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# TRANSPORT OF ANIMALS FROM THE STANDPOINT OF THE OPTIMISATION OF MEAT QUALITY AND SUSTAINABLE CONSUMPTION

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**Abstract:** The paper presents assumptions related to the implementation of sustainable development in logistics, which result from the need to protect the environment which is subject to systematic degradation. The concepts presented in this paper are aimed to both reduce the impact of negative factors on the environment and optimise transport costs. The paper also discusses the topics of sustainable consumption and meat quality. Attention was drawn to the problem of animal welfare contained in the so-called '5 freedoms'. Information on meat defects is also included, as well as information on livestock skin injuries and transport-related animal mortality. As a result of an analysis of literature on this topic, it was found that transportation is still extremely stressful for animals despite advances in transportation technology. An analysis of the collected material led to the conclusion that meat quality depends on many factors, with transport being the critical point that drastically lowers its level.

**Keywords:** animal transport, trade in livestock, meat quality, animal welfare, meat shelf life.

## 1. INTRODUCTION

The socioeconomic progress that took place in the last century has allowed widespread access to the food freezing and refrigeration technology. This allows food products, especially those of animal origin, to retain their flavour and shelf life much longer. At the same time, socioeconomic progress has become a catalyst for intensification of animal husbandry. This has caused an increased demand for animal transport services.

Animals are usually transported using land transport infrastructure (road and rail transport), but sometimes also by sea and, in exceptional circumstances, by air. Regardless of the means of transport used, it has a significant impact on animal welfare and ultimately determines the quality of the meat produced. If transport does not meet the relevant conditions, losses occur, i.e.: quantitative losses (deaths, loss

of livestock weight, and infections of animals) and qualitative losses (meat defects, limited processing and consumption suitability) [Cierach and Idaszewska 2014].

Logistics as a field of science should not be defined only in terms of specific activities, such as transport, storage, or warehousing. These elements are components of logistics processes, but what is most important is their mutual correlation, which determines efficient operation of the logistics chain [Chaberek 2011].

This paper aims to identify the logistical activities involved in the transport of animals and to define the conditions required to preserve their welfare. This is done by focusing on the most common of these modes of transport (road) and the one used occasionally but usually for a commodity – livestock – of exceptional quality (sea). Moreover, the paper presents the impact of negligence during animal transport on lowering of the quality of meat as the final product. The analysis of the issue took into account the concept of sustainable consumption in the context of the reduction to a minimum of the amount of meat consumed for the purpose of obtaining materials of optimal quality unaffected by transport.

## 2. SUSTAINABLE DEVELOPMENT FROM THE STANDPOINT OF LOGISTICS

The noticeable climate change that has been increasing at an exponential rate over the last 50 years has led to growing attention to environmental problems. As a result, measures have been taken to reduce the impact of factors that constitute a hazard to the environment. These problems are the result of a conflict between the welfare of the environment and the technological development that generates socioeconomic progress. As a result of discussions on this weighty issue, the idea of 'sustainable development' emerged [Płaczek 2012].

The purpose of logistics as an economic activity is to generate economic benefits, the achievement of which unfortunately involves environmental risks. The main areas in logistics activities that generate specific environmental risks are those dealing with the management of packaging, storage and above all, transport. Therefore, in order to systematically implement the idea of sustainable development in the field of logistics operations, it is necessary to use modern environmental technologies, which have less of a negative impact on the environment compared to conventional technologies that constitute a hazard to it. It is worth emphasizing the fact that 'sustainable' logistics chains are distinctly different from traditional ones. The individual components of such a chain should be located close to each other in order to optimise the use of the waste generated as secondary raw materials. It should also be noted that transport plays a significant role in sustainable development in logistics. In response to environmental and economic demands, intelligent transportation systems (ITS) have been developed, which include numerous

information, telecommunication, and measurement technologies, but also transport management methods aimed at increasing road safety, optimising transport process efficiency and protecting the environment. According to the paper published by Płaczek [2012], the application of intelligent transportation systems results in an increase of street network capacity by 22.5% on average; a decrease in the number of accidents by 60% on average, which proves an improvement in safety; a nearly 60% decrease in travel time and energy consumption; a reduction of exhaust emissions by 40% on average; an improvement in travel comfort for passengers and drivers in public transport; a reduction of costs related to road operation; and an increase in economic benefits resulting from the application of ITS.

Companies engaged in logistics operations, in their efforts to ensure sustainable development, should focus on activities aimed at eco-development and effective use of modern technology to ensure environmental safety, but also on preserving economic growth and improved competitiveness. The main problem with introducing any new technology is the trade-off between ecology and economics. It seems that such a compromise is extremely difficult to achieve, but many positive examples of it can be found in practice [Płaczek 2011].

## 3. SUSTAINABLE CONSUMPTION

A consumer who buys a product in order to use it, has certain expectations thereof, mainly concerning its quality in a broad sense. Their fulfilment makes him or her satisfied. Every consumer can have a different perception of quality. However, when it comes to food quality, there are a few main characteristics that a consumer, as the end customer, pays attention to. The food manufacturer's assurance of safety in relation to food consumption is usually the most important factor, as it is the consumer who bears the risk of possible adverse health consequences. Other characteristics that are perceived by consumers as measures of food quality include price, availability, nutritional value, sensory desirability, and convenience of use, but also the emotional value of food [Baryłko-Pikielna 1995].

Recent literature sources indicate a spread of the minimalist consumer trend defined as anti-consumerism, deconsumerism, and voluntary simplicity of consumption. These definitions apply to the same trend, but their understanding is slightly different. In general, minimalism in consumption means limiting the amount of products used to reasonable portions. Quantity rationing varies and is a direct result of the consumer's natural, individual, physical, and mental conditions. The most common, and not necessarily desirable, way of expressing the minimalism in question is to reduce not only the amount of products used, but also their variety [Błoński and Witek 2019].

The trend to minimise consumption indicates consumers' growing awareness and sense of responsibility, but it also fits with the idea of sustainable consumption.

Sustainable consumption has its origins in the concept of sustainable development, which includes an attitude of social responsibility. An aware consumer, guided by the concept of sustainable development, understands and accepts certain conditions associated with the product's life cycle that may lead to a higher price of the purchased goods. When making shopping decision, he or she keeps in mind not only their needs but also the consequences of their decisions. These consequences can be broadly described as environmental, social, and economic. Examples of actions that result in higher prices of products made as a result of sustainable breeding or cultivation include greening and the associated reduction in pesticide use; maximising animal welfare; discontinuing the use of chemicals in both food production and crop cultivation, fair trade and other restrictions associated with certified agriculture. An important factor that can potentially influence consumers when they choose sustainable products is the changing offer in the food market and the promotion of products from organic farming and non-intensive agriculture. Theoretically, this is an opportunity to achieve a state of sustainable consumption [Grzybowska-Brzezińska and Grzywińska-Rąbca 2018].

A possible rational way to convince consumers to support the idea of sustainable consumption is to make them aware that even the smallest change towards reducing consumption through economies of scale will contribute to improving the state of our planet. In addition, it would also seem sensible to increase the diversity of consumption by using regional materials, e.g., wild game meat, access to which does not require long-distance transport. Therefore, despite the growing awareness of the public, continuous education is necessary.

## 4. ANIMAL WELFARE

Among the first Polish authors to address the topic of animal welfare are Kołacz and Bodak in 1999. The term ‘welfare’ refers to the shaping of the living conditions and the norms of the handling of animals. A special Code for the Welfare of Livestock was developed [Kołacz and Bodak 1999]. It is assumed that the assessment of animal welfare is carried out on the basis of health, behavioural, physiological and production indicators. However, the division is conventional and is used due to the ease of assessment and interpretation, and due to its relatively meaningful results.

Health is understood as a state of the organism where no specific reactions of the immune systems are observed to the presence of pathogenic agents or agents that are otherwise damaging to the organism. Poor health, and thus a negative health indicator assessment, always implies inadequate welfare. Animals may suffer mutilations caused by physical environmental factors or by individuals. As a result, this can cause behavioural changes in the animals, which lead to changes in their behavioural patterns. Consequently, animals may become aggressive in order to avoid pain, injury, or disease. In deteriorated welfare conditions, animals are more

susceptible to infectious diseases and their outcomes are much worse than those of animals with adequate welfare levels. Such a state of affairs may consequently lead to deterioration of the material obtained from these animals or even to the requirement to dispose of it [Kołacz and Bodak 1999].

In the case of welfare assessment, appropriate behaviour is understood as behaviour of an animal that is appropriate to the pattern of the specific species. A negative assessment of this indicator shows the presence of stereotypies, i.e., behaviours that significantly deviate from the accepted pattern. Stereotypies can occur in different forms and intensities, and can be constant or recurrent.

In the advanced form, when the welfare of an animal is severely impaired, stereotypies may manifest themselves as the performance of meaningless actions, such as walking in circles, refocused actions directed toward objects of no interest in normal conditions, or self-destructive actions. There is a hypothesis that stereotypies are defence mechanism against the development of psychosomatic disorders. Products from animals with improper behaviour are not necessarily of lower quality, but for example poultry may lay fewer eggs than animals with normal behaviour. In the case of cows, this may affect the amount of milk produced [Kołacz and Bodak 1999].

Physiological indicators of welfare can be assessed positively when stressful situations are not present in the animals' living environment. Occurrence of stressful situations, i.e., an impact of stress (environmental) factors on the body that causes inability to control the functioning of physiological systems, as well as internal and external conditions that change with such intensity that the ability to control these systems is limited, clearly indicate a reduced level of welfare [Kołacz and Bodak 1999; Bombik, Bombik and Biesiada-Drzazga 2013].

As livestock production is closely correlated with the profitability of keeping animals, breeders generally try to keep their animals in good health so that they bring in the highest possible income. It should be noted that animal husbandry systems that take into account the highest possible level of animal welfare allow farmers to obtain not only a better-quality product, but often also larger quantities of the product. Therefore, by ongoing monitoring of animal productivity and comparing these values with averages for a specific species it is possible to decide whether the productivity index in the context of welfare can be assessed positively or not [Kołacz and Bodak 1999].

In Poland, since 1 January 2013, cross-compliance (CC) rules have been in force, which indicate what minimum requirements should be met in farms. If these requirements are not met, the farmer or breeder does not receive any financial benefits from the state. The cross-compliance rules are detailed in three areas: area A concerning environmental protection and animal identification and registration; area B concerning food safety; and area C concerning animal welfare.

Animal welfare should be assessed holistically, as each indicator is in some way correlated with another. For the breeder, animal welfare should be the primary goal

and intent of breeding. Animals whose welfare is ensured generate the highest income from the goods produced. Unfortunately, producers often prefer to provide inferior conditions for animals, to get an inferior product and to sell it for a lower price but with less effort. In order to prevent such situations from occurring in Poland and in the European Union, the above-mentioned regulations related to providing animals with appropriate living conditions have been implemented.

## 5. QUALITY DEFECTS IN MEAT

In describing quality defects of meat and animal welfare indicators, it is impossible not to mention the transport of livestock by road to the slaughterhouse, but also the prior and much longer sea transport (if any).

Data published by the specialist livestock sea transport company LiveCorp in Australia, based on animal mortality rates recorded systematically over the last 10 years of their operations, show a calf mortality rate of 0.17% (if more than 1% of animals die during a single trip, the company withdraws the vessel and carries out a mortality analysis), and a sheep mortality rate of 0.9% (only if more than 2% of the transported livestock dies is an investigation carried out; sheep are more sensitive animals). Looking at the time required for transport, the limited space per animal, and the enormous size of a cattle ship carrying up to 18,000 cattle or 75,000 sheep at the same time, the mortality rates indicated in the literature can be considered to be definitely low. It can be assumed that low losses of livestock during sea transport may be associated with the presence of qualified veterinarians, the care of the state of the premises intended for hospitalisation of animals, as well as the care of appropriate equipment of the whole transport unit. Moreover, the fact that animals are carefully checked at the time of boarding can be a very important factor. Veterinary supervision and assistance of qualified personnel make it possible to identify animals that are sick or in poor condition [Szczepańska 2012; LiveCorp Australia 2020].

Transport to the slaughterhouse is inevitable and is a highly stressful factor for animals. One might hypothesise that it is even more stressful than living in improper conditions. The conditions of daily life are familiar, relatively constant, and predictable to animals, while transport is something that happens once or twice in a lifetime and is an unknown process. Road transport carried out in an inappropriate manner, with inadequate equipment and in improper conditions, as well as with inadequate loading of the animals may lead not only to defects in the meat and weight loss of the animals but also to numerous deaths. Such a situation is incompatible with the principles of animal welfare that go in line with the concept of sustainable development.

It is therefore extremely important to make the public aware of the risks and burdens of sourcing meat from industrial and large-scale livestock farms, from which

the livestock is often not transported properly. Improperly performed transportation ultimately leads to an uneven environmental burden. Breeding in industrial conditions is very intensive (reproduction, breeding, feed consumption, faeces generation), which has a negative impact on the environment. Allowing an animal to die during transport places an additional burden on the environment due to the need to dispose of it and to the loss of possibility to consume its meat. From the economic standpoint, the costs related to disposal of carcasses or management of meat of lower technical usability were estimated in 2009 in Poland at the level of PLN 50 million annually (unfortunately, more recent data on this subject is not available). Every year, the Minister of Agriculture allocates considerable sums of money for subsidies to farms that are forced to dispose of dead animals, which, as a consequence, does not motivate the farms to improve the living conditions for animals.

The causes of meat quality variation cannot be viewed through the lens of a single factor. Meat quality, in the broad sense of the term, is a resultant of many environmental factors, such as age, species, breed, animal diet, welfare level, zoo-hygienic conditions of breeding, all factors related to the pre-slaughter handling of livestock (loading, transport, unloading, pre-slaughter holding, slaughtering method), but also of individual factors associated with the animal, such as the ability to produce collagen, intramuscular fat, and short and long muscle fibres.

In numerous surveys, it was found that meat consumers indicate as the most important factors in the assessment of meat quality and desirability the following sensory characteristics: colour, smell, palatability, tenderness; the following technical characteristics: visible marbling, meat juice leakage; and the following culinary characteristics: ease of preparation [Denaburski, Bąk and Daszkiewicz 2003].

Pre-slaughter handling includes loading of animals into the means of transport, transport, unloading, holding during the period immediately prior to slaughter and the manner in which slaughter is carried out. During these operations, slaughter animals are exposed to a wide range of factors that can generate stress, i.e., lack of water and food; restriction of movement; restriction of natural behaviour; exposure to pain due to the limited space area of the means of transport; transport microclimate; inadequate air supply in improperly prepared trailers; movement; sudden turning; acceleration and braking; shocks and vibrations, and noise. So many stress factors simultaneously acting on an animal in an extremely strong way usually lead to increased animal mortality, rapid weight loss, carcass damage, and deterioration of meat quality [Wójcik et al. 2011].

Speaking of quality defects in meat, one must first of all classify the most common ones that affect all animal species: PSE (Pale Soft Exudative), ASE (Acid Soft Exudative), RSE (Reddish-pink Soft Exudative), and DFD (Dark Firm Dry). The occurrence of individual meat defects, such as the number of deaths, depends

on the presence of stress factors, but also to a certain extent on genetic and environmental factors in general.

A study conducted in 2012 by Przybylski et al. on a group of 390 porkers showed that 15.38% of the meat obtained was defective, of which 2.31% of the meat had the PSE defect, 5.13% partially had the PSE defect, 5.38% had the ASE defect, and 2.56% had the DFD defect. In the cited studies, defective meat with low final pH (PSE, partially PSE, and ASE) was found to have higher losses during heat treatment. Moreover, meat with the ASE defect was characterised by the least marbling, juiciness, and palatability after cooking, and at the same time the highest level of acceptability when evaluated raw. The opposite was true of meat with the DFD defect.

The respondents showed the lowest level of acceptance for this meat when raw, while the highest ratings were given to the marbling, juiciness, and palatability of this meat when cooked [Przybylski et al. 2012].

Tereszkiewicz et al. related the formation of the PSE and DFD quality defects to the transportation time (number of kilometres travelled). It was found that for transport over a distance of less than 200 km, the DFD defect is virtually non-existent, while the PSE is present in 21–22% of the total meat yield. In the case of longer transport, over a distance of 300 km, the PSE defect was found in 10% of the meat yield and the DFD defect in 3.7%; for a distance of 400 km, the PSE defect was found in 10% of meat and the DFD in 8.7% of meat. This leads to the conclusion that the DFD defect is associated with long-term animal stress [Tereszkiewicz, Molenda and Pokrywka 2011].

As for animal deaths, the statistics mostly refer to pigs and poultry. In 2006, Ellis and Ritter published a study that shows a relationship between mortality rates and season of the year. In summer and winter, more deaths were observed than in spring and autumn (respectively [% of total transport]: 0.79% in spring, 1.13% in summer, 0.85% in autumn, and 1.16% in winter). The authors concluded that the distribution of results may be influenced by more extreme weather conditions in summer and winter than in seasons with more moderate temperatures.

In 2008, Ritter et al. analysed the problem of seasonality of pig deaths in transport in the context of different types of transport equipment called pot-belly (large, protruding, circular transport surfaces) and straight-deck (straight, rectangular transport surface that uniformly distributes the load). The number of deaths was on average higher in pot-belly trailers, as it was equal to 0.96% of the total transport, and lower in straight-deck trailers where it was equal to 0.85%. The results of this study also confirmed changes in the number of deaths depending on the season: 0.77% of the total number of animals in the spring, 0.82% in the summer, 0.99% in the autumn, and 1.03% in the winter.

On the other hand, the percentage of animals requiring immediate trimming of damaged body parts after slaughter was 6.72% of the total number of transported animals for the former transporter and 7.29% for the latter. The percentage of

animals with markedly damaged skin in the pot-belly transporter ranged from 6.2% in winter to 14.0% in summer, and in the straight-deck transporter – from 2.9% in winter to 9.1% in autumn. On the other hand, a 2009 study by Ritter et al. indicates that there is a relationship between intensification of livestock production and a decrease in the proportion of animal deaths. According to the authors, the technological development of transport has kept pace with the numbers of livestock transported. For example, in Germany in 1993 the death rate was 0.50% of animals transported and in 2003 it was 0.10%. In the UK, the oldest data on animal deaths dates back to 1961 and is 0.10% of the number of livestock transported. The percentage rose as high as 0.27% over the years and then declined to finally reach 0.05% of deaths in 1994. Unfortunately, not in all countries are the figures so optimistic. In Canada, from 1996 to 2004, the percentage of deaths decreased from 0.14% to 0.12% [Ritter et al. 2009].

The number of broiler chicken deaths in transport is referred to as Chickens DOA (dead on arrival). There are very different reports in the literature on the value of this indicator related to poultry transport in Europe [% of total livestock transported], e.g.: 0.15% [Mitchell 2006], 0.19% [Gregory and Austin 1992], 0.25% [Vecerek et al. 2006], 0.35% [Petracci et al. 2006], 0.46% [Nijdam et al. 2004], to as high as 0.67% [Fries and Kobe 1992]. These values are highly variable, but the important thing is that they did not exceed 1% of the animals transported. Such low levels of mortality are not recorded for pigs.

In 2016, Vecerek et al. conducted a study on the relationship between the seasons of the year and the animal transport distance and the mortality during transport. It was found that the smallest number of deaths is recorded for distances of 51–100 km (approx. 0.30%) followed by less than 50 km (approx. 0.34%), 101–200 km (approx. 0.45%), 201–300 km (approx. 0.55%), and above 300 km (approx. 0.70%). On the other hand, with regard to the relationship between the number of deaths and the season, it was found that the smallest number of deaths occurred in summer (approx. 0.28%), followed by autumn and spring (approx. 0.32%), and the largest number occurred in winter (approx. 0.55%). Therefore, the optimal environmental conditions in which poultry live on a daily basis must be taken into account and adapted during transport. Extreme temperature changes – from a warm farm to the transporters – that occur during the winter can result in increased animal death rates.

In addition to meat quality defects or animal deaths, skin injuries are very often observed, which lead to meat hyperaemia and reduce its visual value. Tereszkiewicz et al. 2011 found that during transport of porkers over a distance of 100 km, 67.5% of the animals suffered skin injuries; for a distance of 200 km it was 71.2%, for 300 km – 82.5%, and 400 km – 87.5% of all animals.

The data presented clearly shows that transport is a highly stressful factor for animals. Developments in transport technology cannot completely eliminate animal

deaths during transport. The positive trend in the changes studied demonstrates stabilisation rather than an increase in the percentage of dead animals.

## 6. MARINE TRANSPORT OF ANIMALS FOR SLAUGHTER

Transport of animals by sea can be carried out using specialised vessels (cattle ships) and cargo ships (general cargo ships, bulk carriers, and container ships). Cattle ships can be used to transport slaughter animals for periods of more than 10 days.

Universal means of transport, i.e., roll on-roll off (ro-ro) vessels, are used for transport of small numbers of animals and over relatively short distances. Containers with animals must not be tightly enclosed due to the required access to air. In the case of enclosed decks, the vessel shall be equipped with an adequate ventilation system, an auxiliary power supply, and an alarm system. On the other hand, in the case of open decks, it is imperative to protect the animals from splashing seawater. Development and investment plans of both Tricity and Polish container terminals, due to the intensification of general cargo transport, may also enable development of port services to such an extent that it will increase the frequency of small-scale animal transport [Szczepańska 2012].

## 7. REQUIREMENTS FOR ANIMAL TRANSPORT VEHICLES

Animal welfare in road transport is affected mainly by the design of the means of transport. Compared to the transport of other goods, the transport of animals is subject to particularly strict legal restrictions. This is regulated by a number of national and European Union laws. Unfortunately, published inspection reports and press reports indicate numerous deficiencies in carriers' compliance with the law. Like any logistical process, animal transport can be divided into stages: preparation of animals for transport, loading, transport, and unloading. Each part of the process causes enormous amounts of stress for the animals, which is associated with forced changes to their familiar, safe environments. However, the law in this area states that the carrier is absolutely obliged to carry out transport of animals using means of transport that are suitable for the specific species and age range, but also suitable for the safe and humane transport of animals.

Veterinary literature includes numerous publications that describe the adverse effects of transport on the organisms of transported animals. Ślipek et al. (2015), based on an analysis of legal acts, recommend dividing design requirements for road transport of animals into functional and non-functional. The functional aspect consists in introducing requirements identified as necessary into the equipment of the means of transport. This is aimed to reduce or eliminate omissions of essential

elements and those specified in the requirements. For this criterion, a set of design requirements was created, which are divided into individual functions, in which tasks were assigned degrees of importance. The levels of importance are: critical requirements, which result directly from the current legislation and whose fulfilment theoretically ensures the welfare of transported animals; desirable requirements, which are less stringent, but also important, whose fulfilment is not mandatory but improves welfare of animals during transport; and additional requirements, which can further improve the welfare, but which in the opinion of some carriers are excessive.

The critical requirements describe the fundamental criteria for ensuring minimal welfare of animals during transport. The desirable requirements are those that would be worth putting in place to provide animals with somewhat more than the minimal comfort. Additional requirements, which are currently only a luxury in Poland, make it possible to ensure the lowest possible exposure to stress factors for animals during transport. In addition, the more of the additional requirements are met, the faster and more convenient is the handling of the transport for the workers, and thus the better it is for the livestock.

## 8. LEGAL CONDITIONS OF ANIMAL TRANSPORT

Animal transport is subject to many legal restrictions both in Poland and in the European Union. The basic requirements for ensuring the safety and welfare of transported animals are set out in Chapter 7 of the Act of 21 August 1997 on animal protection (Journal of Laws of 2019, item 122). Detailed regulation of requirements related to animal transport is provided in Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97 (OJ EU.L.2005.3.1). However, these regulations do not apply to transport of animals that does not take place in connection with a business activity and to transport of animals directly to or from veterinary practices.

All regulations related to transport of animals are based on several basic premises. Transport must take place under conditions that prevent injury or unnecessary suffering. The duration of transport should be as short as possible. Animals must be able to satisfy all their needs during transport and it is important to give them the possibility to adapt to the means of transport, the loading, and the unloading. The personnel handling animals during transport must have appropriate authorisations and must not use violence or other methods that cause avoidable fear, suffering, or injury to the animals. The personnel are required to regularly check the condition of the animals and their access to water (and possibly to feed). All laws strictly forbid transporting animals unfit for transport, i.e.: injured, sick, or mutilated animals [Dobrzański, Dobrzańska and Klisko 2012; Tereszkiewicz et al. 2012].

Both road and sea transport of animals require proper licensing. Only authorised carriers with a transport contract or sub-contract are authorised to perform such operations; however, they must also have documents stating the origin of the animals, the dates and times of departure and arrival, and the destination of the animals. There are a number of conditions that must be met to be granted a livestock transport permit and the carrier must demonstrate that it has the proper staff, equipment, and procedures in place. Such a permit for road transport is issued for a maximum period of 5 years and does not apply to long-term transport, i.e., transport lasting longer than the maximum statutory time of 8 hours [Dobrzański, Dobrzańska and Klisko 2012; Tereszkiewicz et al. 2012]. However, transport by sea over a distance of more than 10 nautical miles always involves an inspection of the vessel and the issuing of a certificate of approval in accordance with OJ EU.L.2005.3.1.

Annex I of the Regulation specifies the groups of animals unfit for transport: pregnant females (more than 90% of the duration of pregnancy), females that have undergone parturition during the 7 days prior to the transport, newborn mammals (until the umbilical wound has healed), mutilated animals and animals incapable of independent movement, and animals with open wounds. In the event of disputes, the veterinarian has the final say. Slightly injured animals and animals in the initial stages of a disease suffered during transport should immediately be given first aid and isolated so that they cannot suffer further injury. When an animal is severely injured, a veterinarian may decide that it should be slaughtered immediately [Dobrzański, Dobrzańska and Klisko 2012; Tereszkiewicz et al. 2012].

During the loading, transport, and unloading of animals it is not permitted to sedate the animals (unless, in exceptional cases, the accompanying veterinarian orders otherwise), to use prods, to lift or jerk the animals, to tie, to strike, or to apply pressure. For these reasons, the personnel handling the animals are required to undergo appropriate training, which involves obtaining the necessary qualifications. Animal carers should be calm, patient, and able to handle animals in a way that does not involve cruel behaviour [Dobrzański, Dobrzańska and Klisko 2012; Tereszkiewicz et al. 2012].

Law regulates basically all aspects related to transport and design of vehicles, loading spaces, temperature conditions, watering, feeding, and transport time discussed in detail above [Dobrzański, Dobrzańska and Klisko 2012; Tereszkiewicz et al. 2012].

## 9. SUMMARY AND CONCLUSIONS

The problem presented in the paper covers all logistic processes that can negatively affect the quality of meat. Improper animal transport, whether of short or long duration, cannot improve the final quality of the product, but can significantly worsen it. This is true especially in the case of transport equipment where the vehicle

design requirements presented herein, which are defined as critical, desirable, and additional, have not been taken into account. In theory, fulfilment of the critical requirements should ensure the desired quality of meat, but only fulfilment of all the desirable and additional requirements gives the greatest chance to obtain meat that is not changed during transport. In the case of transport by sea, account must be taken, above all, of the duration of such transport, which can be more than 10 days, as opposed to several hours in the case of transport by truck. This is important because failure to use all possible means to provide the most comfortable conditions for animals during such a long journey is simply inhumane. Animals are unable to comprehend what is happening and why, and transport significantly deteriorates the final quality of their meat, which is uneconomical and non-ecological.

Fulfilling the responsibilities of both the logistician and the staff responsible for the care, loading, transport, and unloading of animals minimises the negative effects of transport. Therefore, only unforeseeable factors, i.e., a sudden change in weather conditions, random events on the road, and unjustified animal fright, can contribute to a deterioration in the quality of the product at the final stage of its trade. This paper shows that quality is a factor that is perceived subjectively, but some defects in meat caused by failure to meet the above requirements make it possible to assess transport objectively.

It is important to take action that will allow for the formation of attitudes and behaviours of Polish consumers aimed at minimising the amount of meat consumed and increasing the diversity of its types. Such changes will allow easier adaptation of the means of transport to the strictest requirements, since fewer animals will be transported and the emphasis will be on meat quality. The current trend in Poland related to minimal consumption, also referred to as deconsumerism, creates fertile ground for further creation of consumer awareness.

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