1:4 Sight restriction as a means of reducing stress during slaughter

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Introduction

There has been an increased awareness recently of the degree of stress to which farm animals are exposed before and during slaughter. Antemortem stress adversely affects meat quality and reduces the efficiency of livestock production. The incidence of dark-cutting (DFD) beef and pale, soft, exudative (PSE) pork has been associated with severe antemortem stress. Such meat is not readily accepted on the retail market.

Farm animals may be routinely exposed to a considerable amount of excitement, especially during the critical period immediately prior to immobilization. Lawrie (1966) observed that turkeys subjected to high levels of physical activity had high myoglobin concentrations in the muscles and a high percentage of dark colored meat at slaughter. He postulated that the dark colored meat was a result of the increased myoglobin content. This suggests that a period of inactivity prior to slaughter might be beneficial to reduce the amount of darker cutting meat at slaughter.

Stress, as defined by Selye (1950), is the action of nervous and emotional stimuli elicited by an animal's environment on the nervous, circulatory, endocrine, respiratory and digestive systems to produce measurable changes in the functional levels of these systems. The sensory receptors which perceive these external stimuli are primarily auditory, tactile, olfactory, and visual receptors. We hypothesized that if the functional level of one or more of these sensory receptors is restricted, there will be a corresponding reduction in the stress perceived by the animal.

To test this hypothesis an experiment was conducted at the University of Connecticut to assess the effect of restricting the sight of chickens prior to and during slaughter.

Materials and Methods

Sixteen eighteen-week-old Single Comb White Leghorn males were divided into two equal groups, with eight birds in each of the treatment and control groups. They were fed a 14% CP commercial grower ration during the last three months prior to slaughter.

Twenty-four hours prior to an experimental run, each bird was surgically fitted with bi-polar electrodes implanted into the pectoral muscles. An experimental run consisted of fitting one control and one treatment bird with a rectal thermocouple probe and placing them into separate holding pens with an unfamiliar bird for a 45 minute conditioning period. Treatment consisted of placing a small piece of black tape over the birds' eyes, to restrict their vision, about 45 minutes prior to shackling. At 30 minutes prior to slaughter the birds were suspended upside down, six inches apart, on a simulated, miniature poultry processing line. Birds were slaughtered by severing the carotid artery and jugular vein on one side of the neck.

Five parameters were evaluated in the experiment: heart rate, respiration rate, rectal temperature, blood and carcass pH, and bleed-out volume.

Heart rate was interpreted from electrocardiogram (ECG) recordings from birds at rest in holding pens, while suspended on the processing line, and during slaughter. Respiratory rate was interpreted as the modulation of the electrocardiograph complex wave.

Rectal temperature was measured using a copper-constantan thermocouple while pH was measured with a portable pH meter. Blood pH was recorded two minutes before and then immediately after slaughter. Carcass pH was recorded at five minute intervals over a 50 minute period, by placing the pH electrode into the gastrocnemius, pars externa muscle.

Bleed-out volume was measured by collecting all blood at the time of slaughter into a graduated cylinder previously treated with sodium heparinate anti-coagulant. Statistical analysis was performed using the SAS GLM program. As a further check for significance, paired T-tests were performed and the results were compared with those obtained from the SAS GLM procedure.

Results

A. Behavioral Aspects

Blindfolding of the birds in the holding pens had a marked effect on their behavior. Birds became much more docile and manageable. In many cases it had a distinct soporific effect on the birds. The blindfolded birds were easier to catch and shackle. Although no objective score could be derived, subjective analysis by two observers was used to describe the behavioral changes associated with blindfolding to restrict the sight of chickens prior to slaughter.

B. Physiological Aspects

The change in behavior of the birds was reflected in a significant ($p<.05$) overall reduction in the heart rate of the blindfolded birds. Electrocardiogram recordings for a control and treated bird, respectively, at rest in holding pens, are shown in Figures 1A and 1B. It is clear that the control (non-blindfolded) bird, Figure 1A, shows much more myogenic and respiratory activity than the treated (blindfolded) bird, Figure 1B, as noted by the increased myogenic activity on the electrocardiograph recordings.

Heart rate increased significantly ($p<.01$) as the birds were moved from the holding pens to their suspended positions in preparation for being slaughtered. Differences in heart rate between control and blindfolded birds during this procedure were also significant ($p<.01$) (Table 1). There were no significant changes in the respiratory rate and rectal temperature between control and blindfolded birds in the holding pens or due to pre-slaughter shackling and suspension.

At the time of slaughter, the mean heart rates observed were significantly ($p<.1$) lower in the blindfolded birds (Table 2). Respiratory rates were also significantly lower ($p<.05$) in the blindfolded birds. Differences in rectal temperature, blood pH and bleed-out volume at slaughter were not significant.

Table 3 shows the postmortem drop, over time, in mean carcass pH values. pH drop over time and the ultimate mean caracass pH (after 50 minutes) of blindfolded birds was significantly lower ($p<.05$) compared to the control birds (5.93 vs 6.13).

There were no differences in the postmortem rectal temperature, over time, between treatments.

Discussion

In this experiment it was found that restricting the vision of chickens, b[illegible] means of blindfolding, for up to sixty minutes prior to slaughter had a marked effect on the level of pre-slaughter stress experienced by the bird[illegible] This statement is based upon the heart rates recorded for blindfolded and control (non-blindfolded) birds under several handling conditions. The u[illegible] of heart rate as an indicator of stress in birds has been well documented. For example, a rapid increase in catecholamine level in the blood of chick[illegible] in response to stressors has been indirectly demonstrated by peripheral vasoconstriction (Duncan, 1973), an increased heart rate (Howard, 1974) a[illegible] by an increase in plasma glucose (Davison, 1975).

Increases in heart rate of up to 100% have been reported in chickens following the entry of an observer into a poultry house (Duncan, 1973). Because heart rate is very sensitive to adverse stimuli, it is the physiological measurement of choice.

It was interesting to note that the heart rate of the sight-restricted bir[illegible] was approximately 5% lower than the control in the holding pen but this difference increased to a 10% lower heart rate after being shackled and suspended. Overall, there was a 17% increase in heart rate for the sight-restricted bird going from rest in the holding pen to shackled and suspended compared to a 22% increase for the control bird.

Physiologically, this means that the sight-restricted bird is under less stress. By measuring heart rate one indirectly also measures substances i[illegible] the body that affect heart rate, such as catecholamine levels and neurotransmitter substances. It is known that heart rate is increased by either decreasing vagal tone or increasing sympathetic tone (Tummons and Sturkie, 1969). That catecholamine levels were decreased in the sight-restricted bird is also evidenced by the fact that the intrinsic heart rat[illegible] following slaughter was lower than that of the control bird. Until the bleed-out is complete, the heart is still supplied with blood and nutrient[illegible] except oxygen, and any circulating hormones or neurotransmitters will stil[illegible] affect the 'intrinsically beating heart'.

It has been reported by Selye (1950) that the basal metabolic rate rises during stress. This was also verified by Green (1969), wherein it was determined that higher levels of corticosteroids were required during stre[illegible] These hormones are often used as a measure of epinephrine secretion.

Besides lowering the stress experienced by the animal during the pre-slaughter period, sight-restriction also resulted in a change in the post-mortem drop in pH. The pH values for the sight-restricted and control bir[illegible] were not significantly different at the moment of slaughter, however by 30 minutes post-slaughter the rate of drop in pH for the sight-restricted bir[illegible] increased. The difference in pH at the end of 50 minutes post-slaughter w[illegible] significant ($p<.05$) at 5.93 for the sight-restricted and 6.13 for the control.

Gibbons and Rose (1950) found that meat from fatigued pigs had low lactic acid, high pH, high electrical resistance, and more susceptibility to bacterial spoilage. In another experiment the dark color of some turkey meats was found by Ngoka et. al. (1982) and Ngoka and Froning (1982) to be due to cytochrome, myoglobin, and hemoglobin pigments which was attributed pre-slaughter struggle and excitement.

The etiology of dark cutting beef, and pale, soft, exudative (PSE) pork h[illegible] also been attributed to pre-slaughter stress (Judge, 1969) .

A higher carcass pH in the more stressed control birds is in agreement wit[illegible] the findings of Briskey (1964) who found that stress reduced glycogen in th[illegible] muscle which was not replenished in the fasted animal and thus allowed th[illegible] mortis to cease at a higher carcass pH level.

Westervelt et. al. (1974) found that there was a significant correlation ($p<.05$) between carcass pH and quality of meat. Although sensory evaluat[illegible] of the meat from the two groups of birds was not done in this experiment, [illegible] visual and physiological indicators point to a superior meat quality from birds which were blindfolded.

Although sight-restriction by means of blindfolding may not become an industry practice in the near future, these studies indicate that pre-slaughter handling of chickens results in a considerable amount of stress [illegible] the birds which may be alleviated. If the birds are allowed a period of r[illegible] or acclimatization to their new environment with restricted vision, it ma[illegible] help to reduce the stress they experience. Perhaps all pre-slaughter handling could be done in darkness or under blacklight conditions.

Nevertheless it should be pointed out that much more research needs to be done, particularly with other food animals, before this technique of reduc[illegible] pre-slaughter stress can be formally accepted. Based upon the results of these pilot studies we are moving forward in this area of research with bo[illegible] cattle and poultry.

Figure 1. ELECTROCARDIOGRAPH RECORDINGS OF CONTROL (1A) AND BLINDFOLDED (1B) BIRDS AT REST IN HOLDING PENS

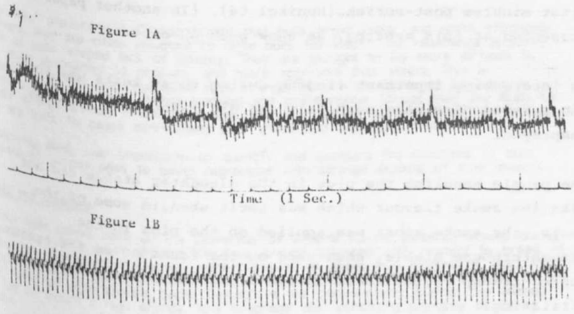

Table 1.

PHYSIOLOGICAL PARAMETERS OF BIRDS DURING THE PRE-SLAUGHTER PERIOD

Parameter	Holding Pen		Suspended		Suspended in Motion	
	Blind-folded	Control	Blind-folded	Control	Blind-folded	Control
Heart Rate	$236 \pm 4.2^{*a}$	248 ± 7.5^{a}	284 ± 6.8^{b}	319 ± 8.2^{c}	290 ± 5.0^{b}	322 ± 5.9^{c}
Respiratory Rate	25.6 ± 0.9^{d}	26.7 ± 1.4^{d}	31.9 ± 1.0^{e}	34.3 ± 1.1^{e}	32.0 ± 0.7^{e}	34.4 ± 0.7^{e}
Rectal Temperature	41.7 ± 0.3	41.7 ± 0.3	41.7 ± 0.4	41.0 ± 0.5	41.7 ± 1.3	41.8 ± 0.6

* Values represent the mean and the standard error of the mean of eight birds per treatment.

a,b,c Means in a given row bearing different superscripts are significantly different ($p<.01$).

d,e Means in a given row bearing different superscripts are significantly different ($p<.05$).

Table 2.

PHYSIOLOGICAL PARAMETERS OF BIRDS AT THE TIME OF SLAUGHTER

Parameter	Blindfolded	Control
Heart Rate	$343 \pm 11.1^{*a}$	395 ± 21.0^{b}
Respiratory Rate	41.6 ± 2.3^{c}	51.0 ± 4.3^{d}
Rectal Temperature(^{o}C)	41.7 ± 0.5	42.1 ± 0.5
Blood pH (before)	7.69 ± 0.03	7.69 ± 0.02
Blood pH (after)	7.61 ± 0.06	7.67 ± 0.02
Bleed-Out Volume (cc/kg)	35.8 ± 3.4	34.9 ± 0.9

* Values represent the mean and the standard error of the mean of eight birds per treatment.

a,b Means in a given row and group bearing different superscripts are significantly different ($p<.1$)

c,d Means in a given row and group bearing different superscripts are significantly different ($p<.05$).

Table 3. MEAN CARCASS pH VALUES, OVER TIME, POSTMORTEM

Time[1]	Mean Carcass pH Blindfolded	Mean Carcass pH Control
5	$6.62 \pm .113^{2}$	$6.72 \pm .033$
10	$6.37 \pm .096$	$6.44 \pm .071$
15	$6.19 \pm .101$	$6.34 \pm .063$
20	$6.12 \pm .093$	$6.29 \pm .064$
25	$6.07 \pm .089^{a}$	$6.28 \pm .065^{b}$
30	$6.03 \pm .082^{a}$	$6.24 \pm .066^{b}$
35	$6.00 \pm .077^{a}$	$6.20 \pm .064^{b}$
40	$5.97 \pm .073^{a}$	$6.17 \pm .063^{b}$
45	$5.95 \pm .071^{a}$	$6.15 \pm .062^{b}$
50	$5.93 \pm .069^{a}$	$6.13 \pm .060^{b}$

[1] Values represent time postmortem, in minutes.

[2] Values represent the mean and the standard error of the mean of eight birds per treatment.

a,b All means within the same row with different superscripts are significantly different ($p<.05$)

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