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THE INFLUENCE OF TRANSPORT ON THE QUALITY OF POULTRY MEAT®

Wpływ transportu na jakość mięsa drobiowego®

Key words: transport, stress, poultry meat, quality.

The paper presents the impact of ante-mortem turnover on poultry stress and the effects of transport stress on meat quality and safety. Animal transport is one of the most stressful phases of ante-mortem turnover, during which birds are exposed to a number of unfavourable stress factors. During transport, skin damage and bodily injuries occur, carcass quality deteriorates, leading to unfavourable quality changes in the meat (changes in pH, colour, defects in PSE and DFD meat, microbiological and sensory changes) and deaths of birds.

Słowa kluczowe: transport, stres, mięso drobiowe, jakość.

W artykule przedstawiono wpływ obrotu przedubojowego na stres u drobiu oraz skutki stresu transportowego na jakość i bezpieczeństwo mięsa. Transport zwierząt jest jedną z najbardziej stresujących faz obrotu przedubojowego, podczas którego ptaki narażone są na szereg niekorzystnych czynników stresowych. Podczas transportu dochodzi do uszkodzeń skóry i urazów ciała, pogorszenia jakości tuszek prowadzących do niekorzystnych zmian jakościowych mięsa (zmian pH, barwy, powstawania wad mięsa PSE i DFD, zmian mikrobiologicznych i sensorycznych) a także padnięć ptaków.

INTRODUCTION

The global production and consumption of poultry meat has increased sharply over the past few decades. It can be predicted that in the next decade the demand for poultry meat will grow [11]. The predominant amount of meat obtained from breeding birds is the meat of burrowing poultry (chickens – 86.2% and turkeys – 7.5%). About 2 million birds for slaughter are produced in Poland [20]. All poultry species employed in the main intensive production systems are transported at least twice during their lifetimes over distances that may range from a few kilometres to journeys with durations of many hours. Most journeys are by road e.g. form hatchery to production site or from farm to processing plant [11, 12]. During transport, slaughter birds are in completely new environmental conditions. The transport process is the most burdensome stage of the ante-mortem turnover for the bird's organism and an indispensable element of the logistic chain [7]. All the procedures and practices involved in transportation and the micro-environments prevailing in containers and vehicles may impose varying degrees of stress upon the birds [11, 13]. Loading at the farm and unloading at the slaughterhouse are the most stressful factors in transport. The result of the accumulation of such a large number of stressors in a short period of time is the increase in mortality, weight loss and carcass damage, and deterioration of the quality of meat [21, 24] Welfare during transport may be improved by a more holistic consideration of the birds' physiology, rearing conditions, pre-transport handling and the prevailing conditions and stressors that may be imposed during the journey [4, 9, 11, 19].

INFLUENCE OF ANTE-MORTEM TURNOVER ON STRESS IN POULTRY

Transport stress is the result of stimuli of endogenous, physical, chemical, emotional and psychological origin [6]. During the ante-mortem turnover, the slaughter birds are affected by many unfavourable stimuli, including lack of water and food, noise, unfavourable living conditions leading to injuries and disturbances of the organism's homeostasis. Stress stimuli are so strong that they exceed the body's adaptive abilities [7]. Whilst genetic selection in broiler chickens has resulted in major improvements in growth rates and production efficiency these advances may also be associated with a reduced resistance to stress, altered heat exchange capacity and muscle and cardiovascular pathologies [11, 12].

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The characteristic basic symptoms of the first stage of stress are nervous agitation, increased blood pressure, hyperglycaemia, temperature increase and leukopenia [6]. Stress stimuli are received in many areas of the brain, activating the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system, which release a number of substances affecting the state of mobilization of the body in order to defend against the stressor. This results in a changed behaviour of birds, actuates a series of metabolic pathways in order to obtain energy, and stimulates the immune system [8]. As a result, there are changes in many physiological parameters, such as the heart rate, body temperature, and the concentration of hormone and energy substances [7]. Existing pathologies and injuries may further compound the situation.

Research indicates that inadequate transport conditions create short-term stress by increasing cortisol levels, which lower levels of prostaglandins, which protect the role of the intestinal mucosa. The consequence of this is the penetration of intestinal microbes into the blood and this into all tissues, posing a serious threat to safe food. Bird fatigue during transport also leads to energy shortages. After short-term transport, an increase in serum glucose is observed as a result of energy being obtained from glycogen stored in the liver. Over time, the bird's organism is not able to maintain a proper energy balance, leading to hypoglycaemia, stimulating glucagon secretion, which intensifies lipolysis, which results in an increase in the concentration of non-esterified fatty acids [1, 3, 7, 23].

Stimulation of hormonal mechanisms releases adrenaline, making the animal ready to fight or flee. There is also an increased metabolism, which leads to an increased energy demand, resulting in the breakdown of carbohydrates, proteins and fats. The first symptom is dehydration [2, 21]. Water losses in the body of birds after a few hours of transport can reach up to 5% of the body weight. A decrease in glycogen levels leads to an increase in the level of glycogen breakdown products in the muscles, including lactic acid, leading to vasodilation and blood circulation disorders. The result is that the meat does not bleed completely during slaughter and the pH level of the meat is lowered. According to Doktor [4], the physiological reaction of birds to high ambient temperature is an increase in rectal temperature, which indicates overheating of the body. Doktor and Połtowicz [5] observed a significant increase in rectal temperature of broiler chickens waiting to be slaughtered at an elevated temperature (35.6ºC) compared to chickens kept under optimal thermal conditions (19.4ºC) before slaughter.

Rapidly growing lines of birds may exhibit a reduced thermoregulatory capacity compared to their genetic predecessors and may thus be more susceptible to heat stress in transit and to consequent problems including muscle damage, acid-base disturbances and reduced meat quality [22]. Genetic selection for improved growth rate and feed conversion efficiency may be associated with altered mitochondrial function and changes in the production of reactive oxygen species. In this context acute heat stress has been demonstrated to increase superoxide free radical production in broiler chicken skeletal muscle [14]. This mechanism may be responsible for the transport stress and heat stress induced muscle damage and for the changes in muscle and meat quality observed in birds. Also it may be suggested that muscle dysfunction may lead to problems of altered locomotor capability and therefore behavioural changes and reduced welfare [11, 15].

THE IMPACT OF THE EFFECTS OF TRANSPORT STRESS ON THE QUALITY AND SAFETY OF MEAT

The most important problems related to the quality of meat resulting from transport stress include PSE and DFD syndrome [10, 11].

Short-term sudden stress may accelerate post-mortem glycolysis, and this increase the rate of acidification of the meat, which contributes to the development of the PSE (*Pale Soft Exudative)* defect. The PSE defect is the result of an abnormal metabolism of the animal's body before slaughter and consists in the formation of a significant amount of lactic acid in the muscles, which results in a rapid drop in pH immediately after slaughter (<5.5). Then, the cell membrane breaks, through which water and muscle pigments leak. The watery PSE meat has a soft texture and a light colour. In addition, it is characterized by reduced water absorption, a moist cross-sectional area and a large leakage of water [9, 11]. The low wateriness of the meat limits its usefulness in processing, and the unnatural light colour and soft texture reduce its value as culinary meat [1, 17]. Modern hybrid chickens are more prone to heat stress and stress-induced myopathies. The occurrence of this defect is favoured by improper loading, type of transport, temperature fluctuations. It is estimated that the PSE defect affects from about 5 to 40% of meat in the poultry industry, leading to significant financial losses [10, 18].

The consequence of long-term pre-slaughter stress and depletion of glycogen stores during the animal's lifetime is insufficient acidification of the muscle tissue, which appears as a DFD defect (*Dark, Firm, Dry*) [10]. Glycolysis is then slow and may end at higher pH values – above 6.0. Higher pH results in light absorption and water binding capacity and results in a dark hard dry surface. In addition, DFD meat can facilitate the growth of bacterial microorganisms, thereby shortening the shelf life. The main causes of stress causing DFD defect are heat stress, temperature fluctuations, transport stress lasting many hours, long distance, improper ante-mortem procedures [9, 11]. The occurrence of meat defects in poultry is described in the literature at 5÷30% [24].

Carcasses of slaughter birds, in order to have full technological suitability, as well as to be able to be traded in or in the form of culinary elements, must be free from bruises and bloody bruising. However, changes of this nature are the most common effect of ante-mortem transport and affect a large number of transported birds. Transport distance and high ambient temperature [9] are decisive in the event of personal injury. The transport of birds contributes to injuries in the form of bruises of muscles and skin, as well as injuries in the form of fractures and dislocations of the limbs. Injuries of this nature most often occur during the loading and unloading of poultry [11]. Ecchymosis or haemorrhage occur in meat after capillary rupture, reduce the sensory quality of meat, its higher pH, and may constitute an ideal medium for the growth of bacteria in the meat and reduce its durability and safety [24]. During transport, the birds are exposed to falls and blows, resulting in internal bruises. It is a sanitary obligation to remove bruises from meat as they shorten its shelf life [21].

The loss of body weight during the transport of chickens to the slaughterhouses has an impact on the efficiency and quality of the final product [4]. The increasing impact of heat stress on the bird's organism significantly increases the loss of body height. Dadgar et ol [3] observed higher weight losses of chickens kept before slaughter a tan elevated temperature (29°C) compared to birds kept in optimal thermal conditions (18°C).

A consequence of transport stress in slaughter birds is the occurrence of the ADS (Acute Death syndrome), which mainly affects intensively fed and rapidly growing broiler chickens [11] The cause of deaths during transport is also asphyxiation due to lack of oxygen. A bird mortality rate of 0.04 to 2% during transport is associated with enormous costs. Falls are twice as frequent in roosters than in hens, which is probably related to their greater body weight [15]. Mortality has long been a concern in relation to poultry transportation and continues to be an episodic issue in all countries where meat birds are produced. Oba et al [16] have described a highly significant relationship between mortality of broilers in transit (Dead on Arrivals) or in lairage and the maximum daily ambient temperature.

SUMMARY

One of the most stressful ante-mortem operations is the transport of birds to the slaughterhouse. During transport, animals are exposed to very high stress related to the change of environment and means of transport, as well as to thermal stress and fatigue. The result of the accumulation of a large number of stressors in a short period of time is the increase in bird mortality, loss of body weight and damage to carcasses and deterioration of meat quality (changes in the pH value of meat, colour parameters, reduction of technological, microbiological and sensory quality). The occurrence of quality defects of PSE meat is favoured by a short period of transport stress, while after long transports, DFD meats is more common.

PODSUMOWANIE

Jedną z najbardziej stresujących operacji przedubojowych jest transport ptaków do rzeźni. Podczas transportu zwierzęta są narażone na bardzo silny stres związany ze zmianą otoczenia i środkiem lokomocji, a także na stres termiczny i zmęczenie. Efektem nagromadzenia się w krótkim okresie czasu dużej liczby stresorów, jest nasilenie śmiertelności ptaków, straty masy ciała i uszkodzenia tuszek oraz pogorszenie jakości mięsa (zmiany wartości pH mięsa, parametrów barwy, obniżenie jakości technologicznej, mikrobiologicznej i sensorycznej). Powstawaniu wad jakościowych mięsa typu PSE sprzyja krótki okres stresu transportowego, natomiast po długotrwałych transportach częściej występuje mięso DFD.

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