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\* Presented at The First International Meeting on Food Control Research, University of Helsinki, Finland, October 15–17, 2008.

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Arch Lebensmittelhyg 60,  
165–167 (2009)  
DOI 10.2376/0003-925X-60-165

© M. & H. Schaper GmbH & Co.  
ISSN 0003-925X

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## Influence of pre-slaughter resting time on shelf life and ammonia level of young bull meat during the storage

*Einfluss von Ruhezeiten vor dem Schlachten auf Haltbarkeit und Ammoniakgehalt von Jungbullenfleisch während der Lagerung*

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Nevijo Zdolec<sup>2</sup>

### Summary

The aim of the present study was to evaluate the impact of pre-slaughter resting time of Simmental fattened bulls (n = 40, age 14–24 months, m = 250–350 kg) on shelf life and ammonia level of the obtained meat. Two groups of animals were transported 140 km to a local slaughterhouse. The first group included farm raised animals slaughtered immediately after arrival, while the second group consisted of extensively raised animals rested 36 hours prior to slaughter. The content of ammonia was measured at 1<sup>st</sup>, 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> and 9<sup>th</sup> day of cold storage (2–4°C) in m. longissimus dorsi and m. gracilis. In both muscles, the initial ammonia levels as well as the ammonia levels measured during storage were higher in the group of animals slaughtered immediately after arrival compared to the animals rested 36 hours prior to slaughter (p < 0.001). At the end of the storage period, the meat was spoiled in both groups leading to the conclusion that 36 hours of resting prior

## Zusammenfassung

to slaughter is not long enough to sufficiently suppress the negative influence of stress on the shelf life of meat.

**Keywords:** bulls, resting time, ammonia level, meat quality, shelf life

Ziel der vorliegenden Studie war es, bei Simmental Mastbullen ( $n = 40$ , Alter 14–24 Monate,  $m = 250$ – $350$  kg) den Einfluss von Ruhezeiten vor dem Schlachten auf Haltbarkeit und Ammoniakgehalt des gewonnenen Fleisches zu ermitteln. Zwei Gruppen von Tieren wurden 140 km zu einem örtlichen Schlachthof transportiert. Die erste Gruppe setzte sich aus intensiv gemästeten Tieren zusammen, die unmittelbar nach der Ankunft am Schlachthof geschlachtet wurden, während die zweite Gruppe aus extensiv gemästeten Tieren bestand, die nach einer 36-stündigen Ruhezeit geschlachtet wurden. Der Ammoniakgehalt im M. longissimus dorsi und im M. gracilis wurde am ersten, dritten, fünften, siebten und neunten Tag der Kühlung (2–4 °C) gemessen. In beiden Muskeln waren sowohl der anfängliche Ammoniakgehalt als auch die während der Lagerung ermittelten Gehalte bei den unmittelbar nach der Ankunft geschlachteten Tieren höher als bei den Tieren mit einer Ruhezeit von 36 Stunden vor der Schlachtung ( $p < 0.001$ ). Am Ende der Lagerung war das Fleisch beider Gruppen verdorben, was zu der Schlussfolgerung führte, dass eine Ruhezeit von 36 Stunden vor der Schlachtung nicht ausreicht, um die negative Auswirkung von Stress auf die Haltbarkeit von Fleisch zu unterdrücken.

**Schlüsselwörter:** Bullen, Ruhezeiten, Ammoniakgehalt, Fleischqualität, Haltbarkeit

## Introduction

The properties of meat strongly affected by pre-slaughter animal treatment are pH value, temperature, colour and shelf life (Kuzmanović and Elabjer, 2000). Biochemical processes active in living tissue do not stop at the moment of death. Therefore, ante-mortem stress entails important modifications in post-mortem biochemistry of muscle (Beltran et al., 1997; Ferguson and Warner, 2008). Pre-slaughter animal treatment has an effect on post-mortem glycolytic processes in muscle tissue. Careful handling of animals in order to avoid stress as well as resting of animals 36 hours prior to slaughter result in lighter meat and lower pH values, i. e. in good quality meat (Kuzmanović and Elabjer, 2000; Kuzmanović and Cvrtić, 2000).

Mixing of animals from different breeds, loading, transport and unloading of animals, temperature and weather aberrations represent physical and emotional stress. This

causes a depletion of glycogen storage in muscles and slows the rate of post-mortem breakdown of glycogen to lactic acid. Consequently, acidification is reduced and the terminal pH value is high, resulting in progressive growth of spoilage ammonia-producing bacteria (Feiner, 2006; Nychas et al., 2008). The ammonia content of muscles marks meat spoilage even before organoleptic changes (colour, odour and taste) occur, thus represents a good criterium for testing meat shelf life (Stephan et al., 1997). The ammonia level of fresh meat is, according to Živković (1986), less than 6.5 mg/100 g. The same author also specifies that the level of ammonia in meat threatened by spoilage raises from 6.5 to 8.0 mg/100 g, while actual spoilage starts at an ammonia level of 8.2 to 8.3 mg/100 g. Meat odour changes at values from 8.3 to 9.0 mg/100 g, while the ammonia level in rancid and rotten meat is 9.0 mg/100 g and more.

The present study was conducted to determine the influence of pre-slaughter resting time of young bulls on

**TABLE 1:** Ammonia content in *m. longissimus dorsi* (mg/100 g) during cold storage

	1 <sup>st</sup> day		3 <sup>rd</sup> day		5 <sup>th</sup> day		7 <sup>th</sup> day		9 <sup>th</sup> day	
	ASR	ASI	ASR	ASI	ASR	ASI	ASR	ASI	ASR	ASI
x	4.22	6.04	5.06	7.28	6.12	7.62	7.21	8.33	8.43	9.68
s	0.30	0.18	0.46	0.27	0.35	0.22	0.27	0.29	0.24	0.60
r	3.42–4.76	5.61–6.46	4.00–5.74	6.52–7.82	5.63–6.78	6.95–7.89	6.80–8.05	7.43–8.78	7.99–8.86	7.65–10.20

ASR animals rested prior to slaughter, ASI animals slaughtered immediately after arrival, x: average value, s: standard deviation, r: range.

**TABLE 2:** Ammonia content in *m. gracilis* (mg/100 g) during cold storage

	1 <sup>st</sup> day		3 <sup>rd</sup> day		5 <sup>th</sup> day		7 <sup>th</sup> day		9 <sup>th</sup> day	
	ASR	ASI	ASR	ASI	ASR	ASI	ASR	ASI	ASR	ASI
x	5.03	7.13	6.53	7.73	7.70	8.45	8.85	8.96	10.00	9.98
s	0.17	0.15	0.20	0.23	0.17	0.26	0.18	0.26	0.26	0.34
r	4.68–5.60	6.89–7.48	5.96–6.80	7.10–8.11	7.29–7.99	7.46–8.71	8.48–9.08	8.35–9.26	9.42–10.42	9.01–10.36

ASR animals rested prior to slaughter, ASI animals slaughtered immediately after arrival, x: average value, s: standard deviation, r: range.

the ammonia level and the shelf life of meat during nine days of storage.

## Materials and Methods

Fourty Simmental fattened young bulls (age 14–24 months,  $m = 250\text{--}350$  kg) were transported 140 km to a local slaughterhouse. Two groups were selected: the first one included farm raised animals slaughtered immediately after arrival (ASI), the second group consisted of extensively raised animals rested 36 hours prior to slaughter (ASR). The handling of the animals during the pre-slaughter rest as well as at slaughter was performed in accordance with national rules on animal welfare and veterinary-sanitary control. After processing, carcasses of both groups were chilled and treated under the same conditions.

The evaluation of the ammonia content was conducted on samples of *m. longissimus dorsi* and *m. gracilis* using microdiffusion method of Živković (1986) at the 1<sup>st</sup> (24 hours post-mortem), 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> and 9<sup>th</sup> day of storage. Samples were kept in a cool room at a temperature of +2 to +4°C.

The results were analysed by statistical methods (Student's *t*-test, Mann-Whitney-U-test and Anova) using the Statistica 7.1 program (StatSoft Inc., Tulsa, USA).

## Results and Discussion

As presented in Tables 1 and 2, the ammonia content increased in meat samples of both groups of animals during the storage period. Initial ammonia levels measured 24 hours post-mortem in *m. longissimus dorsi* were significantly lower in the rested animals than in animals slaughtered immediately after arrival ( $p < 0.001$ ). The difference between the two groups decreased in time, however, a statistically significant difference was observed until the 9<sup>th</sup> day of storage. The least difference between the groups was noted at days 3 and 9. The ammonia level in *m. longissimus dorsi* at the 9<sup>th</sup> day of storage ranged from 7.99 to 8.86 mg/100 g (average 8.43 mg/100 g) in rested animals, and from 7.65 to 10.20 mg/100 g (average 9.68 mg/100 g) in unrested bulls (Tab. 1). According to the criteria of Živković (1986) these ammonia level values indicate an already progressive spoilage process in muscles of the unrested group and the beginning of spoilage in the rested group of animals. We presume that the unrested group was subjected to physical and emotional stress starting at loading and lasting until slaughter, especially since there was no time to adjust to new conditions. Also, these animals were raised on farms with no previous experience with transport and unlike extensively raised animals are unaccustomed to frequent handling and close contact with people that might have helped to reduce the negative influence of novelty. The initial ammonia level in *m. gracilis* was also significantly lower in rested animals ( $p < 0.001$ ). This difference was found during the whole storage period, except at day 9 when the ammonia content was almost similar in both groups (Tab. 2). Since the terminal ammonia level exceeded 9.0 mg/100 g in both groups of animals, it is, according to Živković (1986), a sign of the spoilage process.

The statistically higher increase of the ammonia level in meat of animals slaughtered immediately after arrival

as compared to the rested group is probably the result of faster growth of bacteria and breakdown of amino acids when the glucose storage is depleted (Feiner, 2006). The results of our research confirm the findings of Stephan et al. (1997), who detected a higher muscle ammonia level and a shorter meat shelf life in animals slaughtered immediately after arrival (tired) compared to animals rested prior to slaughter. Contradictory results have been reported by Sanz et al. (1996), who reported that the main cause of glycogen depletion is stress by mixing unfamiliar bulls overnight. We detected a positive influence of animal resting prior to slaughter on meat shelf life presumably due to stress reduction.

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