DEVELOPMENT OF AN ALTERNATIVE ELECTRIC STUNNING DEVICE FOR BROILER CHICKENS

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Abstract –Electronarcosis in a water bath is the most common stunning method used in chicken slaughterhouses in most countries. Although being regulated by the Brazilian legislation, this stunning method causes stress for the birds, due to the hanging and drowning procedures. This study aimed at investigating the feasibility and effectiveness of an electrical stunning device, by direct contact of the electrode with bird's head, and evaluates its influence on the intrinsic characteristics of chicken meat. Fifty six Cobb 500 42 day-old chickens were slaughtered, in a completely randomized design, in a 2x2x2 factorial arrangement (two forms of electrical current application, two frequency parameters and both sexes). The results were analyzed by ANOVA, with a significance level of 5% and Duncan's test. Blood glucose level, meat color, drip loss, water holding capacity and shear force were not influenced by the bird's sex or the electrical stunning method used. The stunning system by direct contact is viable as regards the humanitarian slaughter assurance, without damage in the quality of the final product. However, more studies will be necessary to develop this technological alternative and make it viable to industrial application.

Key Words – animal welfare, electronarcosis, desensitization

I. INTRODUCTION

Electronarcosis in a water bath is the most used stunning method for broiler chickens in Brazil, as well as in most countries. This method is referred to in the Brazilian legislation about humanitarian procedures at poultries' slaughter [1], but causes bird's stress, because they need to be hanged upside down and drowned to be stunned.

To effectively stun a bird by electric methods using low frequencies (50 to 60 Hz), 100 mA, at minimum, is required [2, 3].

Frequency (Hz), voltage (V) and intensity of electric current (A) may be controlled during stunning [4]. These variables influence directly the bird's stunning and the carcasses and meat quality. There are some initiatives to replace the traditional stunning method, in electrified water bath, as "head only" method, in which the electrode is applied in the bird's head only, and "head-to-cloaca", in which the current flows from cloaca to head [5].

This study evaluated an electric stunning method by direct contact (DC) to reduce the stress of broiler chickens at slaughter and its influence on the meat quality.

II. MATERIALS AND METHODS

Fifty six Cobb 500 42 day-old chickens (28 males and 28 females) were slaughtered, in a completely randomized design, with a 2x2x2 factorial arrangement. The factors were: two forms of electric current application (water bath and direct contact), two current' frequencies (60 and 600 Hz) and both sexes, resulting in 8 treatments and 7 repetitions each treatment. In both methods, the voltage was 220 V AC. At slaughter, an ampere-meter was used to measure the current frequency. All birds were individually weighed, bled immediately after stunning, then weight again to estimate the blood loss. Glucose blood level was determined using an Optium Xceed monitor. The presence of ecchymosis in breast meat was visually evaluated. *Postmortem* pH drop was determined in breast and thigh muscles using a meat pH meter with a penetration probe (Model 1120-X, Mettler Toledo). The color of breast and thigh meat was measured using a portable, reflected-color measurement spectrophotometer (Model Mini Scan XE plus, HunterLab) and expressed according to the CIE (Comission Internationale de l'Éclairage) Lab color system, in which L expresses lightness, a redness and b yellowness [6]. Warner-Bratzler shear force was determined

in breast meat according to American Meat Science Association [7] using a texture analyzer with a Warner-Bratzler cell (Model TaXT-2i, Stable Micro Systems). Water holding capacity was evaluated as described by Nakamura and Katoh [8]. The results were analyzed by ANOVA with three factors (frequency, electric application, sex) with a significance level of 5% and Duncan's test [9].

III. RESULTS AND DISCUSSION

The mean values of current frequency observed in this work were lower than the recommended by other authors to promote an effective stunning [5, 10]. But, in all treatments, an effective stunning of the birds was observed, without occurrence of vocalization or other indicative of suffering.

Table 1 shows that glucose blood levels were not affected by the treatments or by birds' sex (P>0.05).

Table 1 Blood levels of glucose after stunning and weight loss during bleeding, in relation to bird weight before bleeding (mean ± standard deviation)

CF (Hz)	Method	Sex	Blood glucose level (mg/dL)	Weight loss bleeding (%)
60	Water bath	M	159.80 ± 38.69	2.63 ± 0.83
		F	197.20 ± 29.42	3.35 ± 1.13
	Direct contact	M	182.20 ± 5.81	3.93 ± 1.00
		F	172.20 ± 30.80	3.12 ± 1.35
600	Water bath	M	214.60 ± 13.32	3.01 ± 0.67
		F	174.40 ± 20.57	2.27 ± 0.64
	Direct contact	M	173.00 ± 30.77	3.18 ± 1.24
		F	180.20 ± 23.84	3.33 ± 0.70
P-value			0.0701	0.1087

CF: current frequency

The results presented in table 1 show that the blood amount drained from the birds' carcasses during bleeding, estimated by the weight loss, was not different for the treatments (P>0.05).

Glucose levels found in this work were lower than reported by Vosmerova et al. [11] and Nijdam et al. [12] probably due to the extension of the fasting period before slaughter, which affects the birds' blood glucose concentration.

Table 2 Final pH in breast and thigh meat (mean ± standard deviation)

CF (Hz)	Method	Sex	Breast meat	Thigh meat
60	Water bath	M	6.70^{ab} ± 0.21	6.90 ± 0.26
		F	$6,90^{a}$ ± 0.21	6,90 ± 0.15
	Direct contact	M	6.40^{b} ± 0.25	6.70 ± 0.23
		F	6.40^{b} ± 0.15	6.90 ± 0.23
600	Water bath	M	6.50^{ab} ± 0.12	6.50 ± 0.06
		F	6.30^{b} ± 0.20	6.50 ± 0.31
	Direct contact	M	6.70^{ab} ± 0.14	6.70 ± 0.10
		F	6.70^{ab} ± 0.10	6.70 ± 0.10
P-value			0.0106	0.2892

Means in a column followed by different letters differ significantly by Duncan's test (P < 0.05), CF: current frequency

The final pH in breast meat was affected by the treatments, contradicting the results reported by Battula et al. [13] and Xu et al. [14]. But these differences among the means did not follow any tendency. The pH of thigh meat did not vary among the treatments (Table 2).

Tables 3 and 4 show the results of color attributes measured in breast and thigh meat, respectively. In CIELab color system, *L* value represents lightness. This varies from 0, which has no lightness (i.e. absolute black), to 100 which is maximum lightness (i.e. absolute white). The *a* value varies from green (negative values) to red (positive values) and *b* value varies from blue (negative values) to yellow (positive values) [15].

The color parameters were not affected by the treatments or by the birds' sex, neither in breast meat nor in thigh meat samples (P>0.05).

Table 3 Breast meat color parameters according CIELab system (mean ± standard deviation).

CF (Hz)	Method	Sex	L	a	b
60	Water bath	M	58.01 ± 2.76	6.61 ± 1.73	17.88 ± 1.72
		F	59.17 ± 3.16	5.64 ± 1.16	18.67 ± 1.62
	Direct contact	M	61.48 ± 6.40	4.80 ± 2.15	17.81 ± 1.45
		F	58.73 ± 4.34	5.30 ± 1.28	18.53 ± 1.75
600	Water bath	M	58.91 ± 3.40	5.33 ± 1.75	18.57 ± 1.98
		F	63.92 ± 3.94	4.01 ± 1.69	19.12 ± 1.13
	Direct contact	M	59.01 ± 4.80	4.91 ± 1.73	17.57 ± 2.26
		F	60.00 ± 3.63	4.69 ± 1.48	18.60 ± 2.09
P-value			0.2211	0.1853	0.7398

CF: current frequency

Table 4 Thigh meat color parameters according CIELab system (mean ± standard deviation).

CF (Hz)	Method	Sex	L	a	b
60	Water bath	M	57.39 ± 6.02	7.67 ± 1.49	12.31 ± 4.78
		F	54.63 ± 5.13	8.15 ± 2.08	13.79 ± 5.63
	Direct contact	M	60.05 ± 4.30	7.15 ± 1.66	14.34 ± 4.46
		F	52.18 ± 6.00	7.91 ± 1.39	13.88 ± 5.30
600	Water bath	M	58.82 ± 4.25	6.97 ± 1.49	8.95 ± 2.72
		F	56.08 ± 5.22	7.13 ± 1.38	14.01 ± 3.84
	Direct contact	M	59.24 ± 5.27	6.64 ± 1.69	12.15 ± 4.70
		F	55.58 ± 6.09	7.81 ± 2.22	12.75 ± 5,30
P-value			0.1259	0.6943	0.4552

CF: current frequency

Water holding capacity and shear force means, measured in breast meat samples (Table 5), were also not affected by the treatments or by the birds' sex (P>0.05).

Table 5 Water holding capacity and shear force of breast meat (mean ± standard deviation).

CF (Hz)	Method	Sex	WHC (%)	Shear force (kg/cm^2)
60	Water Bath	M	56.74 ± 2.34	0.85 ± 0.14
		F	55.91 ± 3.93	0.73 ± 0.18
	Direct contact	M	58.26 ± 7.27	0.84 ± 0.19
		F	56.44 ± 4.55	0.93 ± 0.20
600	Water Bath	M	56.26 ± 4.84	0.83 ± 0.40
		F	58.59 ± 3.53	0.98 ± 0.28
	Direct Contact	M	56.84 ± 4.74	1.01 ± 0.33
		F	57.02 ± 6.09	0.75 ± 0.21
P-value			0.9649	0.3890

CF: current frequency, WHC: water holding capacity

All means of shear force were within the range that corresponds to soft meat, and were compatible with the results reported by McDougall [16].
So, the proposed stunning method did not cause any relevant difference in birds' carcasses or in the meat characteristics.

IV. CONCLUSION

The stunning system by direct contact was effective to promote a humanitarian slaughter to broiler chickens, without damage to the carcasses and meat quality.

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