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Meat quality: Impact of various pre-slaughter conditions

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Abstract. Poor animal welfare is a growing issue of concern all over the world. During pre-slaughter phases, some activities, if poorly performed, lead to stress reactions in animals. Animals' responses to a great extent depend on species, breed, sex and age of animal. Food and water deprivation, exposure to unfavourable environmental conditions, improper handling and social mixing are just some indicators of compromised animal well-being. All these detrimental activities lead to the development of carcass and meat quality defects. Among them, important defects are untimely death of animals, body weight loss, carcass damage, and the two major meat quality defects, i.e. pale, soft, exudative (PSE) and dark, firm, dry (DFD) meats. Consumer dissatisfaction results, and with economic and financial losses, producers are placed in a disadvantageous position.

1. Introduction

Over the past few decades, meat consumption has significantly increased throughout the world [1]. Customer demands for meat safety and quality are high, but at the same time, there are great opportunities and demands for lower meat prices [2]. Meat quality can be defined from the aspect of its functional or conformational attributes. Functional characteristics are desirable and include yield and gross composition, appearance and palatability, while conformance attributes are linked precisely with customers' perceptions [3]. In this respect, important visual traits are texture and colour of meat, and colour, amount and distribution of fat. When the meat is cooked, customer satisfaction is largely determined by meat tenderness, flavour, odour and juiciness [4].

In general terms, each meat trait is under single or multiple gene control. However, expression of genotype depends to a great extent on environmental conditions, which can differ. These conditions, from the aspect of meat quality, include various pre-slaughter conditions and post-slaughter factors. Interactions between genes and environment occur to a greater or lesser degree, and it is difficult to separate each of them [5]. The pre-slaughter phase involves all activities and processes of animals from a farm to the slaughterhouse. These activities are carried out on farm, market, during transportation and at the slaughterhouse. If any of these phases performs poorly, animal welfare will be compromised. Furthermore,



stress reactions then occur, resulting in negative changes to carcass and meat quality [6]. Thus, the aim of this paper is to point out some pre-slaughter conditions that can reduce animal well-being and meat quality.

2. Pre-slaughter stressors

During their lifetime, animals are exposed to various stressful situations. How they respond largely depends on species, breed, sex and age of animal. Ruminants are more resistant to stress than poultry and pigs. Females and young animals are more susceptible to stress than males and older animals [7]. The animal's previous experience with handling on-farm could influence further behaviour [6, 8]. For instance, pigs will be easier to move if they have been correctly handled earlier [9].

After their growth period, animals are sent to the market, or directly from farms to the slaughterhouse. Transportation can have negative impacts on animal health, well-being and performance as well as on food safety and carcass and meat quality. Stress situations cause injury, mortality and morbidity, and are consequences of food and water deprivation during the transportation period, exposure to noise, vibrations and toxins, exposure to variable climate conditions, poor handling and mixing with unfamiliar groups [10]. For cattle, handling procedures during loading and unloading have been described as major stressors [11]. The effects of stress on animal can vary according to various factors such as the quality of the procedure, handlers' experience, the quality of the handling equipment and animal health conditions [12]. Experience of the transport drivers also plays an important role. Body weight loss of animals at unloading was lower in cattle transported by drivers who had 6 or more years experience than in those driven by people with 5 years or less experience [13].

At the markets, animals are usually kept in open pens and can be in mixed groups. Exposure to these negative environmental conditions, starvation, water withdrawal and social dominance are just some of the factors that can affect the physiological integrity of an individual animal. At the slaughterhouses, animals rest in lairage before slaughter in order to fill glycogen reserves that have been harvested during earlier pre-slaughter activities. Despite this positive effect, lairage can be a main source of meat quality problems. Animals can gain bruises and injures as a result of fighting among themselves, being beaten poorly trained workers or overcrowding [7]. The lairage acts as a reservoir of pathogenic microorganisms, and excessive retention of animals increases the risk of carcass contamination [14].

3. Affected carcass and meat quality traits

All of these stressful *ante-mortem* operations lead to the development of carcass and meat quality defects. Among them are mortality, carcass damage, shrink loss, contamination by pathogens, and pale, soft, exudative (PSE) and dark, firm, dry (DFD) meat. Untimely animal death is considered as the worst situation that could happen from the financial aspect, due to the total loss of the carcass. Carcass damage such as bruising, haemorrhagies, skin blemishes and bloodsplash are clear signs of improper handling procedures. All these damages cause extravascular accumulation of blood and, therefore, can serve as a potential medium for microbial growth, allowing accelerated meat spoilage. Trimming off the affected parts decreases meat yield and value and increases costs and processing time [3].

PSE and DFD meats are two major problems faced by the meat industry. Previously, PSE was linked with pigs and DFD with all meat animal species. However, it can be considered that both conditions occur in all animal species in correlation with how the animals were treated before slaughter [15]. Stress is manifested from all pre-slaughter processes and depending on its form, one of these meat defects can develop. PSE is caused by acute stress. Ordinarily, detrimental activities just before the start of slaughter such as the use of electrical goads, hitting animals, or the animals fighting among themselves cause this phenomenon in meat [3]. The accelerated rate of *post-mortem* glycolysis is followed by the rapid decline of pH while the temperature of the meat is still high [16]. Meat with pH lower than 6.0 measured 45 minutes after slaughter or with ultimate pH <5.3 is labelled as PSE [3, 17, 18, 19]. On the other hand, chronic stress

conditions induced by too long transportation, starvation and high stocking density at lairage during a long time lead to the occurrence of DFD meats [3]. Due to a small amount of glycogen *post-mortem*, the normal process of acidification is slowed down, keeping the pH of meat high. Meat with ultimate pH >6.0 can be considered as DFD [19, 20, 21, 22]. Both of these conditions are undesirable to consumers because of the poor meat quality and low processing quality for further processed products [23].

4. Conclusion

Activities and processes before slaughter are essential factors associated with carcass and meat quality. Improper pre-slaughter conditions affect animal welfare, leading to the deaths of animals, body weight loss, carcass damage, and PSE and DFD meats. In addition, along with consumer dissatisfaction, producers are placed in a disadvantageous position due to their economic and financial losses.

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