

**EFFECT OF DIFFERENT ELECTRICAL STUNNING
METHODS ON MEAT QUALITY OF MARMARA KIVIRCIK
BREED LAMB IN TURKEY REPUBLIC***
*EFEKTI RAZLIČITIH METODA ELEKTRIČNOG OMAMLJIVANJA NA
KVALITET MESA KOD MARMARA KIVIRCIK JAGNJADI U TURSKOJ*

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The effects of head-only electrical stunning method were compared with the effects of head- to- back electrical stunning method. A total of 90 kivircik breed lambs were randomly allocated immediately prior to slaughter to one of three stunning treatments: control group (C), head only group (HO; 1.0 A- AC for 3 s at a frequency of 50 Hz), head to back group (HB; 1,0 A- AC for 3 s at a frequency of 50 Hz) electrical stunning. Meat quality was assessed by examining pH, colour as L, a, b values, water holding capacity (WHC) and shear force.

The effect on meat quality was assessed in head-only electrically stunned, head to back electrically stunned and non-stunned lambs. Shear forces were not significantly different between treatments. However colour (L,a*,b*), water holding capacity (WHC) and muscle ultimate pH were found to be significantly higher ($P<0.05$) between the groups.*

Key words: lamb, electrical stunning, meat, quality

Introduction / Uvod

Pre-slaughter stunning is compulsory according to EU Council Directive 93/119 [4]. Protecting welfare in the pre-slaughter period, and protecting slaughterhouse workers against animals' reflex movement, lambs are not slaughtered without stunning in slaughterhouses [1, 20]. At the same time this practice may affect the meat quality like the type of suckling, lairaging, transport condition and handling such extrinsic factors are likely to affect meat quality through stress, which decreases muscular glycogen reserves, a process which may lead to high

* Rad primljen za štampu 30. 01. 2008. godine

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ultimate pH of meat [2]. Electric stunning is the most common commercially used method in the EU. There are several methods used to apply the electrodes used with electrical stunning apparatus like head-only, head-to-brisket and head-to-back [7].

Electrical stunning methods are effective and produce instantaneous insensibility by the induction of epileptiform activity in the brain [8]. The few studies on sheep examine the effect of the type of stunning on bleeding efficiency [9], petechial haemorrhages [6], blood pressure and muscular activity [16], final pH [14], meat quality parameters such as colour, tenderness, juiciness [20] and meat quality parameters, the presence of haemorrhages and the bone fractures [18] but not different electrical stunning methods effects on meat quality parameters.

Materials and methods / Materijal i metode ispitivanja

Animals / Životinje

Ninety male lambs of the Kivircik breed from the flock of the Experimental Farm of Istanbul University were slaughtered at 5 months of age. Animals were separated into three group (n = 30 each) for pre-slaughter handling. In the first group, the lambs were slaughtered without previous stunning. The second group was electrically stunned by the head only method at 1 A for 3 s. The other group was electrically stunned by the head to back method at 1 A for 3 s. Immediately after stunning, the lambs were slaughtered using conventional procedures. The carcasses were chilled at 6°C for 24 h in a conventional chiller.

Measurement / Merenje

Instrumental meat quality was assessed in the M. longissimus dorsi between 11.12. thoracal vertebrae.

The pH was measured rapidly after carcass dressing (pH 0), 45 minutes later (pH 45), 4 hours later (pH 4), 24 hours later (pH 24), 48 hours later (pH 48) and 72 hours later (pH 72) with a penetrating electrode adapted to a portable Hanna HI 8314 electro pH meter.

Twenty-four hours post mortem, the M. longissimus dorsi was removed from the carcass after measuring pH₂₄, and cut into four equal portions. One portion packed in a plastic tray over-wrapped with permeable gas film and stored at 3 °C prior to analysis for initial meat quality. Twenty-four hours post mortem water holding capacity (WHC) and colour (as *L*, *a*, *b* values), 72 hours post mortem shear force (SF) were determined.

The rest of the samples were vacuum packed in Cryovac barrier bags. Samples were taken, as required at 24h, 48h and 72h. During this time the bags were stored at 3°C.

The samples were analysed for pH, colour, WHC as percentage free water [20]. SF was evaluated using an Instron Texture Analyser (model 1140)

equipped with a kremear shear head. Samples were read at 500 kg load cell and 50 range.

Data Analysis / Analiza podataka

The data of the meat quality variables were analysed by the SPSS [17], using the analysis of variance (ANOVA).

Results and discussion / Rezultati i diskusija

Results of the effect of pre slaughter handling (PSH) during ageing on the meat parameters are presented in Tables 1-4.

Table 1. Effect of pre-slaughter handling and ageing on the pH of meat in Marmara Kivircik lambs /

Tabela 1. Efekat rukovanja pre klanja i zrenja na pH mesa kod Marmara Kivircik jagnjadi

Groups Parameters / Grupe Parametri	C (n=30) $\bar{x} \pm s$	HO (n=30) $\bar{x} \pm s$	HB (n=30) $\bar{x} \pm s$	F-value / F-vrednost
0 minute / 0 minuta	7.05 ± 0.050	7.04 ± 0.047	7.03 ± 0.064	2.024ns
45th minute / 45 minuta	6.91 ± 0.040a	6.74 ± 0.053c	6.79 ± 0.045b	104.357***
2nd hour / 2 sata	6.79 ± 0.050a	6.55 ± 0.057c	6.60 ± 0.052b	165.498***
3rd hour / 3 sata	6.68 ± 0.060a	6.38 ± 0.076c	6.43 ± 0.096b	119.686***
4th hour / 4 sata	6.57 ± 0.060a	6.22 ± 0.093b	6.26 ± 0.080b	172.557***
8th hour / 8 sati	6.33 ± 0.080a	5.91 ± 0.108b	5.83 ± 0.048c	311.081***
12th hour / 12 sati	6.05 ± 0.100a	5.70 ± 0.107b	5.64 ± 0.036c	198.139***
24th hour / 24 sata	5.83 ± 0.040a	5.79 ± 0.049b	5.79 ± 0.034b	7.582***
48th hour / 48 sati	5.92 ± 0.030a	5.89 ± 0.024b	5.86 ± 0.031c	28.508***
72th hour / 72 sata	6.00 ± 0.030a	5.98 ± 0.027b	6.02 ± 0.044a	11.691***

***: P<0.001

ns: P>0.05

Table 2. Meat colour measurement with Minolta /
Tabela 2. Merenje boje mesa koristeći Minoltu

Groups Parameters / Grupe Parametri	K (n=30) $\bar{x} \pm s$	HS (n=30) $\bar{x} \pm s$	B (n=30) $\bar{x} \pm s$	F-value / F-vrednost
L	64.17 ± 2.283a	43.93 ± 2.601c	49.02 ± 4.189b	112.659***
a	16.13 ± 1.169c	18.56 ± 1.077b	21.27 ± 3.041a	16.838***
b	14.53 ± 1.211a	8.92 ± 1.196c	12.72 ± 2.418b	28.142***

***: P<0.001

Table 3. Water holding capacity – WHC measurement /
Tabela 3. Kapacitet zadržavanja vode – merenje WHC

Groups Parameters / Grupe Parametri	K (n=30) $\bar{x} \pm s$	HS (n=30) $\bar{x} \pm s$	B (n=30) $\bar{x} \pm s$	F-value / F-vrednost
24th hour (%) / 24. sat (%)	14.10 ± 0.241a	13.83 ± 0.233b	13.80 ± 0.174b	16.685***
5th day (%) / 5. dan	17.27 ± 0.264	17.40 ± 0.285	17.41 ± 0.280	2.399ns
8th day (%) / 8. dan	20.46 ± 0.355b	23.50 ± 0.292a	23.57 ± 0.301a	939.434***
11th day (%) / 11. dan	23.67 ± 0.396a	17.06 ± 0.296b	17.01 ± 0.269b	4154.935***

***: P<0.001 ns: P>0.05

Table 4. Shear force measurement with Instron Texture Analyser (Newton) /
Tabela 4. Merenje mekoće mesa koristeći Instron instrument za analizu teksture (Newton)

Groups Parameters / Grupe Parametri	K (n=30) $\bar{x} \pm s$	HS (n=30) $\bar{x} \pm s$	B (n=30) $\bar{x} \pm s$	F-value / F-vrednost
MLD	1801.90 ± 304.942	1705 ± 374.585	1686.4 ± 422.729	0.280 ^{ns}

ns: P>0.05

pH / pH

The values of pH 45 were similar to those found by Paulick *et al.* [14]. During the first 72 hours post mortem except pH 0, pre-slaughter handling affects the decrease in pH (Table 1). However other studies in lambs [19] showed no significant differences in the pH 0, pH 45 and pH 24 with the stunning method. Head-only electrical stunning method had an effect on the final pH of the muscle. From 45 minutes onwards significant differences between the different pre-slaughter handling groups were found in pH values. In the control group the lowest value was reached at 24 hours post mortem. On the other hand in the other two groups the lowest value was reached at 18 hours post mortem. Our results agree with those of Vergara and Gallego [20] and Paulick *et al.* [14], pH decreases more rapidly, and ageing starts earlier. Petersen and Blackmore [15] found that the increased muscle activity in animals stunned electrically is probably responsible for their more rapid post-mortem pH decline.

Meat colour / Boja mesa

Meat of the non stunned lambs was brighter (higher L* values) than that of electrically stunned groups and the difference between the groups was significant statistically. Also pre slaughter handling affected a* and b* values (Table 2). In similar, studies on domestic birds show that electrically stunned turkeys [5] and broilers [11] have redder meat (higher a* values) than those stunned with CO₂.

Water holding capacity / Kapacitet zadržavanja vode

Significant differences were found between the pre slaughter handling groups in WHC values except on days 5 (Table 3). In all groups (C, HO and HB), WHC decreased (more water expelled) with storage (14.10 ± 0.241 , 13.83 ± 0.233 and $13.80 \pm 0.174\%$ at 24 h post mortem to 20.46 ± 0.355 , 23.50 ± 0.292 , 23.57 ± 0.301 at 8 days post slaughter, for C, HO and HB, respectively). This agrees with the study of Koohmaraie, Whipple and Crouse [10], Moore and Young [12] and Vergara and Gallego [20]. In the C group the highest percentage of water expelled was at 11 days postmortem and 3 days earlier in the HO and HB groups. The tendency to release more water in the C group after 8 days post mortem suggests their initial juiciness could be greater.

Shear force / Mekoća mesa

The meat from stunned animals appeared more tender than that of the non-stunned animals, although the differences were not significant (Table 4). The differences in pH (Table 1) may be the cause of the higher values of shear force in meat of the non-stunned animals group, due to decreased activity of calpain [3]. Another study suggests the activity of calpain depends not only on the amount of

enzyme present, but also on the muscle pH [13]. Vergara and Gallego [20] did not find any differences between the stunned and non-stunned lamb meat shear force value.

Conclusion / Zaključak

The effect on meat quality was assessed in head-only electrically stunned, head-to-back electrically stunned and non-stunned lambs. Shear forces were not significantly different between treatments. However colour (L^*, a^*, b^*), WHC, muscle ultimate pH were found to be significantly higher ($P < 0.05$) between the groups. It is concluded that some of the meat quality parameters are affected by electrical stunning methods.

ACKNOWLEDGEMENT:

This work was supported by Research Fund of the Istanbul University. Project number T-80/23072002.

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SRPSKI

EFEKTI RAZLIČITIH METODA ELEKTRIČNOG OMAMLJIVANJA NA KVALITET MESA KOD MARMARA KIVIRCİK JAGNJADI U TURSKOJ

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Efekti metoda električnog omamljivanja samo glave poređeni su sa efektima električnog omamljivanja od glave do leđa. Izdvojeno je nasumično ukupno 90 jagnjadi Kivircik rase neposredno pre klanja radi sprovođenja jednog od tri vrste tretmana omamljivanja: kontrolna grupa (C), grupa gde je tretirana samo glava (HO; 1,0 A-AC za 3 s pri frekvenciji of 50 Hz), grupa tretmana od glave do leđa (HB; 1,0 A-AC za 3 s pri frekvenciji od 50 Hz) električnim omamljivanjem. Kvalitet mesa je ocenjen ispitivanjem pH, boje kao vrednosti L, a, b, kapacitet zadržavanja vode (WHC), i mekoće mesa.

Efekat na kvalitet mesa je procenjen kod jagnjadi koja su električno omamljena u predelu glave, u predelu od glave do leđa, i kod jagnjadi koja nisu omamljivana. Mekoća mesa se nije značajno razlikovala među tretmanima. Međutim, boja (L, a, b), kapacitet zadržavanja vode (WHC) i krajnji pH mišića su se razlikovali po grupama, odnosno bili su značajno viši ($p < 0,05$).

Ključne reči: jagnje, električno omamljivanje, kvalitet

ЭФФЕКТЫ РАЗЛИЧНЫХ МЕТОДОВ ЭЛЕКТРИЧЕСКОГО ОБОЛЩЕНИЯ НА КАЧЕСТВО МЯСА У MARMARA KIVIRICIK ЯГНЯТ В ТУРЦИИ

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Эффекты методов электрического оболщения только головы сранены с эффектами электрического оболщения от головы до спины. Нами выделено наобум совокупно 90 ягнят Kivircik породы непосредственно до убоя ради проведения одного из трёх видов лечения оболщения: контрольная группа (К), группа, где лечена только голова (НО; 1,0 А-АС за 3 с при частоте от 50 Hz) электрическим оболщением. Качество мяса оценено испытанием pH, цвета в качестве стоимости L, a, b, мощность задержки воды (МЗВ), и мягкости мяса.

Эффект на качество мяса оценен у ягнят, электрически оболщённые в пределах головы, в пределах от головы до спины, и у ягнят, не оболщены. Мягкость мяса не значительно различалась между лечениями. Между тем, цвет (L, a, b), мощность задержки воды (МЗВ) и крайняя pH мышц различались по группах, то есть были значительно бóльшие ($p < 0,05$).

Ключевые слова: ягнёнок, электрическое оболщение, качество