Effects of Electrical Stimulation with Different Impulses on Physical Characteristics of Rabbit Meat

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Abstract. Meat becoming less tender with age. One of the methods to increase the meat tenderness is by electrical simulation. The objective of this study was to investigate the effect of electrical simulation with different level of impulses on physical characteristics of rabbit meat. Twenty carcasses of Flemish Giant rabbit were randomly subjected into four differents treatments (impulse levels), which were control, impulse 25, impulse 50, and impulse 75. Each treatment was repeated 5 times. Measured variables were pH, tenderness, water holding capacity, and cooking lose. The results showed that different levels of electrical stimulation had significant effects on the physical characteristics of rabbit meat. Higher impulse level caused lower ultimate pH and more tender meat. Overall, the best physical characteristics of rabbit meat was obtained from electrical stimulation with impulse level of 50.

Key Words : electrical stimulation, tenderness, rabbit, meat

Introduction

Rabbit is a potential meat animal because of it's rapid growth rate (Khotijah et al., 2004). Rabbit meat contains protein in proportion comparable to other far animals, but it contains low calorie and fat. Fat in rabbit meat is highly unsaturated fatty acids (Dal Bosco et al., 2004). Rabbit meat has relatively lower cholesterol content than other red meat, thus rabbit meat can be categorized as a healthy source of protein. However, to date, rabbits are more known as pet and fancy animal rather than meat animals. Young rabbits are kept as pets, and for breeding purposes, whereas unproductive and old rabbits are slaughtered for meat.

It is generally known that meat from older animals is less tender than that from young animals. Tenderness is one important physical characteristic that determine meat quality (Thompson, 2002). Tenderness is closely related to other physical characteristics of meat, such as pH, cooking loss, and water holding capacity. The decrease of pH to the ultimate pH after slaughter affects induces the release of protease enzyme. This enzyme breaks down meat protein causing more tender meat (Koohmaraie et al., 2002; Thompson, 2002). Furthermore, this affects cooking loss and meat's ability to hold water.

To improve tenderness, several methods have been developed and one of the methods is electric stimulation (Simmons et al., 2006). It has been reported that electric stimulation can increase tenderness of meat (Wiklund et al., 2001). Electrical stimulation facilitate rapid processing of carcasses without compromising meat quality (Janz et al., 2001).

Electric stimulation can be done in high and low voltage. A stimulation which uses voltage more than 150 V is called high voltage electric stimulation, while voltage less than 150 V is called low voltage stimulation. Impulse in electrical stimulation refers to the voltage interval which is coming out from stimulator. Generally, the voltage is on every other second (a second on followed by a second off). The voltage of 100 V in 50-150 second produces 25-75 impulses. The use of electrical stimulation of 100 V for 100 seconds produced optimum tenderness in beef and lamb (Savell et al., 1977; Cross, 1979; Pearce et al., 2009). Therefore, the aim of this study was to obtain electrical stimulation with optimum impulses to produce rabbit meat with optimum physical characteristics.

Materials and Methods

The research was done experimentally in the laboratory using a completely randomized design with four electrical stimulation treatments: impulse of 25, 50 and 75 and a control (no impulse). Each treatment has five replications, thus there were 20 experimental units of rabbit carcasses. Physical characteristics measured were pH, tenderness, water holding capacity, and cooking losses.

Carcasses were produced by slaughtering rabbits using the Kosher method, followed by removal of head, skin, internal organs, and lower legs. Carcasses were hung by the two back legs in a gallow. Electrical stimulation was applied by placing the positive electrode in the two thigh muscles, and the negative electrode at the end of the collar bone. After stimulation, carcasses were cut; samples for physical characteristics measurements were obtained from the thigh. All measurement was done four hours after dissection.

Measurement procedures

The pH of muscle was measured using a handheld pH-meter calibrated with pH 4 and 7 buffer solution. Tenderness of the meat was measured using a penetrometer (Muchtadi and Sugiyono, 1992). Thigh meat was cut 5 cm x 2,5 cm x 1,5 cm, then steamed for 30 minutes at 80-82^{o}C. After the sample reached room temperature, it was placed under penetrometer needle with horizontal fiber direction. The chuck of the penetrometer was released for 10 second, each time at different locations. Tenderness of the samples was read on the scale (gram/10 second).

Water holding capacity was measured using the Filter Paper Press Method according to the procedure described by Honikel dan Hamm (1994). Initially, the free water content of the meat was determined. A sample of 300 mg was placed on a Watman 41 filter paper and pressed between two glass plates for 5 min under 35 kg weight. Then, the wet and meat area in the filter paper was drawed on a transparent plastic. The size of wet area was determined by a milimeter block paper, and free water content (mg H_2O) was calculated as wet area divided by 0.0948 minus 8.0. Secondly, the water content of meat sample was determined using oven method. A porcellain cup was dried in an oven for 30 minutes, cooled in a desiccator and weighed. Meat from thigh part (5 gr) was placed in the cup and weighed. The cup with sample was dried under temperature of 100-102^{0}C for 16-18 hours. The cup and sample was weighed after cooled in the desiccator. The water content of the meat was the loss of weight after drying and expressed in percent. Finally, water holding capacity was calculated using the following formula:

$$\text{water content} = \frac{\text{Mg } H_2 0}{300} \times 100\ \%$$

Cooking losses of the meat was determined using the procedures described by Soeparno (1994). Meat sample was weighed, then placed in a polyethylene plastic bag. Then, the plastic and sample was placed in a waterbath at 80^{o}C for one hour. Cooling was done by placing the plastic bag with sample in a glass cup filled with cold water (10^{o}C) for 15 minutes. Meat sample was removed from the bag, drained and dried using tissue papers. Meat sample was re-weighed. Cooking losses (in percent) were calculated as the loss of weight after cooking divided by sample weight multiplied by 100.

Results and Discussion

The results of the experiment on the effect of electrical stimulation with different impulses on physical characteristics of rabbit meat is presented on Table 1. Data shows that electrical stimulation with different impulses significantly (P<0,05) affected physical characteristics of rabbit meat. The increase of impulse caused pH reduction, which might be due to the increase in the temperature of the meat. The raise of meat temperature caused the increase of chemical and biochemical reaction of the meat. It has been widely known that post-mortem electrical stimulation accelerated the decline on ATP and meat glycogenolysis (Simmons et al., 2006).

Acceleration of glycolysis resulted in higher production of lactic acid from glucose; in turn this decreased meat pH. Castaneda et al. (2005) reported that the rise of carcass temperature due to electrical stimulation accelerated ATP splitting and accumulation of lactic acid

Table 1. The physical characteristics of rabbit meat

Variables	Impulse Level			
	0	25	50	75
Meat pH	6.32 [a]	6.17 [b]	5.97 [c]	6.00 [c]
Tendernes (gram/10 second)	96.24 [a]	101.36 [a]	118.92 [b]	116.32 [b]
Water holding capacity (%)	2.74 [a]	2.27 [b]	1.36 [c]	1.52 [c]
Cooking losses (%)	18.50 [a]	23.30 [b]	33.16 [c]	31.50 [c]

Values bearing different superscript at the same row differ significantly (P<0.05)

resulting in a rapid decrease in pH. Furthermore, Pollidori et al. (1999) reported that in sheep, electrical stimulation with low voltage accelerated glicolysis process, which resulted in significant decreased of meat pH after 6 hours post-mortem of *Longissimus thoracis et lumborum* and *Semimembranosus*. That electrical stimulation accelerates pH decrease of meat was also reported by Wiklund et al. (2001). The decrease of meat pH was followed by the decrease of ATP in the muscle. However, electrical stimulation at 24 hours post-mortem has no significant effects (Maria et al., 2001). Based on the result of this study, the optimum impulse for electrical stimulation of rabbit carcasses was 50 because this caused a significant decrease in meat pH (P<0,05). When the impulse of electrical stimulation was increased to 75, no significant decreased of meat pH was observed.

The decrease of meat pH released proteolytic enzyme in the muscle. Protease enzyme released at low pH. Protease enzymes cleaved peptide bonds into more simple amino acids. Low pH of meat caused protein denaturation and splitting of the actin and myosin binding (actomyosin). Splitting the actin and myosin binding caused resulted in the increase of meat tenderness (Hopkins and Thompson, 2001; Thompson, 2002).

Electrical stimulation with higher impulses resulted in more tender meat. King et al. (2004) reported that the increase of meat temperature during stimulation accelerated ATP splitting and muscle contraction, therefore the structure of muscle fibers were stretched. Stretching the muscle fibers increased meat tenderness (Pospiech et al., 2003). Electrical has been extensivelly investigated to improve meat quality characteristics of goat, sheep, venison, deer, and beef with varying results (Wiklund et al., 2001; Simmons et al., 2006; Bekhit et al., 2007; Gadiyaram et al., 2008; Kadim et al., 2009).

The release of actin and myosin bindings and meat protein denaturation discharged water from the meat because of the lack in the ability of meat protein to hold water. The results of the current study showed that electrical stimulation with higher impulses resulted in lower water holding capacity. However, when the impulse increased from 50 to 75, the decrease of water holding capacity was not significant. This was because the close relationship between water holding capacity and pH of meat; low water holding capacity was attained at ultimate pH. This experiment showed that the pH of the meat decreased when the impulse of stimulation increased to 50, then it increased when the impulse increased from 50 to 75. In can be concluded that the ultimate pH of rabbit meat in this experiment was between 5.97 and 6.0. At this pH, the meat has low water holding capacity.

Wiklund et al. (2001) reported that electrical stimulation have no detrimental effects on drip loss. Meat with low water holding capacity means that proteins have low ability to hold water, and this will lead to more water release during chilling (drip loss) and cooking (cooking loss). The results of the current study indicated that the increase of impulse was followed by the increase of cooking losses. However, increasing stimulation of impulses from 50 to 75 have no significant effects on cooking losses. This means that the electrical stimulation of rabbit meat with impulse 50 produced meat with the best water holding capacity and cooking looses.

Conclusions

Electrical stimulation of rabbit carcasses significantly affects the physical characteristics of the meat. To produce rabbit meat with optimum physical characteristic, the use of electric stimulation with impulse of 50 is recommended.

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