Effects of Electrical Stunning Frequency and Voltage Combinations on the Presence of Engorged Blood Vessels in Goose Liver

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ABSTRACT The purpose of this study was to investigate the influence of nine electrical stunning methods using various frequency and voltage combinations on the occurrence of engorged blood vessels in goose liver. Two hundred seventy Gourmaud geese (liver-type line SI 14) were slaughtered at 12 wk of age, in groups of 90 at three different times. Thirty birds each were subjected to one of the nine stunning methods. Neck cutting was performed immediately after stunning. The duration of exsanguination was 11 min. After completion of bleeding, the birds were scalped, defeathered manually, and kept refrigerated. At 1 d postmortem, the carcasses were eviscerated and cut up. From the slaughterhouse, the livers chilled in ice were transported to the cannery where they were weighed and graded at 2 d postmortem and were further processed. All of the veins and capillaries full of blood were removed from livers, because their presence was a hazard to product quality by causing discoloration of the canned liver, and the percentage of liver weight loss was then determined. The loss in liver weight due to removal of engorged blood vessels was reduced ($P < 0.05$) at 350 Hz, 70 to 90 V, and 80 to 85 mA when compared to the results obtained with any other stunning method tested. It was concluded that the use of high-frequency currents for electrical stunning of liver geese might have considerable commercial advantages.

(Key words: electrical stunning, frequency, voltage, blood vessel, goose liver)

INTRODUCTION

Hungary is the world’s top producer of raw goose liver. Therefore, this product is regarded as a Hungarian specialty in many countries. Large quantities of this commodity are exported to France. In fact, Hungary’s goose liver exports make up approximately two-thirds of goose liver imports by France. The further-processed product, known as foie gras, is a great delicacy.

In recent years, there has been considerable public concern for the welfare of food animals, including poultry species, during stunning and slaughter. The European Union (1993) adopted detailed welfare-at-slaughter rules, which are set down in Council Directive 93/119/EC on the protection of animals at the time of slaughter or killing. Presently, the technologies to humanely stun and slaughter poultry are widely employed. The methods legally usable for stunning include captive bolt pistol, concussion, electronarcosis, and exposure to carbon dioxide.

From an animal welfare perspective, stunning should produce a rapid onset of stress-free insensibility of sufficient duration to allow the bird to remain unconscious until dead, either as a result of the stun itself or due to subsequent killing operations such as neck cutting during slaughter (Fletcher, 1999; Savenije et al., 2002). Electrical water-bath stunning is the most common method of immobilizing birds for easier killing in commercial poultry processing plants (Bilgili, 1992; Raj, 1998; Savenije et al., 2002). Electricity is convenient, economical, and requires little room. Much diversity exists in electrical equipment, concepts, and approaches to water-bath stunning. Electrical stimuli vary with respect to magnitude (current and voltage), duration (length of the water bath and line speed), oscillation frequency, waveform, current direction, and energy (Kranen et al., 2000). By passing sufficient electric current through the brain, a general epileptiform insult will occur, which is characterized by rapid and excessive depolarization of the membrane potential (Fricker and Müller, 1981). Upon electrical stunning the animal may die due to a heart attack and loss of oxygen to the brain. Insufficient currents may physically immobilize the bird but may not prevent perception of pain, stress, or discomfort by the animal (Bilgili, 1999). Stunning with high electrical currents is a humane method, when compared to low amperage or no stun, because there is less likelihood of a bird regaining consciousness before death (Gregory and Wotton, 1986). However, the high amperage applied in Europe causes more carcass and meat...
damage than the lower amperage customarily used in the United States (Craig and Fletcher, 1995; Hillebrand et al., 1996; Kang and Sams, 1999). Appearance defects result in a decline in sales and, thus, economic losses to poultry processors (Fricker and Müller, 1981).

The conflict between welfare and meat quality with the conventional low-frequency (50 Hz) water-bath stunning systems has provided the incentive for further developments in the area of stunners operating at high frequencies (>100 Hz). The use of high-frequency currents for electrical stunning of poultry may result in a marked improvement in carcass quality (Wilkins et al., 1998, 1999; McNeal et al., 2003).

The literature on stunning in swine, cattle, and broilers is abundant, but there is little information about pre-slaughter electrical stunning in geese (Schütt-Abraham et al., 1992; Turcsán et al., 2001). The objective of this research was to investigate the effects of electrical stunning methods with various voltage and frequency combinations on the occurrence of engorged blood vessels in goose liver.

**MATERIALS AND METHODS**

**Experimental Birds**

In previous force-feeding trials, the Gourmaud goose hybrid has been found to have optimum liver production characteristics (Szigeti et al., 1999). Therefore, this experiment was carried out with Gourmaud geese (liver-type line SI 14). Ninety birds, reared under common conditions and, as a result, varying in body size by no more than 10% (i.e., 7.2 to 7.9 kg of live weight), were slaughtered at 12 wk of age. Ten each were subjected to one of the nine stunning methods tested. The geese were removed from feed and held in coops 8 h prior to slaughter. The entire experimental program was repeated three times.

**Electrical Stunning**

The geese were hung by their feet in steel shackles and were electrically stunned in a water bath for 8 s. The control group was stunned with a conventional low-frequency (50 Hz) water-bath stunner customarily used in the poultry processing plant of Merian Oroszá Inc. (Oroszá, Hungary). Another group of geese was subjected to stunning in the same stunner equipped with a special frequency modulator. The maximum stunning frequency achievable with the latter system was 200 Hz. In addition, seven more groups of Gourmaud geese were stunned in a recently developed variable frequency stunner that used various frequency and voltage combinations as shown in Table 1.

**TABLE 1. Technological parameters of electrical stunning in geese**

<table>
<thead>
<tr>
<th>Stunner</th>
<th>Frequency (Hz)</th>
<th>Voltage (V)</th>
<th>Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>50</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>Linco</td>
<td>200</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>Stork 1</td>
<td>50</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>Stork 2</td>
<td>200</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>Stork 3</td>
<td>200</td>
<td>110</td>
<td>90</td>
</tr>
<tr>
<td>Stork 4</td>
<td>350</td>
<td>50</td>
<td>85</td>
</tr>
<tr>
<td>Stork 5</td>
<td>350</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>Stork 6</td>
<td>350</td>
<td>90</td>
<td>85</td>
</tr>
<tr>
<td>Stork 7</td>
<td>350</td>
<td>110</td>
<td>90</td>
</tr>
</tbody>
</table>

1 Model VKA-67 (Monori Gégyártó Vállalat, Monor, Hungary).
2 Model VKA-67 (Monori Gégyártó Vállalat, Monor, Hungary).
3 Model BA 4 (Lindholst & Co. A/S—Linco, Trige, Denmark).
4 Model HD II-3.5 F (Stork PMT B.V., Boxmeer, The Netherlands).

**Processing**

Neck cutting was performed immediately after stunning. The duration of exsanguination was 11 min. After completion of bleeding, the birds were scalped (62°C, 5 min), defeathered (for 2.5 min) manually, and kept refrigerated (0 to 2°C, 1 d). At 1 d postmortem, the carcasses were eviscerated and cut up. From the slaughterhouse, the livers chilled in ice were transported to the cannery where they were weighed and graded at 2 d postmortem and were then further processed.

**Determination of Liver Weight Loss**

Because weight is one of the major characteristics influencing the general appearance and, thus, the value of raw goose liver (Szigeti et al., 1999), livers were weighed using a precision balance. It should be noted that the livers evaluated in this study were similar in size, ranging from 580 to 620 g in weight. All of the veins and capillaries full of blood were removed in the course of processing because their presence is a hazard to product quality by causing discoloration of the canned liver. The degree of loss of liver weight caused by trimming engorged blood vessels, however, is of concern to processors. Therefore, the livers were weighed twice, i.e., before and after removal of blood vessels, and the difference was expressed in terms of a percentage.

**Statistical Analysis**

The data obtained were subjected to ANOVA using the general linear model procedure of STATISTICA data analysis software system, version 6 (StatSoft, 2001). Significant differences among the means were determined by using Duncan’s multiple range test at P < 0.05 (StatSoft, 2001).

**RESULTS**

The effect of various electrical stunning methods on liver weight loss due to removal of veins and capillaries
In conclusion, the loss of liver weight caused by trimming engorged blood vessels can be reduced considerably if an appropriate stunning method is applied. At 350 Hz, 70 to 90 V, and 80 to 85 mA, the variable frequency stunner of Stork was found to be most suitable for the preslaughter stunning of geese used for liver production. With this system, the major electrical parameters (frequency, voltage, current levels) can be adjusted easily and accurately in order to stun various poultry species under commercial conditions, and this may be of great importance to slaughterhouses that have only one processing line.

**REFERENCES**


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