupad kunskap i ämnet.

Nyckelord: charkprodukt, fermenterad korv, livsmedelstillsats, produktutveckling livsmedel

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1. INTRODUCTION

1.1 BACKGROUND

Meat products arose from the need to preserve meat in ancient time. Lowering of water activity (a_w) combined with a pH decrease are the oldest preserving techniques. This was performed through salting and drying and by allowing natural microorganisms in the meat to grow and ferment. Little was known about the process and it was seen as a craftsmanship. Early products were dry-cured ham and fermented sausage. This has been said to be part of the success of the Roman Empire (Vandendriessche, 2008). The general consumption pattern of meat products is increasing. The consumption of meat products in Sweden 2008 were 217 million kg and 76% of those were mixed meat products (e.g. sausages, paté) (SJV, 2010).

The food market has evolved in the last decades. It has changed from being supply-based for many years, to nowadays being demand-based. This has had an effect on product development. The supply-based food market consisted of the products the farmers and the food processors offered for sale. To get what you wanted you had to be there in time. The modernization of the farming, e.g. through advances in mechanization, fertilizers and pesticides, increased the amount of available raw material drastically and saturated the food market. When the markets became saturated successful sales were only accomplished through filling a demand for the consumer. From this the need of consumer-oriented food product development arose. Food product development is an important process for food producing companies. The development of new products serves as a competitive mean for the company. It is a way to strengthen their position on the market as the consumer needs and wants continuously changes (Linnemann et al., 2006).

Consumer-oriented food product development starts with consumer and market research to identify the needs and wishes. This information is then brought back and discussed throughout the production chain where the needs and wishes of the consumers have to be translated into technological specifications for a new product (Linnnemann et al., 2006). Recent consumer attitude surveys in Europe tell us that consumers prefer "natural" meat; they want processing to be kept to a minimum and be as simple as possible. Consumers draw a line between fewer additives and wholesomeness of the product. There is a strong criticism against excessive intervention and manipulation of food (Verbeke et al., 2010). Also seen in these surveys was the importance of origin. Meat products with an origin recognized by the consumers are considered safer and of better quality (Grunert, 2006; Verbeke et al., 2010).

Consumers' interest for origin and production method has increased in recent years (Roninen et al., 2006). Both origin and production method are examples of extrinsic quality cues. The other group of quality cues would be the intrinsic; these are the ones that are part of the physical product like taste or appearance. The general opinion is that the use of extrinsic cues by producers to assert quality will increase and the cues will play a major role when consumers judge quality (Grunert, 2006). Locally produced food is an example of products with known origin, studies show that there are several reasons why consumer buy locally produced food (Roninen et al., 2006; Winter, 2003). Supporting local farmers and the local economy are two of them, also knowledge about the foods origin, to know what you get (trustworthiness). The intrinsic quality is by some also thought to be higher for these products, but irrespective of that the idea of local production is enough by itself.

Consumer's show generally an increasing interest for "stories", like locally produced, linked to their products. These stories extend the experience of the product beyond its basic meat functions and add extra value. The stories are backed up with extrinsic cues. These cues are then used by the consumer to draw a whole line of conclusion about the product quality. The conclusions about these cues are so strong that even if the product does not live up to the quality assigned to it consumers stick with them anyway (Grunert, 2006).

Lindell´s Gårdsslakteri AB (Lindell´s from now on) is a local meat producer with focus on quality. Most processing steps are done by hand and allow extra watchfulness to ensure good quality. The distribution chain is also very short which allows a deeper quality control. Lindell´s has since 1993 slaughtered and processed the pigs they produce. Today they have a newly built production plant in Ottravad outside of Tidaholm in Västergötland and have about 18 employees. Their own pig production is not enough to fill their needs today, pigs are bought from farmers nearby and beef meat is bought from another local slaughterhouse. Their main areas is producing and selling fresh meat to supermarkets. Lindell´s started up by selling their meat in the local supermarket, and is still today the main meat distributor to the food stores in Tidaholm with a place in many "Tidahôlmares" hearts. Lindell´s has widened their distribution net during the years and can now be found in many of the food stores in a 100km area from Tidaholm.

Lindell´s bought up Tibro Chark a few years ago and in 2009 they moved the production to their production plant in Ottravad. Lindell´s current meat product assortment consists of 32 differentiated products and this is an area where they see possibilities for progression and expansion. The main part of their current meat product supply is traditional Swedish meat products, some with a local connection. It is recipes with a limited amount of food additives and high meat content. Their typical product is locally produced, made by hand and a step higher in quality than the conventional product.

1.2 Aim of the project

The aim of this project was to develop a meat product that is requested by the consumers and fit well into the existing assortment at Lindell´s, a product that can gain market share and increase the profit. To prepare for this product to be easily incorporated into the production the labeling directives and the safety of the sausage concerning the EHEC bacteria has been further looked at.

Lindell´s has experienced an increased interest from the consumers about some of their ingredients. Questions and worries arose about why they use them and their effects. To widen the knowledge at Lindell´s some debated ingredients from their ingredient lists have been more deeply looked at; why they are used in meat products, how they affect the consumers and if they could be replaced and the consequences of that.

2. LITERATURE REVIEW

2.1. IN THE MEAT PRODUCT INGREDIENT LIST

Ingredients are every substance (including food additive) that has been used during the manufacturing or processing of a foodstuff and that are still present in the final product even if in another form (LIVSFS 2004:27).

Topical meat ingredients have been selected from the ingredient lists of Lindell´s meat products. Blood protein is not used by Lindell´s but came up in a discussion at Lindell´s and awoke interest. Lindell´s use regenerated smoke from condensate (see smoke aroma) when smoking their products, when this project was performed smoke aroma did not have to be added to the ingredient list when using regenerated smoke. However, from January 20th 2011 it has to be included in the ingredient list and because of that it was more deeply looked at here.

2.1.1. NITRITE/NITRATE

Salt has been used to preserve meat since ancient time. Addition of salt to meat for this reason is to cure the meat. In the 19th century people realized that some salt had better effect than others. The reason for this was the contamination of saltpeter (KNO_3) in some salts, which improved the preservative properties and gave the product a red color. The nitrite formation from nitrate was found to be the curing agent (late 19th century) and the chemistry behind the coloring effect was revealed going into the 20th century. Nitrite was introduced into meat products processing only a few years later. Nitrite though is about 10 times more lethal than nitrate and was in the beginning added in to high amounts mostly due to mix-up with salt or sugar, causing intoxication and death. The solution to this was found to be curing salt; nitrite mixed in sodium chloride at a level of about 0.6% nitrite. This is nowadays regulated by EU law; curing salt is the only form of nitrite allowed to be added to meat products. Curing salt is also the only form of nitrite allowed to be sold for food-use (Honikel, 2008; LIVSFS 2007:15).

As mentioned above, nitrate need to be reduced to nitrite before having curing properties in meat products. The reduction is done by microorganisms and takes time. Nitrite is therefore added directly into most modern meat products to save time. In some traditional meat products where curing last for a longer period (e.g. dried sausages and hams) nitrate is still added, this to make sure a nitrite source are available during the whole process (Sebranek, 2009).

Nitrite and its functions and properties in meat are not easily understood. Nitrite is a highly reactive compound with many possible reaction pathways; it can be converted to a variety of related compounds in meat e.g. nitrous acid, nitric oxide and nitrate. Nitrite has multiple effects in meat products; it is responsible for the pink color of cured meat, the cured flavour, antioxidative protection of cured flavour and bacterial inhibition (Honikel, 2008; Sebranek, 2009). The cured color is formed by a reaction between nitric oxide (formed from nitrite) and myoglobin in the meat. They form the bright red complex nitrosylmyoglobin. When heating nitrosylmyoglobin the pink color is formed, this color is stable even though the globin protein denatures during the heating process. Nitrosylmyoglobin is relatively stable in the absence of oxygen. But it is, especially under aerobic conditions, sensitive to light. An antioxidant is often added in combination with nitrite. The antioxidant favors the reduction process of nitrite to nitrogen oxide. The complex nitrosylmyoglobin forms more readily in the surplus of nitrogen oxide. A reductant can also help in converting metmyoglobin to the deoxymyoglobin state; needed for the curing complex to form (Schwartz et al., 2008).

Reductants and pH are the two main factors controlling the curing process in meat products. Addition of reducing compounds speeds up the curing process (Strasburg et al., 2008). Some of the nitrite added in meat products ends up as nitrate in the meat product, this after acting as an antioxidant hindering the development of a rancid flavour in the product (Honikel, 2008). Nitrite´s complete effect on flavour and bacterial inhibition is not fully known but it is believed that the process mentioned above and the intermediate forms included have effect also on those characteristics. Nitrite's practice antibacterial effect on anaerobic bacteria, most importantly *Clostridium botulinum* but it also controls *Listeria monocytogenes* (Sebranek and Bacus, 2007).

The regulation for nitrate and nitrite are a bit special compared to other food additives since they do not remain unchanged during processing. Both the ingoing and residual amounts of nitrite and nitrate are regulated by law. Nitrite and nitrate addition are only approved for meat products. Maximum 150-180mg/kg for nitrite and up to 300mg/kg for nitrate (expressed as $NaNO_2$) are allowed to be added in processing, the different amounts applies to separate meat products where the curing salt is added to the meat in different ways (e.g. dry cure, immersion curing, injection curing) (LIVSFS 2007:15).

In EU the permitted level of nitrite addition is lower for organically produced meat products than for conventional ones, and also type of nitrite/nitrate allowed to use are further specified. However, the use of nitrite and nitrate in organic meat products shall be re-examined before the end of 2010. The perspective is that they shall be withdrawn from the approved list of meat additives for organic products. During re-examination research developments of possible replacers and processing steps to exclude nitrite/nitrate will be reviewed. (EEC 2092/91) In the US nitrite and nitrate addition are not permitted at all in organic meat products. This has led to research and development of alternatives to nitrite in meat products (Sebranek and Bacus, 2007). An alternative used in organic products have been naturally produced nitrite. Rich natural sources of nitrate are added to the meat product (e.g. sea salt, celery) in combination with a starter culture to speed up the reduction of nitrate to nitrite, which act as the curing agent. This method results in cured meat products in the same way as synthetically added nitrite without having to write nitrate or nitrite in the ingredient list.

Problems that arise with using rich natural sources of nitrite are uncertainty concerning the nitrite amount in the product. Amount of nitrite decides how long the product will have the special curing characteristics, which have been shown to diminish with time and depletion of nitrite in the product. This diminishment is especially of concern for the antimicrobial effect of the nitrite, where naturally nitrate treated products might pose a higher risk for botulism. In most cases the nitrite is anticipated to be lower in the naturally cured products but since the nitrite pathway is complicated nitrite levels might also be higher than in conventional products increasing the risk for N-nitrosamines formation (Sebranek and Bacus, 2007). The problem in finding one ingredient or technology that can replace both quality and safety functions of nitrite in meat products are discussed by Sindelar and Houser (2009), ingredients or additives that give antimicrobial effect like nitrite or the stable pink color have been found, but more research seems to be needed before the mystery of nitrite and curing are solved and nitrite can be replaced.

Both exogenous and endogenous sources of nitrite and nitrate make up for the amount in the human body. Exogenous sources, except for meat products, are the natural amounts in vegetables such as lettuce, spinach, celery, beets and drinking water. Acceptable daily intake (ADI) of nitrate is 3,7mg NO_3^-/kg bodyweight and for nitrite 0.06 mg NO_2^-/kg bodyweight. Nitrite can be produced from nitrate in the stomach. Nitrite plays an important role in several normal body functions. Concerns have come up regarding the possibility of nitrite and nitrate to form nitrosamines in the acidic environment of the stomach-intestinal canal and the carcinogenic effect of these. Still there are no definite answers but the International Agency for Research on Cancer (IARC) has classified nitrite and nitrate that can form nitrosamines as probably carcinogenic for humans. Another health effect of nitrite and nitrate is their bonding to red blood cells. Transformation products of nitrite can bind to red blood cells, blocking them from transporting oxygen in the blood. Small children are especially sensitive to this. The actual intake level of nitrite is critical and difficult to be sure of since humans produce nitrite themselves in the body. Nitrite reacts in the body, forms from nitrate and is consumed both as an additive and naturally. Some people groups may exceed ADI (Average Daily Intake). The National Food administration in Sweden (NFA) recommends a general lowering of nitrite- and nitrate intake (Sebranek and Bacus, 2007; Sindelar and Houser, 2009; SLV, 2010a).

2.1.2 Glutamate

Ingredients made up of protein hydrolysates (soy or fish sauce) or ingredients naturally high in free amino acids (e.g. tomatoes, mushrooms and cheese) have been used in cooking for many centuries all over the world to enhance the sensory properties of the food. The ingredients had flavour enhancing and palatability increasing effect. In Europe anchovy paste or sauce was used for this purpose. The taste was in Japan described as umami. In 1908 a Japanese scientist, Ikeda, identified glutamic acid as the source of the umami taste (Bellisle, 1998; Yoshida, 1998). Umami is now recognized as the fifth taste (sweet, sour, bitter, salty and umami) Glutamic acid and aspartic acid (also called glutamate resp. aspartate) are the two amino acids that elicit umami taste responses in humans (Berg et al., 2007). Umami taste help to improve flavor in food, by adding meaty and savory flavors. Glutamate occurs naturally in most foods. Glutamate needs to be in free form in the food to give umami taste, protein-bound glutamate are tasteless. Protein hydrolysation through fermentation, ageing, ripening and heat cooking will increase the free glutamate content of food. Large amount of both free and bound glutamate are found in vegetables, seafood, meat and cheese and contributes to its taste characteristics (Jinap and Hajeb, 2010; Yoshida, 1998).

Glutamates are additives and grouped as taste enhancers. Salt of glutamate is frequently added to food to enhance the original tastes of the food; a taste enhancer. The salt that is most common as well as most studied are monosodium glutamate (E621), it is used as a taste enhancer in both processed food and home cooking (Bellisle, 1998). Other glutamates used as taste enhancers are monopotassium glutamate (E622), calcium glutamate (E623), monoammonium glutamate (E624) and magnesium diglutamate (E625) (LIVSFS 2007:15). The salts disperse in the food matrix and free glutamate appears in the food. Added glutamate improves the palatability and taste of the food to which it is added.

There is an optimal glutamate concentration for each food; an increased glutamate concentration over this limit does not increase the palatability further, rather decrease it (Beyreuther et al., 2007; Jinap and Hajeb, 2010). Glutamate intake from food in European countries range between 5 to 12g/day, about 0.4g of these is from added glutamate. The concentration of glutamate in convenience foods adds up to 0.1-0.8% of weight, this is similar to the free glutamate concentration in tomatoes or parmesan. Glutamate is metabolized in the lumen as are other amino acids. There is no difference between the uptakes and usage of naturally occurring and added glutamate in the body (Beyreuther et al., 2007).

Addition of glutamate can be used to stimulate appropriate food choices and increase nutritional status of elderly people. Glutamate can be used to increase the palatability of fat-reduced and/or sodium chloride reduced food. Addition of glutamate can maintain palatability of these products and make them more competitive on the market. Elderly people could benefit from adding glutamate to their food, glutamate make their food tastier and compensate for the losses in taste that develop with age (Beyreuther et al., 2007; Jinap and Hajeb, 2010). It has been suggested that since glutamate addition increase palatability of food it could cause overweight and obesity. Very little research has been done on the subject. The expertise does not agree and further research is needed before any conclusions can be drawn (Jinap and Hajeb, 2010).

Glutamate ingestion has been proposed to cause what is called “the Chinese restaurant syndrome”; a feeling of discomfort or asthma after eating glutamate containing food. It originated in the 1960s when persons having ingested Chinese cuisine felt ill, it was believed that glutamate was the cause. This has been debated ever since, several reviews (Beyreuther et al., 2007; Jinap and Hajeb, 2010; Kenney, 1986) concludes that it still do not exist proof that glutamate is the cause of these reactions. No double-blinded studies have been able to show reproducible results. NFA suggests that "the Chinese restaurant syndrome" might be caused by the intense spiciness of this type of food (SLV, 2010b). Glutamate has been concluded to be safe by the EU, no limit for acceptable daily intake is set and glutamate is allowed to be added in "quantum satis" (no upper limit) in most processed and flavored foods but not at all in food for children (LIVSFS 2007:15).

Glutamate has since being proposed to cause "the Chinese restaurant syndrome" brought a bad reputation to its name, the current "dangerous additive discussion" have further increased this. Today there is a trend in meat processing and food processing to decrease the amount of additives; "clean labels". This is also something many consumers wish to see after the additive debate (Campbell's, 2010; Nilsson, 2008; LIF, 2009; SVT, 2010). Alternative enhancers have with this gained market space, as mentioned many foods are naturally rich in free glutamates. Some of the natural glutamate sources found in the ingredient lists today are yeast, soy sauce and hydrolyzed vegetable protein, these are classified as ingredients instead of additives and therefore do not have E-number identity. Yeast can be used as yeast extract, yeast autolysis (partly self-degraded yeast) or inactivated dry yeast. It contains glutamic acid and have both a taste enhancing and taste bearing effect and also contributes with an own taste. Yeast extracts are soluble and suitable for use in stocks, soaps and sauces. Autolysis and dried yeast are not as soluble and can be used in e.g. seasoning mixes, snacks and meat products (Hegenbart, 1998; LIF, 2009; Sydsvenskan, 2010).

2.1.3 Blood protein

Blood protein is a meat-derived ingredient. It is a byproduct from slaughtering. The blood is collected immediately after slaughtering and an anticoagulant such as citric acid or sodium citrate is added. It is then centrifuged in order to separate the plasma (60%) from the cells (40%). Both porcine and bovine blood is used. The plasma is usually spray-dried. Dried blood plasma protein consists of about 70-95% protein (differ with animal species and age) and is an off-white powder almost void of pigmentation. Blood plasma protein (BPP) has none of the side-effects found for hemoglobin (e.g. off-flavour). BPP is a rich and nutritive protein source. The functional properties of BPP proteins combined with its economical advantage over other proteins give BPP a widespread usage area (Álvarez et al., 2009; Dávila et al., 2007; Guzman et al., 1995; Silva and Silvestre, 2003; Tarté, 2009).

Blood plasma protein is a diverse mix of about 100 different proteins. The typical composition is albumin 50-60%, globulin 40-50% and fibrinogen 1-3%. The properties of BPP are a sum of the individual proteins properties, the interactions between them and their surroundings (e.g. pH, protein concentration, temperature and cooking time). BPP gelling, emulsification and solubility properties make them useful as ingredients in meat products. Usage level of BPP in meat products are 0.5-2% depending on the product (Dávila et al., 2007; Tarté, 2009).

The pigmented part of the blood, the erythrocytes (red blood cells) ends up in the cellular fraction. The main protein source here is hemoglobin that contains almost 70% of the total protein in blood. The use of this fraction as ingredients in meat products are limited, mainly due to its dark color and the off-flavour it impart. Hemoglobin can be decolorized, but some reddish color will still remain. The methods tried so far have also had negative side effects on the protein. In Sweden and some other countries hemoglobin is used as a color enhancer in meat products (e.g. SCANs Hotdogs and Småländska isterband (fermented sausage)). Hemoglobin has also been proposed as a nitrite alternative but is yet not commercially used for that purpose (Álvarez et al., 2009; Dávila et al., 2007; Guzman et al., 1995; SCAN, 2010; Silva and Silvestre, 2003; Tarté, 2009).

Blood and products of it are not included in the ingredient category definition of meat (LIVSFS 2004:27), it has to be specified as blood or blood protein in the ingredient list followed by species, e.g. blood protein from pork (SLV, 2010d).

BPP could be used as a fat replacer in low-fat meat emulsion. The quality of fat reduced sausages has been seen to benefit from the addition of BPP. The sausage showed increased water holding capacity and reduced textural problems (Cofrades et al., 2000). Since BPP is a meat-derived ingredient it is non allergenic and could be used as replacement for other commonly used proteins such as soy and milk (Tarté, 2009).

BPP can further be fractioned into its protein group's albumin, globulin and fibrinogen. These can be used separately for their specific properties or be combined in other proportions to meet specific requirements for a certain product (Cofrades et al., 2000). Fibrinogen is used together with thrombin (a proteolytic enzyme) to reconstruct meat pieces into bigger parts, under the name "Trombin". Both fibrinogen and thrombin are derived from the blood plasma. It has been discussed under the name "meat glue" in Sweden. The preparation is applied to meat where the thrombin transforms fibrinogen to fibrin which form a gel, reacts with collagen and bind together meat pieces to the required form or shape. The binding is "cold-set" (chemical), no heat treatment is needed for gel formation and the meat product can for example be sold raw and chilled or marinated. This method could be used to replace phosphate as a binding agent in meat products.

"Trombin" was classified as an additive in the EU, in the category stabilizers, and therefore needed to be approved before use. The European Food Safety Authority (EFSA) was asked to perform a risk analysis and found no safety concerns with its usage. The European commission voted yes with restrictions that it could not be used in large-scale catering establishments. The European Parliament voted in February 2010 no to usage of "Trombin" in the EU. Their main argument was the risk for consumer misleading. Consumers could be fooled to think reconstructed meat were in fact intact muscles. In the US "Trombin" addition is allowed under the name "Beef fibrin" in meat and poultry. Depending on how much beef fibrin that is included "Formed with Beef Fibrinogen and Thrombin" should be included either in the product name (7-10%) or in the name qualifier (<7%) (Berg et al., 2007; Boles and Shand, 1998; DN, 2010a; DN, 2010b; EFSA, 2005; Tarté, 2009; USDA- FSIS, 2010).

2.1.4 Phosphate

There are at least 10 different specific phosphates that can be used in meat products, they differ in properties (pH and solubility) and thus also in application. Phosphates are salts (potassium or sodium salts) derived from phosphoric acid. Phosphates can be separated into 4 groups; orthophosphates (single phosphate unit), pyrophosphate (di-phosphates), tripolyphosphate (3 phosphate units) and polyphosphate (about 10-25 phosphate units). Phosphates are allowed to be added to meat products in the order of 5g/kg (expressed as P_2O_5) (LIVSFS 2007:15; Ruusunen and Poulanne; 2005; Sebranek, 2009; Xiong, 2005).

Traditionally phosphate has been added to meat products to increase its water-holding capacity and stability. Increased water retention has several positive effects on the meat product such as improved texture, tenderness, juiciness and cooking yield. Phosphates increase water retention in several ways. It increases pH and ionic strength, which increases protein repulsion between myofilaments leading to higher water retention of the cells. Phosphate also has the ability to remove transverse proteins (cross-bridges) in the myofibril structure which otherwise act as constraints against myofibril expansion (LIVSFS 2007:15, Ruusunen and Poulanne; 2005; Sebranek, 2009; Xiong, 2005).

Addition of phosphate in meat batters has a positive effect on emulsion stability and yield. Sodium tripolyphosphates seems to be the most effective one for this purpose (Barbut et al., 1988). Phosphates have an antioxidant effect in meat products, preventing off-flavors and stabilizing color. The reason is phosphates alkalinity and their chelating ability that binds metallic ions (Liu et al., 1992).

Phosphate can be used to lower the sodium chloride level in meat products. Sodium chloride level of sausages can be lowered to 1.0-1.4% if phosphates are added. Many phosphate salts are sodium salts, they add some sodium to the product but sodium tripolyphosphate, for example, contains about 8 percentage points less sodium than sodium chloride. Phosphates are in addition used in much smaller quantities, typically 0.5% compared to 2-4% sodium chloride. Potassium phosphate can, however, be used to even further reduce sodium content without negatively affecting quality. Quality is maintained since phosphates act synergistically with sodium chloride enhancing its properties (Hand et al., 1982; Ruusunen et al., 2002; Ruusunen and Puolanne, 2005; Sebranek, 2009).

2.1.5 Smoke Aroma

Smoking of food has been done for centuries, originally as a preservation technique. The keeping qualities were prolonged partly by drying and partly by the addition of antimicrobial agents like phenols from the smoke. Nowadays smoking is mainly used to give the characteristic smoke taste, texture and appearance to the food. Its function as a preservative is only minor since so many other preservation techniques are available (EC, 1992; Rozum, 2009).

The composition of smoke depends among others on the burning temperature, the kind of wood used, the water content of the wood and the accessibility of air (EC, 1992; Rozum 2009; Simko, 2002). The smoke comes in direct contact with the foodstuff during the smoking and the substances of the smoke will attach to the surface and some will also penetrate the food. These processes give smoke flavor and appearance to the food but it is also the reason for the health issues linked to smoked foods (EC, 1992; EC 1995).

Smoke is generated from thermal pyrolysis of wood when there is a limited access of oxygen. During pyrolysis cellulose and hemicelluloses are decomposed to acids and aldehydes and lignin to phenols and tars. The acids contribute to the smoke´s overall flavour, its tartness, antimicrobial activity, and they accelerate the nitrite curing process. The aldehydes in smoke cause surface browning (Maillard reaction; aldehydes in the smoke react with amino acids in the meat product) to the meat product. Incomplete breakdown of lignin results in tar and the complete breakdown in phenols. The phenols are the foremost taste contributors in smoke and also the main components for antimicrobial and antifungal activity (Rozum, 2009).

Smoking of food is done either traditionally by direct or indirect smoke, by smoke condensates or by a combination of these two. In direct traditional smoking is the foodstuff exposed to newly generated smoke from the open fire of burning hardwood underneath it. This process is difficult to control and standardize (e.g. temperature, humidity and smoke density), something that is needed since the smoking process has moved from the households to the food industry where higher demands of uniformity often are set. Uncontrolled smoking causes food quality issues like uneven smoking and nutritional concerns like higher levels of PAHs in the smoke and food. In indirect traditional smoking are the fresh smoke produced in a separated smoke generator and thereafter lead into the smoke chamber. Indirect smoking giver rise to a better control than the direct method and also the possibility to treat or clean (e.g. remove some of the PAHs) the smoke before it enters the smoke chamber. The level of control is in spite of this to low. Indirect smoking give rise to side effects like lowered smoke effect due to removal of too many substances and formation of new unknown substances due to treatment. One solution to the problem with uncontrolled smoking is the usage of smoke condensates (EC, 1992; EC, 1995; Wretling et al., 2010).

Smoke condensate is produced by letting smoke condense (move into liquid phase), this condensate is then fractionated into 3 parts: water based primary smoke condensate, water-insoluble high-density tar phase and water-insoluble oily phase. The water-insoluble liquid phase is unfit for use but the water based primary smoke condensate and fractions of the water-insoluble high-density tar phase (the primary tar fractions) are further processed. Next step is purification to remove components that are a risk for human health. Most of the PAHs are removed in this step. Remaining afterwards are primary products of smoke condensate, these can be used as they are or further processed and mixed with additives, aromas, emulsifiers etc. (EC 2065/2003; SLV, 2010c).

Each primary product has to be evaluated and approved by EFSA and added to the authorized primary product list before usage (EC 2065/2003). The products stemming from the condensate are called smoke flavorings and have many possible applications. They can be used in a smoke chamber combined with heat to mimic the smoking process, be sprayed, dipped or brushed on the product or blended directly into the food (EC, 1992). The usage of smoke flavorings instead of traditional smoking is generally considered to induce a smaller health concern. However it still imparts some health concerns and therefore is its wider usage applications in foods that are normally not smoked (e.g. in soaps, sauces and confectionary) taken into account when they are approved (EC 2065/2003; EFSA, 2010).

Smoking in regenerated smoke has been proposed to have positive environmental effects compared to traditional smoking because it releases less emission and causes less wastage handling. The waste (e.g. charcoal) is produced in fewer places (the production places of condensate) (Rozum, 2009; Wretling et al., 2010). The flavors given from smoke flavoring are more or less the same as the one from traditional smoking, but the meat product will not get the smoking texture and color if smoke flavoring are not added in a chamber combined with heat. Addition of smoke flavoring instead of smoking can reduce both production time and waste (EC, 1992).

The labeling regulations for smoke flavorings differentiate depending on how they have been added. If regenerated smoke aroma condensate has been used in a chamber to mimic the traditional smoking process smoke aroma does not have to be stated in the ingredient list and the product are also allowed to be called smoked, like after traditional smoking. If smoke flavoring has been added in any other way (spraying, dipping etc.) smoke aroma has to be noted in the ingredient list and the foodstuff is not allowed to be called smoked but the expression "with smoke taste" are allowed. From 20th of January 2010 when the new aroma directive 1334/2008 come into force all types of addition of smoking flavors shall be noted as smoke aroma in the ingredient list (LIVSFS 2004:27; SLV, 2010c).

One health concern with smoke is polycyclic aromatic hydrocarbons (PAHs). It is a group of compounds consisting of two or more aromatic rings linked together. Some of them are known to be carcinogenic (Duedahl-Olesen et al., 2006; Simko, 2002). PAHs are formed during incomplete combustion of organic material like wood, coal or oil. General daily intake of PAHs in Sweden according to the NFA is 2.75µg (SLV, 2010f). Food groups contributing to this intake are fats, cereal-, and smoked products and to a minor extent drinking water. PAHs in meat products are mainly formed during processing (e.g. smoking, drying, cooking) and during domestic preparations (e.g. barbecuing, frying and roasting). The main part of the PAHs in smoke is in the tar.

PAHs is a large group of compounds and all are still not risk assessed, one that is known to be carcinogenic is benzo[a]pyrene (B[a]P). B[a]P is used as a marker of the level of carcinogenic PAHs in food (Duedahl-Olesen et al., 2006; Rozum, 2009). The legal limit for smoked meat and meat products is 5µg/kg wet weight, food produced for children shall not exceed 1µg/kg (EC 208/2005). The content of PAHs in the smoke can be reduced through the choice of source material, smoke generating temperatures below 400°C, indirect smoking, avoiding open fire, reduced smoking time and by optimizing the moisture and air supply (EC, 1992). For products treated with smoke aroma or condensed smoke is the limit of B[a]P 0.03 µg/kg (EEC 88/388).

In a survey conducted by the NFA in 2006-2007 the level of PAHs in smoked Swedish meat was examined (Wretling et al., 2010). 38 samples of smoked (traditionally smoked in different ways) meat and meat products were analyzed for their B[a]P levels to see if they exceeded the maximum EU level. Most of the smoked products had B[a]P levels well under 5µg/kg, the exceptions were products from northern Sweden smoked in so called sauna smoking method where 9 out of 10 exceeded the B[a]P level and showed between 6.6 and 36.9µg/kg. Overall the PAHs level in Sweden was satisfying, but for the sauna method some actions to lower PAHs needed to be taken. The lowest level had products smoked by indirect smoke (<0.3µg/kg), this is still 10 times more than the upper limit for products smoked in regenerated smoke from condensate (EEC 88/388).

2.2 Food product development

Successful new product development can stop the down spinning trend of "price war" experienced by many food producers. It can do so by help meeting the new and differentiated demands from the consumer, by creating new competitive edges and by making it more difficult for retailers to substitute one supplier for another (Grunert and Valli, 2001). There are several different kinds of "new" food products where a product development process could be used. They can be separated in to the following categories: (Linnemann et al., 2006)

- Me-too products – a product that is basically the same as another one but produced by another company. (The largest group of new food products)
- Line extensions – new variants of a well known product e.g. a new flavor. Demands relatively little time and effort and usually no major changes in process or distribution.
- Repositioned existing products – current products that are promoted again. An example could be a margarine that due to attention to health aspects was repositioned because it was a rich source of vitamin E.
- New form of existing product – existing products that have been altered into another form (e.g. dried, solved, frozen or concentrated). One example could be dried soups.
- Reformulation of existing products – known products with a new formula. Reasons could be to reduce ingredient costs or include new ingredients with improved characteristics to get a product with better color, flavor, shelf life or less fat etc.
- New packaging of existing product – current products with new packaging concepts. E.g. prolonging shelf life with modified atmosphere packaging or packaging for a new application like microwave packaging.
- Innovative products – known products changed in other ways than the ones mentioned above. One example is the "ready-to-cook" product with frozen berries and pastry on a tray. '

- "True new products" – products newly brought into existence; never-before seen products. These products have the highest risk of failing.

Between 60 and 80 % of all new products on the consumer food market fail (Grunert et al., 2004). The most successful category is line extensions which offer variation in taste, they pose about 65% of the successful new products. The success rate is higher for bigger companies than for smaller ones (Lord, 2000, cit. Linnemann et al., 2006). The previously used method of trial-and-error in product development is now replaced by more structured processes (Linnemann et al., 2006). Product development that is based on consumers needs and wishes are more likely to be successful. Consumer-driven product development is a necessity for companies that wish to stay in business. Necessary is also the cooperation between marketing and processing staff for successful application of the consumer thoughts into the process (Grunert et al., 2004; Linnemann et al., 2006).

The concept of food quality in the consumer point of view has widened in the past years. In the past the consumers wanted value for their money in the form of attractive foods, convenience and variety. Nowadays consumers also consider nutrition, food safety, processing methods and societal and environmental effects of the product. This is probably because of improved information supply and better education that have made consumers more knowledgeable. This has made consumer led product development even more important with constantly new quality aspects to incorporate and possibilities to strengthen your brand and company (Earle, 1997; Linnemann et al., 2006).

A general food product development process can be divided into four stages. Between each stage the top management should make a decision to take the process to the next stage (Earle, 1997).

1. *Product strategy and planning*. Analysis of consumer, market, scientific and technological progress. It is of most importance with collaboration between the market- and processing research. The outcome should be ideas of possible products to develop; identification of project.

2. *Creation, design and development of product*. The project is started up. Choice of product and develop product and process design. The outcome should be a product concept, its design (prototype) and a flow chart including the process conditions.

3. *Production process, marketing strategy, quality assurance and commercial product*. Testing of the product, defining the market, manufacturing of production process, making of a hazard analysis and defining critical control points, marketing planning and financial analysis. The outcome should be the final product, the production method, hazard control and a financial report.

4. *Launch and post-launch*. Launching on the market, studies of product quality and process efficiency, studies of buying behavior and consumer attitudes. The outcome should be repeated purchase of consumers, advance of product and process and improvement of product positioning and marketing.

The four stages above cover the development of a completely new product innovation and some of them can be neglected if for example a product improvement is preformed.

2.3 Labeling of meat products

The marking on the label of meat products is controlled by directives from the EU through directives from the NFA. The marking directives exist to make it easier for the consumers to make informed choices when buying foodstuffs. Marking is every word, information, brand, brand name, illustration or symbol regarding a foodstuff and which is on its package, label, document, sign, message, neck ring or cape which are attached to the product, accompany the product or directs to the foodstuff. The following information needs to be included in the marking of prepackaged foodstuff (LIVSFS 2004:27):

- valid name and description
- ingredient list
- amount of some ingredients or categories of ingredients
- net weight
- best before or last day of consumption
- special directions for storing or usage
- name of producer, packer or seller and their address
- origin
- manual of usage
- alcohol strength

Marking of food is a wide and diverse subject and in this study focus is on the sections relating to ingredients of meat products. As mentioned earlier, ingredients is every substance (including food additives) that has been used during the manufacturing or processing of the foodstuff and that is still present in the final product even if in another form, but there are also some exceptions. A component that is removed from the foodstuff during processing and then later added in an amount that does not exceed the original does not have to be included in the list, neither does additives that occur in one or more of the ingredients but have no technological function in the current foodstuff. Additives used as process aids or other substances used as processing aids that remain in the final product in another form are excluded from the definition of ingredients. So are also carriers and solvents of additives or aromas. However, all ingredients that are classified as possible allergens have to be specified in the ingredient list, some examples are cereals, egg, soybeans, milk, nuts and celery (LIVSFS 2004:27: SLV, 2010d).

An ingredient list does not have to be added to the marking of foodstuffs with only one ingredient if the ingredient is part of the name or description of the product. The ingredient list should include all ingredients in descending order sorted after their weight at the start of manufacturing. The list shall be preceded by an appropriate heading including the word ingredient. Added water needs to be included in the ingredient list if the amount in the finished foodstuff exceeds 5% of weight. Ingredients that constitute less than 2% of the finished foodstuff do not have to be added in descending order and should be placed after the rest of the ingredients (LIVSFS 2004:27).

Some type of ingredients can be summarized in the ingredient list with its category name. One of the categories is spices; this can be used when a mix of spices is used and as long as none of them constitute more than 2% of the weight of the finished foodstuff. Another category is meat (followed by species), this category can only be used when meat is used as an ingredient in a composed foodstuff. The meat category includes in this case skeletal muscles (with some exceptions) from mammals or birds with a total level of connective tissue and fat that does not exceed the stated amounts. If, for example, the stated amount of fat in pork is exceeded, fat has to be added as a separate ingredient in the list. Mechanically recovered meat (meat that has been mechanically removed from the bones either through separation by pressing the grounded bone/meat mixture through a sieve or by high pressure treatment, for further reading Lawrie and Ledward, 2006) is not included in the meat category and shall not be included in the stated meat content (LIVSFS 2004:27).

Additives shall be specified in the ingredient list with their function (one of the function classes specified) followed by the general name of the additive or the E-number. If the additive has more than one function in the product, the most important function shall be noted (LIVSFS 2004:27). E-numbers for all approved food additives can be found in the E-number key issued by the National Food Agency (SLV, 2010e).

If the amount of the ingredients should be noted on label has to be decided for each case. If the ingredient is part of the name or description of the product or if it associated with the product by the consumers then the amount should be noted on the label. It should also be noted if the amount of the ingredient is crucial for the buying or have economic or nutritional impact. The meat content of sausages falls under this definition and so does also for example liver in liver paté. The content noted should be content originally added during the process and should be stated in percentage by weight (LIVSFS 2004:27; SLV, 2010d).

Fat content (percentage by weight) falls under another directive and has to be added to the marking of pre-packed processed products (minced, heat treated, smoked, salted, seasoned, dried, marinated etc.) from meat that contains at least 20% meat (3.2gram meat protein/100g product). Whole meat products are not included (LIVSFS 2002:47).

2.4 Theory of the production of fermented sausage

Fermented sausage is a product with large diversity both when comparing different parts of the world and when looking nationally. Local traditions due to climate, meat sources and other specific conditions have contributed to this. Characteristic for all are the combination of lactic fermentation, salting and drying (Adams and Moss, 2008).

The manufacturing of fermented sausage is very complex and several internal and external parameters interfere with the color, taste, aroma and texture of the end product. Some examples are: a_w, pH-value, relative humidity (RH), buffering capacity of proteins, presence of nitrite/nitrate, temperature, air velocity, ripening time, smoking/non-smoking, type and level of meat used, level of fat, level of salt, type and amount of sugar, spices, type of starter culture, particle size of meat and fat, type and diameter of casing, mixing system (Feiner, 2006).

2.4.1 Ingredients

The quality of all the ingredients is very important when producing fermented sausage. Unwelcome microbial flora can interfere with the fermentation process giving rise to unsafe products. The general composition of a European-style fermented sausage is: (Adams and Moss, 2008; Feiner, 2006; Lindahl, 2010; SLV, 2003)

- Lean meat, 55-70%
- Fat, 25-40%
- Curing salt, 3%
- Fermentable carbohydrates, 0.4-2.0%
- Spices and flavoring, 0.5%
- Starter culture, ascorbic acid, etc., 0.5%

Other possible ingredients are

- gels of soy isolates to replace meat (cost-effective) or fat (low-fat products)
- a white-colored cooked emulsified sausage made from e.g. chicken meat and starch to replace fat (low-fat products)
- potato (due to tradition, exclusively for Sweden)
- phosphate to promote easier filling, make the paste flow better (be more slippery) and reduce the risk of fat smearing
- acidulants, e.g. glucono- δ- lactone (GDL) that hydrolyses to gluconic acid in the sausage, help secure acidification either alone or in combination with lactic acid bacteria
- surface yeast and mold

The type and amount of fermentable carbohydrates can be adjusted to control rate and extent of acidification. A larger amount of sugar causes an increased pH drop. Meat itself contains a certain amount of sugar. In addition to this are sugars usually added. Glucose can be directly fermented into lactic acid and is the fastest fermentable sugar, sucrose needs to be split into monosaccharides before they can be turned into lactic acid; it is the second-fastest sugar. Maltose and lactose require longer time. The fermentation rates are depending partly on how the sugar units are bonded to each other, but also on the fermentation pattern of the bacteria. Glucose, for example, can be fermented by all lactic acid bacteria, while sucrose can be fermented by about 85% and maltose by around 70%. Generally 0.1% or 1g of dextrose (pure glucose) per kilo sausage lowers the pH by 0.1 pH unit. A mix of sugars is usually added to the sausage not only to control acidification but also to contribute to flavor. To get a reliable and consistent fermentation of the sausage a starter culture is added (Feiner, 2006).

A starter culture consists of selected bacteria chosen for their positive properties contributing to acidification, color and flavor. It is added in the range of 10^7 CFU (culture forming units) per gram sausage in a freeze-dried, frozen or liquid state. The most important genera used in fermented sausage are *Lactobacillus*, *Pediococcus, Staphylococcus* and *Micrococcus*. Members of the family *Lactobacillus* are the most significant microorganisms in the starter culture since they are the main acidifiers. Some *Pediococcus* species are used as acidifiers in sausage fermented at high temperatures (40°C). *Pediococcus* have proteolytic properties and contribute to the sausage flavor. Generally *Micrococcus spp*. and *Staphylococcus spp*. are only mild acidifiers and are added for their contribution to color, aroma and flavor. They produce nitrate reductase that reduce nitrate back to nitrite, by this they are important for obtaining and stabilizing a strong curing color and flavor of the sausage. Some species also have proteolytic and lipolytic properties that contribute to the typical flavor of fermented salami. Combinations of these different types of bacteria are usually added to get the desired sausage. There are cultures on the market specifically put together for fast (1-2 days), medium-fast (2-4 days) and slow (several weeks) fermentation times. In slow-fermented salami though are the cultures not starters that contribute to acidification but rather protective or competitive cultures. They are added to inhibit growth of undesirable bacteria until a_w has decreased to 0.95. Acidification is performed by lactic acid bacteria naturally present in the meat (Feiner, 2006).

2.4.2 Manufacturing process

The temperature during the manufacturing of the sausage is very important. The fat is usually added frozen to keep a low temperature in the mix and also to avoid fat smearing. Clear and sharp white fat particles are wanted in the finished sausage, fat smearing would also decrease the drying of the sausage by hindering water emission. Meat is added in a semifrozen or chilled state to keep a low temperature and to keep the fat particles frozen on the surface. The final temperature of the batter shall be between -4 and -1°C. The manufacturing can take place in a bowl cutter, where all the ingredients are added, minced and mixed. Or the ingredients can be separately minced and then mixed together in a mincer-mixing system. The last-mentioned has the advantage that all meat and fat particles are of exactly the same size. This is not the case in the bowl cutter. It is very important that all the ingredients are uniformly mixed otherwise the fermentation could be uneven and cause an unsafe and bad sensory quality product. After mixing the batter should, without too much delay, be filled into the permeable casings. If the batter is left to stand for too long the temperature may decrease under -5°C causing the water in the muscle tissue to freeze. The ice-crystals formed make the filling difficult and also give pores in the final product (Adams and Moss, 2008; Feiner, 2006).

During fermentation the raw and microbiologically unstable sausage is turned into a shelf-stable and microbiologically safe product with strong curing color, good slicing ability and pleasant flavor. Generally, microbiological stability is reached either through drying to a_w of or below 0.89, or by acidification to a pH value below 5.2. Combinations of drying and acidification are also common. Regardless of technique the raw material, the handling and the process that results in the finished product also need to be considered for acquiring microbiological stability (Adams and Moss, 2008; Feiner, 2006; SLV, 2003).

The fermentation process starts with a conditioning period at 16-22°C to level off the temperature differences which will cause condensation on the sausage surface. The temperature is important here to make sure that the lactic acid bacteria are favored. Conditioning shall last just long enough to dry off the condensate and must end in time before case hardening occurs. The temperature is raised in the next step to 22-28°C to optimize conditions for the lactic acid bacteria to grow and produce lactic acid. How high temperature depends on how fast the fermentation shall be. Which also go back to the type of starter culture used. The RH shall during this stage be 2-5% units lower than sausage a_w to ensure drying but avoid case hardening. Some sausages are smoked during fermentation to create the typical smoked color and flavor. The sausage is not smoked until the full curing color has been developed and stabilized usually after 36-48h. The pH need to be below 5.2 to ensure the denaturation of nitrosylmyoglobin and thereby stabilization of color. This is because smoke has a negative effect on the development of curing color. Depending on fermentation time smoke is applied in intervals of 1-3 hours a day until the desired smoke color is reached. The fermentation ends when the sausage pH is stabilized, drying goes on until the goal a_w is reached giving the desired texture. The speed of drying is adjusted by the temperature, air velocity and RH, increasing them increases drying speed. Drying lasts for a few days up to several weeks (Adams and Moss, 2008; Feiner, 2006; SLV, 2003).

The flavor of slow-fermented sausage stems from protease and lipase action on proteins and fat. Fast-fermented sausage is not given the time for this process and the flavor arises from internal acidity and spices. Fast fermented sausages are produced and packed/sold within a week from start of manufacturing. (Feiner, 2006)

2.5 Safety of fermented sausage

Fermented sausage is a product that is exposed to temperature treatments that would be detrimental for other products. And it is not submitted to a heat treatment that kills off the microorganisms. The hurdle principle is instead used to ensure the safety of the sausage. A_w, pH, a competitive micro flora, lactic acid, nitrite, sodium chloride and time and temperature are the most important hurdles (Lake et al., 2003; SLV, 2003).

2.5.1. EHEC

Enterohaemorrhagic Escherichia Coli (EHEC) is a group of *Escherichia Coli* bacteria that produce verotoxin (the group is also called VTEC). The most common one is E. coli O157. Central for the spreading of infection is the presence of EHEC in the intestinal canal of cattle. Food can be contaminated through contact with feces (during slaughtering), irrigation with contaminated water or by infected persons handling the food. In EU, EHEC has been found in up to 13% of the beef livestock's and in Sweden in up to 9%. The infective dose is very small (for sure <100 bacteria, maybe less than 10); therefore growth in the sausage is not necessary. If the meat is contaminated killing the bacteria is crucial. Humans respond differently to an infection by EHEC. It spans from carriers without symptoms to non-bloody/bloody diarrhea, hemolytic uremic syndrome (renal failure) and death. Food that has been connected with EHEC infection is under-cooked minced meat, unpasteurized milk and juice, vegetables and fermented sausages (SLV, 2003).

In the past fermented sausage has been thought of as a safe product. Slow-fermented sausages were produced and EHEC was not considered a problem unless serious faults were made hygienically or process wise. The problem arose with the production of fast or semi-fast fermented sausage where not enough time is given for killing off the bacteria and not enough other obstacles are introduced (Incze, 1998). In Skåne 2002, about 20 persons were infected with EHEC after eating fermented sausage. This addressed focus to the risks with EHEC in fermented sausage and NFA is still performing studies that will result in recommendations for producing a safe fermented sausage. It is not possible to control EHEC through sample-taking, EHEC needs to be controlled through introduction and maintenance of HACCP (Hazard Analysis Critical Control Points) control programs (SLV et al., 2007).
Avoidance of contamination is the most important step for a safe sausage. To achieve this high demands for slaughtering hygiene has to be set. GMP (Good manufacturing processes) and HACCP (Hazard Analysis Critical Control Point) routines should run throughout the whole food chain to avoid contamination. Sampling of E. coli could be performed regularly to signal fecal contamination. The fermentation process should be controlled to avoid growth and to get optimal killing of E. coli. A rapid start of the starter culture is vital to change the conditions and hinder growth. To control this it is vital to know a_w and pH of the sausage batter. The fermentation process gives rise to a combination of conditions (low pH, high level of lactic acid, low a_w) that can hinder growth and cause killing in the sausage (SLV, 2003).

Temperature is the most important factor when it comes to killing of possible EHEC bacteria in the product. A_w and pH are also contributing factors but not the dominating ones. Dying rate is mainly affected by temperature where higher temperature speeds up the killing. However, it is a_w and pH that initialize dying by making the product unfit for growing. Temperatures above chilling temperature (4°C) during storing of the sausage could be used to significantly increase killing rate of EHEC. Killing rate is highest in the span of 15-25°C. However, such storing temperature could cause problems with other microorganisms like *Staphylococcus Aureus* and *Listeria Monocytogenes*. To avoid this, fermentation and growth of lactic acid bacteria are crucial to create competition. The optimal temperatures, times, pH- and a_w levels are difficult to generalize and need to be set for each product (SLV, 2003). A_w of 0.95 are thought to be the lower limit for growth of EHEC (Lake et al, 2003; SLV et al., 2007).

In a plan of action assembled by concerned Swedish authorities (see reference) it is stated that food producers having products that could possibly be infected by EHEC have to show how they ensure avoidance of and manners of killing EHEC in their products (SLV et al., 2007).

2.6 A QUALITATIVE MARKET SURVEY

A qualitative market survey aims at finding a pattern and has none of the requirements for statistical significance as for a quantitative survey. To collect samples or participants are strategic selection and convenience sampling used (Trost, 1997).

Convenience sampling is a common and practical method used for qualitative studies. In contrast to a quantitative study where a homogenous and statistically representative selection is requested a qualitative study requests a heterogeneous and strategically varied selection. To get a strategic selection a number of characteristics (in which variation is wanted) are chosen e.g. gender and age. These are then given categories e.g. men and women, young and old. Convenience sampling is after this process a way to find the samples you need. It means that you take what you happen to find by sweeping the super market or advertize in the local paper. When you find a person that match you add him to your sampling (Trost, 1997).

The open interview form is one type of interviewing used for qualitative studies. The open interview consists of one broad question from which the interviewer asks follow-up questions to widen the understanding of what the respondent want to say (Lantz, 1993).
During analysis of a qualitative study none of the rules accompanied with a quantitative study exist. Adapting, analyzing and interpreting material from a qualitative study is about finding the pattern in the data and no uniform method exists (Trost, 1997).

3. METHODS AND MATERIALS

3.1 THE MARKET SURVEY

The market survey was conducted in two steps; a review of the competitors range of products and a consumer survey. Strategic selection and convenience sampling was used to find the participants.

3.1.1 REVIEW OF COMPETITORS

The review was conducted on the internet using the competitor's homepage and a list of the meat products Lindell´s supply (appendix 1). The competitor's selection of meat products was analyzed and the product groups not produced by Lindell's were noted. Consideration was taken to include companies of different sizes (small, medium, large), of different origin (south, middle and north of Sweden) and with different markets (local, national). Sampling was done through convenience sampling, using general knowledge about the larger producers and using Google.com and the search-word "chark".

3.1.2 CONSUMER SURVEY

The consumer survey was conducted in a local super market (ICA Kvantum) in Lindell's main selling area (Tidaholm) the 1th of October 2010 from 10:00-17:00. Day (Friday) and place was chosen in an attempt to maximize the amount of consumers passing. The food store is the larger of the two food stores in Tidaholm. The survey reached over a full day to catch different shoppers; from morning shopping senior citizens to families with children in the afternoon.

Convenience sampling was used to collect respondents. A wide spectrum of consumers purchasing food in Tidaholm was needed. Notice was taken to get variation of men, women, young adults, middle aged and older. The survey was set up near the meat counter. A taste of one of Lindell's meat products was treated to consumers and the open interview was performed. The question asked was "Which meat product from Lindell's do you miss in the processed meat product counter?" To consumers that replied "I don´t know" at the interview question a questionnaire was handed out (appendix 2) which included five examples of processed meat products (resulting from the competitor review) that they were to pick from and discuss.

3.2 DEVELOPMENT OF A FERMENTED SAUSAGE PRODUCT

A discussion with Lindell´s about what type of fermented sausage they wanted to produce started the development process. In the next step a company that develops meat products and supplies non-meat ingredients was contacted for a first draft of a recipe on Swedish smoked and fermented sausage: "rökt medvurst". A "medvurst" is a fast fermented sausage produced in a few days; this can be compared to salami (another type of fermented sausage) which can take weeks or even months to produce.

Table 1. Ingredients of Lindell´s "rökta medvurst" in descending order down to < 2%.

Ingredients of Lindell's "rökta medvurst":
Pork meat
Beef meat
Pork back fat
Water
Curing salt
Dark syrup
White pepper
Black pepper
Nutmeg
Ginger
Dextrose
Sodium ascorbate (E301)
Starter culture

The content of the recipe was discussed both with Lindell´s and with a person with in depth knowledge on fermented sausage manufacturing and also evaluated against scientific information of the subject. Thereafter the recipe was altered accordingly. After ordering and receiving the ingredients (table 1) the first product sample of totally 100kg was manufactured.

The pork fat was minced (3mm) the day before and put in -18°C to freeze. All ingredients were weighed up according to recipe no 1 (appendix 3). Chopping and mixing were performed in a bowl chopper according to table 2. The batter was immediately after the mixing put into the filling horn and filled into fibrous semi permeable casing with a diameter of 75mm. No air pockets were allowed in the stuffed casings. The sausages were then hanged on a rack, as evenly distributed as possible, and left for tempering at 13°C for 8 hours. The smoking chamber was programmed according to the recipe (appendix 3) and included the rest of the tempering (now at 16°C) the fermentation at 30°C, smoking at 35°C and cooking until 47°C core temperature. Regenerated smoke from condensate was used for smoking. After the treatment in the smoking chamber the rack was rolled into the cooling room (4°C) and left for 2 days to mature and dry. After 2 days the first sausage sample was taken out and put trough visual and sensory evaluation performed by the staff at Lindell´s and persons in the immediate surroundings of them. The pH was controlled after the arrival of the pH-meter three days later.

Table 2. Manufacturing process

Step	Process	Velocity
1	Run pork and beef meat plus ice in the chopper until finely chopped	1:II
2	Add starter culture, mix well	1
3	Add seasonings and the rest of the additives. No salt! Mix well and run until an even paste is formed	1:II
4	Add salt, mix well	1
5	Add the minced pork fat and mix until the fat particles are evenly distributed and about 1x1mm.	1

A new test run was performed a week later, the amount of some spices (white pepper, ginger and nutmeg) was increased and two new spices were added (onion and paprika) according to recipe no 2 (appendix 4). The same manufacturing process was used (table 2), but the filling method was altered since smaller casings (55mm) were used for this trial. These casings were used to obtain smaller sausages that can be sold as a whole. The same temperature treatments as described for the first trial were used but since the sausages had a smaller diameter the times in each step were reduced (appendix 4). After 2 days the first sausage sample was taken out, pH was controlled and the sausage was put through visual and sensory evaluation performed by the staff at Lindell´s and people in their immediate surroundings.

4. RESULTS

4.1 THE MARKET SURVEY

The competitor review resulted in a list of 17 products (appendix 5) not found in Lindell´s assortment today (appendix 1). After discussing this list with Lindell´s 4 products that they were especially interested in and had the possibilities to produce were chosen. These were: liver paté, classic salami, “medvurst” and blood pudding. One proposal also came from Lindell´s at this point; a mild sausage for kids.

One conclusive pattern could be seen during the consumer survey, Lindell´s is very popular in Tidaholm and many of the consumers there would replace any meat product of another brand for Lindell´s product at any time. The products fulfill consumers’ expectations of quality (they like the intrinsic factors of the products as well as the fact that they are locally produced).

About 70 households participated in the survey. It was not a perfect blend of ages (middle aged persons were overrepresented) but several participants from each age group and from different type of households were included and their answers were in most cases coinciding over the group borders. Only a few new product suggestions came from consumers during the survey e.g. bacon, paltbröd (rye bread baked with blood), “biff Lindström” (minced beef with beetroot, caper and onion) “ready-to-fry” minced meat mixture and garlic sausage. Most products proposals were of traditional meat products. From comments during the day could a desire to get back the original be seen, consumers requested natural meat products like the ones they had eaten before the industrialization of the food production.

Most of the participators were satisfied with Lindell´s assortment and saw no immediate need for a change, but were also open for the possibility to buy additional meat products from Lindell´s. All of the participants who had children with them were fond of the idea with a mild sausage for kids. Comments on the low meat content and the many strange ingredients of competing brands equivalents arose. Overall liver paté and “medvurst” were what most participators would like Lindell´s to produce.

Because of the combined interest from Lindell´s and the consumers for a “medvurst” product in the assortment, this became the product to develop. In the previously mentioned categories for “new” food products (see paragraph 2.2) the “medvurst” would be a “me-too product” since a similar or even close to identical product could already be on the market. This product is unique because it is made by Lindell´s.

4.2 Lindell´s "rökta medvurst"

A "medvurst" would be a good complement to the current supply of meat products. Notice was put on making a "medvurst" with high meat content and good seasoning and smoking, which by itself gives lots of taste. The goal was to produce a "medvurst" back to basic style with high meat content and few additives and diluents. This was the results after the first discussions with Lindell´s and also what was told the company who constructed the first recipe.

A fermented sausage manual in Swedish was written for the staff at Lindell´s. It included a summary of the theory of production of fermented sausage and "what went wrong?" part for troubleshooting (appendix 6).

4.2.1 First trial

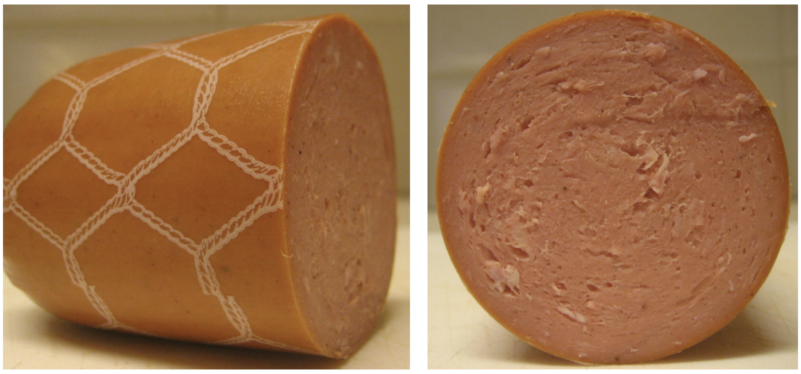
The resulting recipe and manufacturing process (appendix 3) were put through a first test trial. The manufacturing was performed by the writer herself and the meat product producing responsible at Lindell´s. The temperature of the sausage batter was after adequate mixing 5°C. The minced fat was added late and there were still frozen particles when filling. Filling resulted in 50 sausages of 75mm in diameter and of about 2kg each. The manufacturing process was followed as precise as possible. The sausages are meant to be sold sliced and packed to consumers or as a whole to supermarkets with a deli counter. After hanging for two days in the cooling room the sausages were evaluated. The finished sausages had a pH of about 4.7. The visual evaluation was positive from all participants. The sausage had the desired appearance (picture 1) with the white dots (fat particles) evenly spread in the sausage. The smoking had resulted in a nice looking brown/red surface layer and combined with curing the sausage got a fresh red color.

Picture 1. Sausage from the first trial.

The sensory evaluation was mostly positive but with a few comments. The level of sourness in the sausage was good, all participants agreed to this. Also the salt level was good. Most participants agreed that even though the sausage tasted good, some more seasoning would probably make it even better and that the amount of spices added should be increased. It was also decided, after discussion, that paprika- and onion powder should be added to the recipe.

4.2.2 SECOND TRIAL

The reworked recipe and manufacturing process (appendix 4) were tested in the second trial. The sausage batter was 11°C when it was adequately mixed. Due to the high batter temperature a decision to shorten the tempering time was taken. The trial resulted in 240 sausages of about 450g each in 55mm casings. Due to waiting time for the smoke chamber the whole tempering were performed in 13°C in the production area. After being left to hang for two days in the cooling room the sausages were evaluated.



Picture 2. Sausage from the second trial.

The resulting sausage can be seen in picture 2. The finished sausages had a pH of about 4.5. The visual evaluation was not as positive as last time, although still very positive; the white dots (the fat particles) were not as clear and distinct as in the first trial. The red color though, was good. The surface was not as dark as desired and this was also noticed in the sensory evaluation when the sausage did not have as much smoke flavors as wanted. The sensory analysis was overall very positive; the changed mixture of spices gave an enhanced taste experience. The texture of the sausage was softer than in the previous trial and as seen in picture 2 the cohesiveness was also decreased.

4.2.3 THE FINAL RECIPE

The recipe used for the second trial (recipe no 2) was after evaluation and discussion set to be the final one. The process of chopping and mixing the ingredients into the sausage batter (table 2) is the same for both sizes of sausages. Two separate processes after filling were decided from the above results (appendix 7), these two does not differ in temperature and steps. But the times given for each step are shorter for the 55mm sausage compared to the 75mm. A shorter smoking time was used for 55mm sausages in the second trial. This did not give the desired results though and in the final recipe the smoking time was the same for both sizes.

4.3 LABELING OF LINDELL´S "RÖKTA MEDVURST"

Lindell´s "rökta medvurst" is a sausage that should be sold in supermarkets prepackaged; as a whole or in slices. The ingredient list on the label is shown in table 3 (Swedish version appendix 8). The ingredients are mentioned in descending order down to < 2%. There are two alternatives for writing meat, either as category or separated into pork meat and beef meat.

The fat added can be noted as pork fat or as "späck" which is a well known expression for back fat from pigs in Sweden. Curing salt and sodium ascorbate are additives and are therefore written with their functional group and general name or E-number. The category spices is summarizing all spices added, this save space on the label. Meat content is calculated from the amount of added meat at start of processing. Fat content of the sausage needs to be analyzed at a laboratory.

Table 3. Ingredient list of Lindell's "rökta medvurst".[1]

Lindell´s "rökta medvurst"
Ingredients: Meat (pork and beef) OR Pork meat, beef meat, pork fat, preservative curing salt OR (E250), glucose syrup, dextrose, spices, anti-oxidant agent sodium ascorbate OR (E301). Meat content 70%. Fat content XX%.

1 Created based on the Swedish directives

5. DISCUSSION

This project ended before the product development process was finished, more exactly somewhere in the middle of the third step: *Production process, marketing strategy, quality assurance and commercial product* (see paragraph 2.2). Lasting quality tests needed still to be sent off to an external laboratory. Hazard analysis and decision of critical control points was under construction by the quality responsible at Lindell´s. A_w of the sausage needs to be analyzed experimentally as a first step to verify the safety of the sausage process. If the a_w is found to be too high to ensure safety other measures need to be taken. The temperature when heat treating the sausage could be raised in order to have more of an effect in killing of pathogens (reviewed in Inzce, 1998), this could affect other quality parameters though, that need to be considered. A prolongation of the maturing and drying period at higher temperatures might also have to be considered to increase the period of killing (SLV, 2003).

Other ways to increase the safety of the sausage could be to add extra hurdles instead of raising the height of the existing ones. One such hurdle could be to change the composition of the starter culture so that it contains bacteria that produce bacteriocin (antibacterial peptides or proteins that kill or inhibit other bacteria). This offers a natural way of preservation, posing no risk for humans and does not affect flavor. Usage of bacteriocin producing cultures is not yet common practice. It is a rather new method with most of its good results to be found in literature rather than practice. Holding the usage of these cultures back is the implementation of it into existing production lines. Problems with equal distribution of the bacteriocin, adsorption to fat and meat particles and influence of other ingredients arose (Leroy and De Vuyst, 2009).

The main concern for safe sausage though is the quality of the raw material. Special care has to be taken so that the meat is not contaminated during slaughtering (SLV, 2003; Feiner, 2006). If this project was to be started again it would have benefitted from the risk assessment being the main concern from the start. Unfortunately the risk assessment came up late in this case, when the recipe was already made. Consequences of this might be some extra work and possible remodeling of the recipe and the manufacturing process. The awareness of the EHEC risk in fermented sausage is still relatively new and clear directions from the NFA on how to avoid EHEC in Swedish fermented sausage is still under construction (SLV, 2008).

According to the literature the optimal temperature for the sausage batter after mixing should be between -4 and -1°C (Feiner, 2006). These low temperatures were not possible to reach during our manufacturing. In the first run chilled meat (2°C) and frozen fat (-18°C) were used, and the sausage batter was about 5°C after adequate mixing. The filling process was started directly and the final result turned out as desired despite the too high temperature. Our conclusion was that with the available machines, temperatures in the range of -1 - -4°C could not be reached. The machine produces too much frictional heat when used. In the second run was the meat left out in the warm production room too long (7°C) causing the temperature to go up. This caused an end temperature of the batter of about 11°C. The high temperature of the batter probably caused the result of the final sausage. It lacked the sharp white fat particles, had poorer cohesion ability and softer structure. These results are consistent with fat smearing due to high temperature during handling (Feiner, 2006).

The results from the consumer survey were not as expected. Expected was more own suggestions from the consumers about what products they missed in the meat product shelves. Instead the list of our suggestions had to be used in most cases. The reason for this might have been, as some consumers also expressed, that they were caught offhand. They had not had any time to think about it and could not come up with anything at the moment. This was something we had overlooked. A solution to this could have been to post signs in the store some time before the survey which advertised it. Arranging a competition in the supermarket for "best proposal" could have been another solution. This competition would have needed to last for a few weeks to allow consumers' time to think. Both these two alternative solutions would probably have solved the problem we encountered.

The increasing importance of extrinsic factors for the consumers opens for new aspects in food product development. The consumers engage in the products history. Organic production, animal welfare and "naturally" produced products have gained increased interest and added to the list of possibilities for the meat industry to make their products stand out. The qualities are almost entirely credence characteristics, since the consumer cannot himself evaluate if the products' history is true, not when buying and not during cooking and eating. It is not the actual attributes like local origin or a certain production system that makes the consumer buy them but rather the consequences of them. These consequences are desirable since they relate to realization of the basic life values like security for one-self and the family and social relations to others. This is referred to as the means-end chain, because it shows how consumer regards products as a mean to reach an end. The success of these extrinsic factors depends on the company's ability signaling them and the participators of the distribution chain abilities to effectively move the information along the chain. That the consumers have the knowledge needed to understand the signals and that they put trust in them are also critical for success (Bernués et al., 2003; Grunert and Valli, 2001; Grunert et al., 2004).

It has been found though that individuals views as citizens and their role as consumers does not add up. The individual's opinions as citizens do not seem to substantially affect their meat-buying habits. Expected would be, for example, that consumers who support small-scale farming would consume fewer heavily processed meat products and vice versa, but a pattern like this could not be found (Verbeke et al., 2010). The main reason for not acting accordingly to your citizen opinion seems to be the price (Bernués et al., 2003).

Product development is difficult and risky, a major part of new products fail. Three factors have been pointed out as critical for successful product development. The first is a clear and consistent strategy for product development. Second is an organized and controlled process which promotes communication and learn from previous projects. Thirdly the process need to be market orientated all the way through (Harmsen, 1992, cit. Grunert and Valli, 2001).

From January 2010 smoke aroma has to be added to the ingredient list if regenerated smoke from condensate has been used when smoking the meat product. This change has started a discussion where the opinion of Swedish Meat Industry Association is that regenerated smoke is not an ingredient (KCF, 2010). They believe that resemblance of regenerated smoke with smoke aroma (added through spraying or blended directly into the product) could have negative consequences. Consumers could choose traditionally smoked products instead and thereby risk increasing their intake of carcinogenic substances (PAHs). The same would happen if additional companies start smoking with fresh smoke. Today, about 80% of the smoked meat products have been smoked using regenerated smoke from condensate.

All additives used in food have been controlled and approved for use in that particular food by the EU. They are deemed safe and given E-number identification (SLV, 2010g). That does not mean that it is necessary to use them. Additives are added to food both during home cooking and in the industry. The usage level is for many reasons higher in the industry, the food might need to be transported a long distance, supermarkets and consumers request increased shelf life and low-fat/sugar products. The price pressure makes the industry look for ways to lower their costs, additives might be one way. The additive debate that has been topical in Sweden for the last couple of years has placed all additives in the same group and mainly been concerned about their negative aspects and a request to get them out of the food. The response from the food industry has been a drastic lowering of added food additives (SVD, 2010).

Some of the additives removed had probably lost their purpose due to advances in technique. Not to forget though is that additives are critical for the safety of some foods, Danielsson-Tham (2009) pointed out sodium nitrite as an example where stop using it could cause deaths due to botulism. She further wrote that all additives need to be thoroughly evaluated before being removed. Why were they once added? Are there other solutions? The food as we know it today is in many cases formed by additives and removal of the additives would in some cases have such an impact on the food that the consumers do not recognize it. If the consumer wants bread that last in the kitchen cabinet for 10 days or low-fat cook-able crème fraiche the additives have to stay. Either the additives stay or the consumers have to change their requests. Transparency throughout the food process and the food chain and more well informed consumers are possible solutions to the food additive dilemma. A better informed consumer would feel more secure and be able to make informed choices about what they buy and when they need food with additives.

6. CONCLUSIONS

The success rate of food product development would increase if the consumer played a bigger part already in the process. It is their needs that shall be filled and they probably keep many good ideas on how that should happen. Consumer's interest in extrinsic factors and their request for more naturally produced food with fewer additives has created a whole new market with many new possibilities for product development. This project is only one example of this. Production of fermented sausage is a science with many factors to consider, the most critical one obviously being temperature. Temperature of the raw material, temperature during mixing and filling, tempering, fermentation temperature, heat treatment temperature, maturing temperature and last but not least lack of high temperature treatment before consumption.

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8. APPENDICES

Appendix 1. Current meat product supply at Lindell´s
Appendix 2. Questionnaire for consumer survey
Appendix 3. Recipe no 1
Appendix 4. Recipe no 2
Appendix 5. Results from competitor review
Appendix 6. Manual for fermented sausage
Appendix 7. Final recipe
Appendix 8. Ingredient list for Lindell's "rökta medvurst"

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Appendix 1.

Current meat product supply at Lindell´s

Nuvarande utbud av charkprodukter hos Lindell´s

Produkter	
falukorv	julskinka
lindellsringen	helgskinka
isterband	ost och bacon korv
wienerkorv	chorizo
grillkorv	slottsskinka (skiv.,atm pack)
prinskorv	drängaskinka (skiv.,atm pack)
ärtsoppa	kokt skinka (skiv.,atm pack)
bruna bönor	almogekassler (skiv.,atm pack)
lindells rökta	rökt nötrulle (skiv.,atm pack)
rimmad bog	
rimmad sida	
rökt bog	
rökt sida	
korvkaka	
leverkorv	
rimmad svintunga	
kassler	
frukostkorv	
fläskkorv	
mager kebab	
julkorv	
grynkorv Tibro charkens grynkorv Lindells	

Appendix 2.

Lindells planerar att utöka sitt charksortiment. Vilken ny produkt skulle du helst vilja se i charkdisken?
(Markera de 2 du helst skulle köpa)

( ) Lindell's Leverpastej

( ) Lindell's Salami

( ) Lindell's Medvurst

( ) Lindell's Milda grillkorv för barn

( ) Lindell's Blodpudding

( ) Eget förslag: ……………………………

Appendix 3.

Recipe no 1

Lindell´s rökta medvurst

Satsstorlek: 100kg

Tarm: Fiber 75mm (50st)

Ingredienser

Råvara	*Mängd (kg)*	*Kommentar*
Fläsk II		0°C
Nöt III		0°C
Ryggspäck		-18°C, tärnat eller grovmalen
Is		

Produkt	**Mängd (kg)**	**Kommentar**
Mörk sirap		
Nitritsalt		
Vitpeppar		
Svartpeppar		
Muskot		
Ingefära		
Rosalin		druvsocker
Pökulus		E301: natriumaskorbat
Kultur LS1		torkad

Metod

Nr.		**Hastighet**
1	Kör fläsk, nöt samt is. Kör tills fint hackat	1: II
2	Tillsätt kultur LS1, blanda in	1
3	Tillsätt kryddor och övriga tillsatser, kör till slät smet	1
4	Tillsätt salt	1
5	Tillsätt det grovt fördelade frysta späcket	1

Sluttemperatur på massan ska vara -2°C
Fyll på tarm omgående

Fermentering

	Tid (h) (75mm)	**°C**	**°C kärna**	**Kommentar**
Temperaturutjämning		16-18	→→	I produktionslokal/ skåp
Mogning		30	→→	I skåp
Rök intensiv		35	→→	I skåp
Kok/Rök			47	Stoppar syrabildning
Kyl	3-4dygn	4		Tills önskad konsistens är nådd

Appendix 4.

Recipe no 2.

Lindell´s rökta medvurst

Satsstorlek: 100kg
Tarm: Fiber 55mm (2 rullar)

Ingredienser

Råvara	***Mängd (kg)***	***Kommentar***
Fläsk II		0°C
Nöt III		0°C
Ryggspäck		-18°C, tärnat eller grovmalen
Is		

Produkt	**Mängd (kg)**	**Kommentar**
Mörk sirap		
Nitritsalt		
Vitpeppar		
Svartpeppar		
Muskot		
Ingefära		
Paprika		
Lök		
Rosalin		druvsocker
Pökulus		E301: natriumaskorbat
Kultur LS1		**1 påse**, torkad

Metod

Nr.		**Hastighet**
1	Kör fläsk, nöt samt is. Kör tills fint hackat	1: II
2	Tillsätt kultur LS1, blanda in	1
3	Tillsätt kryddor och övriga tillsatser, kör till slät smet	1
4	Tillsätt salt	1
5	Tillsätt det grovt fördelade frysta späcket	1

Sluttemperatur på massan ska vara -2°C
Fyll på tarm omgående

Fermentering

	Tid (h) (55mm)	**°C**	**°C kärna**	**Kommentar**
Temperaturutjämning		16-18	→→	I produktionslokal/ skåp
Mogning		30	→→	I skåp
Rök intensiv		35	→→	I skåp
Kok/Rök			47	Stoppar syrabildning
Kyl	3-4 dygn	4		Tills önskad konsistens är nådd

Appendix 5.

Results from competitor review

Resultat från genomgång av konkurrenter

Produkt	Kommentar
bacon	tärnat, skivat, kotlettbacon
köttbullar	råa rullade, förlagade, färdiga
hamburgare	råa formade, förlagade, färdiga
leverpastej	ugnsbakad, skivbar, bredbar
ölkorv	
salami	original, mager, hel bit, skivad
medvurst	kokt, rökt, cognac-, hushålls-, hel bit, skivad
pastrami	
lufttorkad skinka	
sylta	pressylta, rullsylta, kalvsylta
pölsa	
blodpudding	
rostbiff	
saltrulle	
kryddade revben	
aladåb	
rökt fläskkarré	hel bit

Manual for fermented sausage

Om tillverkning av fermenterad korv: Medvurst

En fermenterad (syrad) korv är stabil och hållbar p.g.a. sitt låga pH och låga vatteninnehåll. Denna medvurst är snabbfermenterande och därför hinner inte så mycket vatten avges under den korta torkningen. De huvudsakliga faktorerna som gör korven hållbar och säker är det låga pH- värdet (4,7- 4,8), en vattenaktivitet under 0,95 samt nitrit. Det är också pH-sänkningen som binder ihop korven. När pH sänks koagulerar proteinerna i köttet och bildar gel som omsluter och binder ihop fett- och köttpartiklar.

Att ingredienserna är av hög kvalité är mycket viktigt när man producerar medvurst. Främmande bakterier kan hindra tillväxten av mjölksyrabakterier och därmed förhindra tillräcklig pH-sänkning, då riskerar produkten att bli farlig.

Kött
Köttet som används ska ha ett pH-värde under 5,7–5,8; ökad vattenhållningsförmåga är inget som eftersträvas då produkten ska torka till viss del. DFD-kött bör inte användas eftersom det p.g.a. sitt höga pH inte är lika mikrobiologiskt stabilt som normalt kött. Det har ju också högre vattenhållningsförmåga p.g.a. sitt höga pH. Att använda PSE-kött har inga negativa effekter då dess låga pH och dåliga vattenhållningsförmåga snarare är positivt i medvurstprocessen. Man bör dock undvika att använda en för stor del PSE kött för det kan påverka korvens färg negativt. Köttet tillsätts kallt (0°C) för att hjälpa till att hålla temperaturen låg under mixningen.

Fett
Fettet tillsätts fruset för att undvika att fettet smetas ut under mixning och stoppning. Om fettet smetas ut kan det hindra vattenavgången under torkning samt ge korven ett mindre attraktivt utseende. Fettet är ju önskvärt att ha i tydligt avskilda vita fettpartiklar i korven. Fett från rygg och nacke på gris är det hårdaste fettet och därför det som föredras vid medvursttillverkning. Fett från äldre djur är generellt hårdare och kan med fördel användas.

Socker
Sockret tillsätts som en energikälla till mjölksyrabakterierna. Olika bakterier föredrar olika sockerarter och olika sockerarter förbrukas olika snabbt. Sockerart och mängd kan användas för att styra hur snabbt och hur mycket korven syras. Vanligtvis används en blandning av olika sockerarter av den anledningen.

Startkultur
Startkulturen är vanligtvis en mix av olika bakterier som tillsammans ska ge korven dess önskade egenskaper (syrning, smak, stabilitet, hållbarhet). I medvurst original används kulturen

Appendix 6

LS1. Den innehåller *Lactobacillus curvatus* som syrar korven genom produktion av mjölksyra och *Staphylococcus carnosus* som främst bidrar till färg och smak. Kulturerna hanteras overksamma (torkade). Kulturen är portionerad (1påse/100kg smet) för att undvika små uppvägningsvolymer och fel mätning, det är mycket viktigt att tillräckligt med kultur tillsätts vid varje produktionstillfälle. Påsens innehåll ska sättas direkt till smeten, kulturen ska sedan blandas in innan andra ingredienser tillsätts.

Övriga ingredienser
Nitrit sätts till korven för att hindra tillväxten av ovälkomna bakterier, nitrit ger även den traditionella nitritfärgen och smaken. Vanligtvis sätts också en antioxidant (ex. natriumaskorbat) till smeten för att snabba upp och stabilisera nitritens verkning. Rosalin är ett produktnamn för druvsocker. Pökulus är ett produktnamn för natriumaskorbat (E301) utblandat i druvsocker. Mängden mörk sirap kan justeras efter smak och önskemål.

Medvursten kan tillverkas på flera sätt, att alla ingredienser tillsätts och hackas i en korvhack (snabbhack) eller att kött och fett mals separat för att sedan blandas med övriga ingredienser i en blandare. Oberoende av metod är det mycket viktigt att temperaturen i massan så låg som möjligt (optimalt mellan -4 - 0°C) för att undvika att fettet smetas ut. Det är också viktigt att smeten blandas ordentligt så att alla ingredienser är jämt fördelade annars kan syrningen påverkas (inte hela korven syras och produkten blir farlig) och färgen bli ojämn.

Tiden mellan mixningen och stoppningen ska vara så kort som möjligt annars finns risk att temperaturen sjunker ytterligare i smeten och att iskristaller bildas. Iskristallerna försvårar stoppningen och ger även hålrum i den färdiga korven. Om smeten blir stående och temperaturen sjunker behöver den sättas tillbaka i blandaren så att temperaturen höjs igen.

Efter stoppningen bör korven hänga för att temperaturutjämna innan den sätts in i värmen, då avdunstar av kondensen. I skåpet bör luftfuktigheten vara hög (gradvis sjunkande från 95% till 90% under mognaden). Om torkningen sker för fort p.g.a. för torr luft så kan en hård yta bildas på korven. Temperaturen i skåpet ska vara 30°C (en skillnad på bara 3°C upp eller ner har stor effekt på slutresultatet). Under mognaden i skåpet förökar sig mjölksyrabakterierna och producerar syra. I slutet av mognadsprocessen tillsätts rök för att ge smak och färg. Korven upphettas sedan till 47°C för att avsluta mjölksyrabakteriernas arbete. Efter mognaden hängs korven i kyl där vatten tillåts avdunsta tills korven fått sin rätta konsistens.

Vad blev fel?

För lågt slutligt pH	• pH sänkningen har inte kontrollerats	• Upphettningen för att stoppa kulturen har inte varit tillräcklig
Syrningen går för sakta	• Kulturen har tinats för länge vilket lett till att den inaktiverats • Temperaturen under mognaden har varit utanför kulturens optimala; för hög eller för låg • För mycket oönskade bakterier har kontaminerat smeten och utmanövrerat mjölksyrabakterierna eller neutraliserat den producerade syran • Korven har varit kallare än normalt när den kommit in i skåpet och därför är processen försenad • Förändringar i kryddningen har påverkat kulturen	• För hög tillsats av nitritsalt har inaktiverat kulturen • Direkt kontakt mellan kulturen och nitritsaltet har inaktiverat kulturen • Hög fetthalt på råvarorna har orsakat vattenbrist och därmed hindrat kulturen (fett innehåller 15 % vatten, kött 75 %) • För snabb vattenavgång har orsakat vattenbrist och därmed hindrat kulturen • För lite socker har tillsats så kulturen saknar energi
Syrningen går för fort	• Temperaturen har varit för hög • Förändringar i kryddningen har gynnat kulturen • Överdriven mängd tillsatt vatten har ökat vattenaktiviteten och gynnat kulturen • Korven har haft högre temperatur än vanligt när den kom in i skåpet	• Magrare råvaror har ökat mängden tillgängligt vatten vilket gynnat kulturen • Luftfuktigheten har varit högre än normalt • Kombinationen av sockertyper har varit felaktig

Appendix 6

Syrningen skiljer från sats till sats	• Spridningen av kultur, nitritsalt, kryddor och/eller druvsocker är inte jämn p.g.a. otillräcklig blandning • En del av köttet har torkat ut eftersom det legat för länge innan användning • Ojämn temperatur i korvarna	• Satserna har gjorts med olika kryddningar, köttdelar, tarmdiametrar, pH eller vatten/fettinnehåll • Temperaturen eller fuktigheten i skåpet har varit olika mellan satserna
Ingen syrning har skett	• Kultur har inte tillsatts • Kulturen har inaktiverats genom direktkontakt med nitritsalt • Kulturen har blivit utsatt för hög temperatur under transport eller lagring och är inaktiverad	• Kulturen har hanterats fel vid upptining • Inte nog med socker har tillsats • För mycket salt eller fett har tillsatts
Otillräcklig vattenavgång	• Luftfuktigheten har varit för hög • Överdriven torkning eller rökning i början av processen har orsakat ett hårt ytskikt, så att vatten ej kan passera • pH har varit för högt; syrning har ännu inte skett	• Fett ha smetats ut och hindrar vattenavgång • Temperaturen har varit för hög så fettet har smält och smetats ut på insidan av tarmen vilket hindrar vattenavgång
För hög vattenavgång	• Luftfuktigheten har varit för låg • Syrningen har varit för snabb	• Kulturen har varit för snabb och därmed orsakat ett för lågt pH
Korven fortsätter syras när den är färdig	• Upphettningen för att stoppa mjölksyrabakterierna har inte varit tillräcklig	

Appendix 6

Korven luktar illa	• Oönskade bakterier har växt under processen eller efter paketering • Dålig fett/köttråvara har använts • Dålig renhållning efter tillverkning	
Korven är missfärgad	• *Staphylococcus carnosus* har inte funnits i kulturen • Köttpigment har oxiderats p.g.a. kontaminering av oönskade bakterier eller metall joner i orent salt • Korven har utsatts för solljus • För lite nitrit har tillsats • Syrningen har varit för snabb • Råvarorna har varit dåliga	• Det har funnits för mycket kaliumsorbat i tarmarna • Det har vuxit jäst på ytan • För hög röktemperatur har orsakat grå/grön kant • Fett som smetats ut eller torr yta har hindrat vattenavgången och gett en grå missfärgning i kärnan
Korven är mosig i konsistensen	• Smeten har mixats för länge • Fettet har smetats ut • För lite eller inget salt tillsatt • Råvarorna har varit dåliga • Bakterier som bryter ner proteiner har kontaminerat under processen	

(Fritt översatt: Chr. Hansen Bactoferm™ Meat Manual vol 1.)

Appendix 7.

Final recipe

Lindell´s rökta medvurst

Satsstorlek: 100kg

Tarm: Fiber 75mm (50st) alt Fiber 55mm (2 rullar)

Ingredienser

Råvara	*Mängd (kg)*	*Kommentar*
Fläsk II		0°C
Nöt III		0°C
Ryggspäck		-18°C, tärnat eller grovmalen
Is		

Produkt	**Mängd (kg)**	**Mängd (skopor)**	**Kommentar**
Mörk sirap			Ca **2 cm** från kanten
Nitritsalt			
Vitpeppar			
Svartpeppar			
Muskot			
Ingefära			
Paprika			
Lök			
Rosalin			druvsocker
Pökulus			E301: natriumaskorbat
Kultur LS1			**1 påse**, torkad

Metod

Nr.		**Hastighet**
1	Kör fläsk, nöt samt is. Kör tills fint hackat	1: II
2	Tillsätt kultur LS1, blanda in	1
3	Tillsätt kryddor och övriga tillsatser, kör till slät smet	1
4	Tillsätt salt	1:II
5	Tillsätt det grovt fördelade frysta späcket	1

Sluttemperatur på massan ska vara så låg som möjligt för bästa resultat.
Fyll på tarm omgående.

Fermentering

	Tid (h) (75mm)	**Tid (h) (55mm)**	**°C**	**°C kärna**	**Kommentar**
Temperaturutjämning			16-18	→→	I produktionslokal/ skåp
Mogning			30	→→	I skåp
Rök intensiv			35	→→	I skåp
Kok/Rök				47	Stoppar syrabildning
Kyl	2-4dygn		4		Tills önskad konsistens är nådd

Ingredient list of Lindell's "rökta medvurst"

Ingrediensförteckning för Lindell's rökta medvurst

Lindell´s rökta medvurst
Ingredienser: Kött från gris och nöt *alt.* griskött, nötkött, fett från gris *alt.* späck, konserveringsmedel nitritsalt *alt.* (E250), glukossirap, druvsocker, kryddor, antioxidationsmedel natriumaskorbat *alt.* (E301). Kötthalt 70 %. Fetthalt XX %

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