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Use of Infrared Thermography in Determining Meat Quality

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Abstract

In recent years, meat quality has started to take an important place in food products. Situations such as stress, pain, and infection before slaughtering reduce the quality of the meat. There are many different techniques used in determining meat quality, these are include invasive and non-invasive techniques. Because of advances in technology, the popularity of non-invasive techniques has increased. Thermography can be considered as the most recent of these invasive techniques. Thermographic measurement can be made from different parts of the body such as skin and eye. Due to the minimal artifact formation, measurement of eye temperature is used more frequently than other areas of the body. This review is aimed to give information about the non-invasive detection of meat quality by infrared thermography.

Keywords: Artifact, eye, food, non-invasive, temperature.

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INTRODUCTION

Meat and meat products are the main sources of animal protein in human life. In addition to containing high-quality protein, meat contains vitamins, minerals, and other substances necessary for human health (Nurhayati et al. 2016). Advances in people's living standards have led to questioning the quality and safety of the food products that people consume. Chemical methods, mechanical methods, and inspection methods, which are among the traditional methods used in determining the quality of meat and meat products, have begun to leave their place to non-invasive methods because they are both times consuming and boring (Xiong et al. 2017). Non-invasive techniques recently used to determine meat quality include ultrasound imaging, dual-energy X-ray absorptiometry, tomographic imaging, optical imaging, magnetic resonance imaging, biopsy, and odor imaging (Scholz et al. 2015; Xiong et al. 2017).

Pre-slaughter stress

Stress is one of the most important factor affecting eating and meat quality. It has determined that the stress level before slaughter is directly related to the softness, aroma, juiciness, and shelf life of the meat (Warner et al. 2007). Many studies have reported that handling and stress applied to the animals before slaughter affect the meat quality by changing the pH and color, muscle glycogen, and rigor temperature of the meat (Hughes et al. 2014; Jorquera-Chavez et al. 2019).

Metabolic, behavioral, and physiological indicators can be used to determine stress in animals (Xiong et al. 2017). Metabolic indicators include the measurement of enzymes, hormones, and metabolites in blood plasma (Möstl and Palme, 2002). Behavioral indicators include lying, vocalization, and aggressive behaviors such as kicking (Rocha, 2016). Physiological indicators of stress are heart rate, heart rate variability, respiratory rate, body, and skin temperature (Mohr et al. 2002).

Measuring body temperature

Stimulation of the autonomic central nervous system increases metabolic activity and heat production by making changes in blood flow and peripheral vascular tone (Terrien et al. 2011). This situation causes an increase in body temperature. Previous studies have shown that body temperature in animals is directly related to stress (Stewart et al. 2005; Pighin et al. 2014). Body temperature can be measured with invasive and non-invasive ways; each has its own advantages and disadvantages. Although there are different anatomical sites used for measuring body temperature in animals, the most widely used region is the rectum (Giannetto et al. 2020). However, rectal measurement of body temperature is time-consuming and difficult in aggressive animals (Piccione et al. 2009). Therefore, temperature-detected microchips have been used in recent years (Jorquera-Chavez et al. 2019). These microchips can be implanted to the rumen, reticulum, ear, skin, or stomach (Prendiville et al. 2003; Gonzalez-Rivas et al. 2018; Jorquera-Chavez et al. 2019; Giannetto et al. 2020). However, since these microchips can migrate to other parts of the body, it may cause accidents, especially when eating meats offered for consumption (Pizzuti and Mirabelli, 2016).

Infrared thermography is a technique that measure the temperature of an object without any contact. In nowadays, this technology is using for the detection of body temperature in animals (Tattersall, 2016). So many anatomical locations have been used to detect body temperature in animals with infrared thermography such as skin and eye.

The previous studies have shown that the technique is highly correlated with animal core body temperature (George et al. 2014). Although the measurement of skin temperature is easier than the measurement of face temperature, the presence of residues, hair, feces, and water on the skin causes artifacts results by changing the temperature values (Weschenfelder et al. 2013). Because the eye is close to the brain and there is no possibility of artifacts that may occur in these areas, it is a suitable location for measuring the body's core temperature (Horcada et al. 2020). However, it has been stated that in commercial settings eye temperature becomes difficult to measure as animals shake their heads constantly (Rocha et al. 2019).

Relationships between ocular temperature and other biomarkers

Eye temperature is strongly correlated with meat color and pH. It has been reported that eye temperature is elevated when the meat color is darker than a score of 3. During stressful events, the animal body starts to use glycogen from the muscles. As a result of glycogen deficiency during slaughter, an insufficient amount of lactic acid will be produced and the pH of the meat will remain high, leading to dark, firm, and dry meat (Devine et al., 2006; Gregory, 2008). Since Creatine kinase and Aspartate transaminase have a direct relationship with muscle damage and physical stress (Mpakama et al. 2014; Tvarijonaviciute et al. 2017), eye temperature may increase.

CONCLUSION

The assessment of eye temperature in cattle is directly related to meat quality, as it may be a sign of pre-slaughter stress and pain in animals. This makes thermography a suitable technique for evaluating both meat quality and animal welfare.

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