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The effect of fatteners transport on pork quality

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ABSTRACT

Transport of slaughter animals is one of the basic environmental factors exerting influence on their well-being and, consequently, on the quality of meat. Failure to provide suitable conditions for animals during transport brings many losses to both the producer and the consumer. The result of poor welfare, excessive stress of animals and numerous fractures and injuries during transport decreases both the quantity and quality of meat from transported animals. Most often, animals are transported by car. Means of transport designed for this purpose must meet numerous technical requirements and provide animals with adequate welfare. Semi-trailer sets (tractor + semi-trailer) or trailer sets (car with trailer) are most often used. The basic requirements during transport should be to provide the animals with adequate space, depending on their weight. Cars should be protected against adverse weather conditions, must have roofing, ventilation or heating. The transport should last no longer than 8 hours, after which rest of the animals should take place in designated places. Loading and unloading of animals is also important. It should be run by qualified personnel on appropriate ramps, protecting against injury and exiting animals outside. Improper transport leads to stress, as a result of which the quality of obtained meat deteriorates, and in critical situations, even the death of an animal may occur. This creates defective meat PSE or DFD, having a worse culinary value for the consumer. Once the animals reach their final destination, they should be unloaded, have permanent access to water and ensure rest before slaughter. Transport is a very important factor in the production of high quality meat. Properly carried out, with the preservation of proper welfare conditions to minimize the stress of animals, contributes to the acquisition of a good raw material from which many excellent meat products can be produced.

Keywords: fatteners, transport, quality pork

1. INTRODUCTION

The transport of pigs, even in the best possible conditions, using modern technologies, is not always able to meet the needs of pigs, which leads to stress and a decrease in the quality of meat obtained from them, and in extreme cases can lead to the death of animals. Despite the relatively short duration in the whole pig production process, transport of animals to meat plants often causes serious economic losses. This is due to the fact that during transport animals are exposed to many different stress factors in a short time. Together with the deteriorating welfare during transport, economic losses for both the breeder and the slaughterhouse increase [1].

The quality of meat is called a set of all the characteristics that are important for this raw material, which determine its utility value and clearly indicate whether the value of this meat is suitable for the consumer. The most important qualitative features of pork for the consumer include: tenderness, juiciness and desirable and proper taste and smell. The quality of pork is influenced by both genetic and environmental factors. It is believed that between 25-45% of pork quality is determined by genetic factors and 55-75% by environmental factors. Among the latter, factors such as nutrition, transport, ante-mortem hunger strike, slaughter and the rate of cooling of half-carcasses after slaughter have the greatest impact.

High-quality meat should be characterized by the absence of microorganisms, chemicals, physical contaminants dangerous for health, be free of quality defects and have a high nutritional value. The crispness, juiciness, desirable and proper taste and smell of meat are the most important quality traits of pork for the consumer. The high quality of pork is influenced by both genetic factors in 25-45% and environmental in 55-75%. Genetic factors include race and genotype of the animal. On the other hand, environmental factors: nutrition, transport, ante-mortem fasting, slaughter and cooling rate of half-carcasses after slaughter [2].

Transport is one of the basic environmental factors that can mainly cause a decrease in the quality of pork. Incorrect handling of animals during loading, poorly constructed vehicle for transport, poor conditions and animal welfare during transport can directly cause stress to pigs, which in turn results in economic losses for slaughterhouses and meat processing plants. The transported at short distances from the farm to the meat plant, often in the absence of ante-mortem rest, high level of glycogen in the muscles and many stress factors, tends to produce defective meat PSE. However, with a long transport time and rest before slaughter, when fatteners are exposed to long-term stressors, excessive use of glycogen and ATP resources may occur, which in turn leads to the formation of defective meat DFD [3].

The aim of the work is to present problems related to the transport of pigs, rules, requirements and conditions of transport of these animals, and changes occurring in the pigs during transport, which greatly affects the quality of pork obtained from them.

2. RESULT

2. 1. Rules and conditions for transporting pigs

The carriage of live animals as part of an economic activity is subject to specific rules. Business which will transport animals for more than 8 hours, must obtain a route plan, animal health certificate and animal certificate of origin. The basic requirements to be ensured during transport is a suitable area for the pig, depending on the weight of the animals. For weaners,

which are now more and more frequently transported, 0.15 m² / piece must be provided, while for adult pigs, a minimum of 1 m² / piece is required.

The carriage of live animals is subject to detailed rules. Pork should be loaded so that it can stand and lie in a natural position. It should also be ensured during transport the appropriate loading surface for the pig, depending on body weight, eg for adult pigs, it is about 1 m² / piece. The following floor area should apply to each piece:

- pigs weighing up to 25 kg - area from 0.20 to 0.24 m²,
- pigs weighing between 25 kg and 80 kg - 0.53 to 0.60 m²,
- pigs with a body weight from 80 kg to 130 kg - 0.66 to 0.83 m²,
- pigs weighing 130 kg to 200 kg - 1.00 m²,
- pigs with a body weight of over 200 kg - 1.5 m².

It is very important that all animals are allowed to stand up, lie down, in a natural position. If there are specific conditions for transported pigs related to the breed, their temperament, length or atmospheric conditions, the area per one piece should be increased by 20%. Not only the right conditions during transport are important, but also qualified service for loading and unloading animals [4]. These two activities should take place in peace and quiet, without causing unnecessary suffering to the animals. It is allowed to use electric drovers to chase adult pigs, but not longer than 1s. For animals during unloading, often exhausted travel and numerous injuries, appropriate care should be provided. The transport of more than 8 hours must be carried out by specialized companies, vehicles adapted to this purpose. Unloading and loading of pigs must take place using safe ramps, gangways where the inclination angle should be 20°. Platforms should be made of non-slip materials, additionally have hoof supports to improve the movement of the animals. Transported animals should be of similar age and weight, to reduce the risk of falls of smaller animals [5].

2. 2. Welfare of pigs

Table 1. Conditions for the welfare of pigs

Requirements of well-being	Conditions necessary to meet welfare requirements
Free from hunger and thirst	By providing fresh water and fodder covering needs for growth, health and food
Free from discomfort	By securing a comfortable resting area, shelter opportunities and optimal environmental conditions
Free from pain, injuries and diseases	By providing prevention, prevention, rapid diagnosis and effective treatment
Free from fear and stress	By eliminating stress factors
Capable of expressing normal behavior	By providing adequate living space and social composition in the group

In the literature on the subject, the term "well-being" can be found with numerous definitions. In the case of animals, as well as in humans, there is a division between physical and mental well-being. Compliance with the principles of animal welfare provides them with humane treatment that takes into account physical, behavioral and health needs. The basic and most important welfare assumptions assume that animals should be free from: hunger and thirst, discomfort, pain, injuries, diseases, fear, stress and be able to exhibit natural behavioral behaviors (Table 1). A low welfare rate leads to weakening the animal's immune system and reducing the level of adaptation to stressful situations (Table 2). The most important factor in shaping well-being is a person who is directly responsible for handling animals. According to Sainsbure (1983), well-being is a set of conditions that cover the biological and behavioral needs of the organism, which makes it possible to reveal its full genetic potential.

Table 2. Indicators of low and high well-being

Low level of well-being	High level of well-being
<ul style="list-style-type: none"> - reduced level of adaptability to stressful situations - limitations in the manifestation of natural behavioral reactions - behavioral pathologies (stereotypes) - reduction in the ability to grow and reproduce - bodily injury (environmental toxicity) - immunosuppression -diseases 	<ul style="list-style-type: none"> - manifestation of various forms of normal behavior - maintaining physiological indicators in the standard - maintaining behavioral patterns in the norm

2. 3. Construction of vehicles for transporting pigs

Road transport is most often used to transport animals between a breeding place and meat establishments. Vehicles used for the carriage of live animals must meet certain technical requirements. Cars transporting pigs must be designed to protect animals from adverse weather conditions. The most common types of transport are sets consisting of a tractor unit and a semi-trailer or a car with a trailer. The use of large semi-trailers in transport, usually consisting of three decks, allows the transport of a large number of pigs, reducing transport costs [7]. The individual decks are lowered or raised during loading and unloading, thus the loading time of the entire trailer is often very short. In modern transport vehicles a number of improvements are used, such as movable partitions, the ability to spray animals with water during transport or sewage systems, which improves the welfare of animals during transport. The loading area of a standard pig transporter consists of three decks, one of which is fixed and the other two movable. Trailers must be made of insulated walls and roofs and must have a ventilation or heating system during transport. Ventilation holes should constitute a minimum of 20% of the floor area, while vehicles with many loading floors should be at

least 30%. The size of the ventilation slots must be adjusted so that the air flow can be changed depending on atmospheric conditions [8]. The ventilation openings should be constructed in such a way as to prevent the limbs or head from being exposed to the outside of the trailer. The rear part of the body is a gangway, with folded side barriers and an internal door layout. The trap plays a role during the loading and unloading of animals. It can be an inclined plane on which animals are introduced or removed, and if unloading is carried out by means of ramps, the gangway plate forms a double-leaf door. Trailers for transporting pigs are divided into closed sectors, which aims to reduce the risk of cumulative transport of animals in one part of the body, which may contribute to causing a traffic accident. In addition, vehicles for the transport of animals are built in such a way that it is impossible to drain impurities from the upper decks to the lower and to the road surface. The duration of pig transport should not last longer than 8 hours, but in exceptional cases, it can include a maximum of 24 hours with stops. In Poland, supervision over compliance with the appropriate transport conditions and animal welfare is carried out by two institutions: the Road Transport Inspectorate and the State Veterinary Inspection. The use of modern trailers for transporting pigs, improves the conditions and comfort of animals during transport, reducing the number of injuries and falls often occurring in vehicles that do not provide adequate welfare [9,10].

2. 4. Damage of pigs during transport

The transport of pigs, as well as all animal species, taking place in very good conditions is not to eliminate the stress response in pigs. The result of stress in pigs are both quantitative and qualitative losses of the obtained pork meat. Quantitative losses, which are directly related to transport, include personal injuries taking the form of bruises, wounds and fractures. Numerous studies indicate that the injuries of pigs during transport are widespread and in high intensity. According to the research, it was determined that over 60% of fatteners transported for slaughter have skin injuries that have occurred during transport [11]. The most dangerous for body injuries are heavy individuals, and those with social stress, as a result of the combination of fattening pigs from different herds from several producers. As a result, there are fights between animals from various farms, joined in groups during transport. The size of the pigs' fattening pigs has a significant influence on the amount of damage in the pigs: distance, way of loading, stocking, transport time and genetic features of pigs. The technical condition and equipment of vehicles also have an impact on the damage. It is unacceptable to have sharp edges on the surface of trailers to transport animals that would contribute to the formation of wounds. The injuries of pigs occurring during transport are very important for commercial reasons. The basic causes of seizures of meat raw materials include: damage and abrasions of the skin, bone fractures and contusions as well as congestion of muscle tissue. The distribution of deductions was determined due to the deteriorated quality of carcasses due to the injuries of pigs. Confiscations due to congestion of muscle tissues amount to approx. 6.5%, skin damage - 5% and limb fractures - over 3%. As a result of changes in the carcass, its commercial value decreases and the possibility of using it in the meat processing [12].

2. 5. Stress during transport

Stress is determined by the unspecific reaction of the body to various requirements of the animal. It appears when the influence of the environment exceeds the self-regulation

possibilities of the organism. The response of animals to stress is dependent on many factors, but the individual characteristics of a given individual are considered the most important. Providing animals with stress factors for a long time leads to a high level of glucocorticoids in the blood, thus weakening the immune system and wasting the body [13]. If the stressor's action is of low intensity, the animal's body incorporates adaptive mechanisms to adapt to changing environmental conditions [14].

Pigs are a species of animals with high sensitivity to unfavorable conditions and environmental stimuli. This is due to the specific properties of the cardiovascular system, which include low heart mass and short duration of the resting phase of the heart. Myocardial fibers are heavily loaded during exercise than in other farm animals. In addition, the blood of pigs has a small mass compared to the weight of the whole body. Pigs also have a high sensitivity to thermal stress, which is caused by the lack of sweat glands. These factors influence the difficulty of adapting to the conditions that prevail during transport. Stress and stress factors during transport include: noise, vibrations, vehicle movement, changes in thermal and light conditions, beatings and excessive driving, and many others caused by changes in the environment [15].

During transport, social stress may occur as a result of the impact of other individuals' behavior. Stress in the body during transport can lead to many different symptoms, the most common of which are: cardiac arrhythmia, elevated temperature and increase in blunt breathing, limb stiffness and immobility. In pigs particularly exposed to stress, which have the RYR1^T gene in their genome, even the death of an animal can occur. A very common phenomenon of the transport area is the loss of body weight, skin damage and, above all, the occurrence of qualitative changes in meat. If the stress occurs for a long period, DFD meat may be found which has a deteriorated culinary value. The highest sensitivity to stress is found in high-pigs, due to the reduced ability to adapt to changing temperature conditions. In pigs exhibiting high stressogenicity, as a result of accelerated metabolism, caused by excessive heat energy production during transport, an increase in blood flow is observed, which results in hypothermia of the body [16, 17].

The growing knowledge, both of the breeder and employees of meat plants, translates into a continuous fight to reduce the occurrence of stress factors in transported pigs. Remember to provide constant access to water, and if possible, transport animals at night or in the morning when the air temperature is lower, thus reducing the negative impact of high temperatures on the pigs' organism. Night transport also limits fattening pigs, against contact with sunlight, which is a strong stressor, in animals whose entire production cycle takes place in closed buildings. An efficient ventilation system, air conditioning system and sprinkler system are the basic elements used to reduce the air temperature prevailing in animal transport vehicles, which has a large impact on the reduction of thermal stress in pigs.

The main determinant of stress response is the individual's individual characteristics. Stress leads to a high level of stress hormones (corticoids) in the blood which results in weakening of the immune system and wasting the body. If stressors are present in low intensity, then the pig organism tries to adapt to them and to this end it incorporates adaptation mechanisms. Pigs are a species of animals susceptible to adverse conditions and environmental stimuli. This is due to the characteristic properties of the cardiovascular system (low heart mass, short duration of the resting phase of the heart) of pigs. In addition, the blood of pigs has a small mass compared to the weight of the whole body. Lack of sweat glands in pigs determines their greater susceptibility to thermal stress.

Highest sensitivity to stress is characterized by high-pigs, due to the lower ability to adapt to changing temperature conditions. During transport of pigs, social stress and transport stress may also occur. Social stress occurs when there is a struggle between individuals to determine the hierarchy encountered during transport, for example in the case of mixed litters. Transport stress is manifested by a decrease in body weight due to skin damage and, above all, by the occurrence of qualitative changes in meat. Stressful factors occurring during transport include: too high temperature, noise, beating, too much driving, changing light conditions, mixing litters, hunger and thirst. Stress leads to the occurrence of pigs in the pigs: heart arrhythmia, elevated temperature, increased breathing rate, limb stiffness and immobility. The effects of transport stress are: falls, body weight losses, mechanical damage to the skin and quality defects of the meat [18, 19].

Negative effects of pig transport include: mechanical injuries of the skin, wounds, bloody bruising in the muscle tissue, fractures and bone contusions. Studies show that over 60% of pigs being transported for slaughter have skin injuries during transport. The social stress that arises as a result of mixing litters during transport causes fights over the hierarchy between pigs. The amount of damage to fattening pigs is influenced by: technical condition and equipment of the vehicle, transport time and distance [18].

2. 6. Falls caused by the stress of pigs during transport

High mortality during transport indicates extremely poor animal welfare during transport. In Europe, about 0.03% of pigs die during transport, which does not last longer than 8 hours. It is estimated that 70% of these falls are still in the car, while the remaining 30% during unloading. The mortality of fatteners during transport is strongly influenced by the design of the car, the density of animals on it, and handling of animals during loading and unloading. Therefore, it is very important to train the personnel in the field of ways of catching pigs on a transport vehicle to reduce animal stress and possible falls, thus improving the welfare and comic parameters of production [20].

The main cause of the mortality of pigs during transport is considered to be hypothermia, caused by the combination of environmental factors and the genotype of the animal. Environmental factors include physical exertion, stress and high temperature. Stress and intense exercise often cause elevated body temperature, which can lead to cardiac arrest and death. Diseased individuals are very easy to recognize because they have difficulty in breathing, a bluish skin color, and the aforementioned elevated body temperature. High temperature in the vehicle can significantly affect the frequency of this disease. Also the genetic factors of a given individual have a large impact on mortality during transport. By reducing the frequency of appearance of the hallucinogen gene, it reduces the loss during transport. The gene of halotane sensitivity is responsible for the coding of muscle proteins of the rianodyne receptor, which is responsible for controlling the transport of calcium from the sarcoplasmic reticulum to the muscle cytoplasm of muscle cells. In animals that are carriers of the halatonic sensitivity gene, they control prolonged muscle cramps during exercise, leading to hypothermia and death of the animal [21, 22]

In order to reduce the occurrence of stress in pigs, it is recommended to transport animals at night or in the morning when the air temperature is lower, thereby reducing the negative impact of high temperature on the animal body and contact with sunlight. The pig production process takes place mainly in enclosed buildings, so limiting contact with sunlight reduces the stress level in animals. The ventilation system, air conditioning and sprinkler

systems are also used to reduce air temperature and thereby reduce the occurrence of thermal stress in pigs in vehicles [23].

2. 7. Impact of transport on meat quality

Carriage of slaughter animals, carried out in an incorrect way, contributes to the occurrence of stress reactions, significantly affecting the quality of the meat received. The incentives that occur among fattening pigs during transport may have many substrates, related to environmental conditions, conditions and time of transport or maintenance of animals before sale. As a result of the long-term effect of stress in pigs, there are many changes in their behavior, fighting between them, which in turn leads to many abrasions, cuts and fractures, which significantly affects the subsequent technological quality of carcasses.

Transport also affects the glycogen content in the muscle of pigs during slaughter, which affects both the quality and purpose of pork processing. Glycogen is the main storage material that occurs in the muscles and in the liver of animals. The intensity of glycolytic changes in the body depends on the initial level of glycogen in muscle tissue and on glycolytic and energy resources after slaughter. The unfolded portion of glycogen remaining in the muscles is called residual glycogen. It is formed as a result of slowing down and stopping the process of anaerobic glycogenolysis. Presence in meat has a negative impact on its technological value. The breakdown of glycogen leads to the formation of lactic acid in muscle, pH drop and significant deterioration of pork. It happens that transport is more important for the obtained meat quality than the genotype or sex of the animal. Studies have shown that treatment of pigs with electric drovers during loading and unloading results in the loss of glycogen, which contributes to the increase in the pH of pork. During transport, the content of glycogen in the muscles decreases, but there are no significant differences between the stress-resistant pigs and the carriers of the stress sensitivity gene [16].

The occurrence of glycogen deficiency before slaughter leads to incorrect acidification of the meat, and the raw material obtained later is defective. There are two types of defective meat, the causes of which are associated with transport. In pigs, the formation of PSE-pale, watery and leaking meat is characteristic. The creation of such meat is the result of an abnormal metabolism in the animal's body before slaughter, often the transport has the decisive influence on the creation of this fault. In this meat, a large amount of lactic acid is formed in the muscles, which leads to a rapid drop in the pH immediately after slaughter. Proper handling of animals prior to slaughter can affect the elimination of defective meat from PSE. PSE meat in addition to bright, pale color is characterized by a large leakage of muscle juice. DFD meat - dark, dry and hard, resulting from the long-term effect of stress factors during transport [24, 25].

Prolonged fasting and careless driving are the main reason for the presence of DFD traits in meat. When the stress before slaughter lasts for many hours, the glycogen reserves are reduced, and the production of lactic acid and posthumous acidification are insufficient. DFD meat, as the name suggests, is darker, more dry, less tasty and more susceptible to bacterial contamination [26, 27]. The reason for the formation of stout meat is too little glycogen in the muscles during slaughter, so that the pH does not fall to the optimal level. From a practical point of view, it is a disadvantage less advantageous for processing than PSE [28-30]. This is due to the greater water absorption of the meat with prolonged curing time. After transport, the animals should be unloaded, fed and should have access to water. Until slaughter, rest in

dependence from the time and hardships of transport in the warehouse livestock, in the correct conditions defined by regulations.

3. CONCLUSIONS

Transport, no doubt has a big impact on the quality of obtained pork meat. Many researches indicate the effect of transport stress as a factor affecting the direct losses of the raw material. Failure to ensure appropriate conditions during transport leads to numerous abrasions, wounds and infections, increased mortality of pigs during transport, but also to improper biochemical processes after slaughter, bad acidification of meat, which leads to defects that disqualify raw material in processing. For some time, thanks to numerous publications, more and more attention is paid to the appropriate animal welfare during transport, knowing how much it affects the quality of the raw material obtained at a later time. It should be remembered that all activities related to the transport of animals, such as loading or unloading, should be carried out at high standards, without exposing animals to additional stress. Striving to improve the quality of meat, it is necessary to know that man affects both genetic and environmental factors shaping its quality, which is why at any price we should be guided towards improvement in order to obtain the best raw material. The most negative impact on animal welfare is caused by improper transport, because at this point animals are subjected to the greatest stress related to environmental change. Anti-slave trade (loading, unloading, transport) should be carried out by trained personnel in accordance with all standards. Vehicles for the transport of animals must be properly designed and should guarantee the correct animal welfare by the possibility of regulating the temperature inside the vehicle, access of animals to food and water, and the possibility of free movement.

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