Livestock Science 164 (2014) 154–158

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Short communication

Relationship between stress-related exsanguination blood variables, vocalisation, and stressors imposed on cattle between lairage and stunning box under conventional abattoir conditions

J.K. Probst [a,b,*], A. Spengler Neff [a], E. Hillmann [b], M. Kreuzer [b], M. Koch-Mathis [b], F. Leiber [a,b]

[a] Research Institute of Organic Agriculture, Department of Livestock Sciences, FiBL, Ackerstrasse 21, 5070 Frick, Switzerland
[b] ETH Zurich, Institute of Agricultural Sciences, Universitaetsstrasse 2, 8092 Zurich, Switzerland

ARTICLE INFO

Article history:
Received 15 May 2013
Received in revised form
12 March 2014
Accepted 14 March 2014

Keywords:
Slaughter
Stress
Animal welfare
Electric prod
Cortisol
Vocalisation

ABSTRACT

Physiological and behavioural reactions of cattle to handling procedures in a commercial abattoir (electrical prodding actions and duration of the animals' stay in the stunning box) were evaluated and set in relation to sex, breed type, and carcass weight. A total of 192 cattle comprised of 45 bulls, 61 steers, and 86 heifers from different breed types (30 dairy breed, 70 beef breed, and 92 crossbreds) were observed from lairage to slaughter during one day. The frequency of electrical proddings and the waiting time in the stunning box was recorded for each individual. As a measure of a behavioural stress response, the number of vocalising animals was recorded. Exsanguination blood serum samples were analysed for cortisol, glucose, and lactate concentrations. Forty-nine animals received no electrical prods; 117 animals were prodded one to three times, and 24 animals received between 4 and 9 prods. Thirteen per cent of all animals were recorded as vocalisers. There was a trend ($P=0.07$) that heifers vocalised more than bulls and steers. Mean levels per ml of blood were 77.2 ng cortisol (SE=68.8), 5.7 μmol glucose (SE=1.3), and 6.7 μmol lactate (SE=3.3). Cortisol concentrations were lower in bulls than in steers and in heifers ($P<0.01$), and concentrations above 90 ng/ml were measured in 21.3% of the steers and 27.8% of the heifers, but not in the bulls. Lactate and glucose concentrations were not influenced by sex. Breed type had no influence on any of the stress-indicating traits. Prodding categories were not related with concentrations of the blood variables and the number of vocalising animals. A longer stay in the stunning box led to increased cortisol concentrations ($P<0.05$), but had no influence on lactate and glucose concentrations or on the number of vocalising animals. In conclusion, stress levels were relatively high in the present case, but it was not possible to relate the stress indicators unequivocally to the potential factors of influence investigated.

1. Introduction

Slaughter animals encounter many stressors at the abattoir, including isolation, unknown other animals, a novel environment, noise, thirst and fasting (Terlouw et al., 2008).

* Corresponding author at: Research Institute of Organic Agriculture, Department of Livestock Sciences, FiBL, Ackerstrasse 21, 5070 Frick, Switzerland. Tel.: +41 62 865 0441; fax: +41 62 865 7273.
E-mail address: johanna.probst@fibl.org (J.K. Probst).

http://dx.doi.org/10.1016/j.livsci.2014.03.013
1871-1413/

The contact with unfamiliar persons at the abattoir is in most cases aversive to animals (Grandin, 1997). The use of electric prods for moving animals forward from the lairage pen to the stunning box is particularly stressful to the animals (Warner et al., 2007).

Vocalisation is a suitable indicator for the affective state in cattle (Manteuffel et al., 2004; Grandin, 1998). Consistent with this, an increasing frequency of calling is often correlated with an increase in the physiological stress response (Hemsworth et al., 2011). Increased cortisol, lactate and glucose levels in exsanguination blood are useful as indicators of a preceding period of stress (Gruber et al., 2010).

In cattle, stress responses are the result of complex interactions of genetically predetermined reactions (Terlouw et al., 2008) as well as previous experience (Hemsworth et al., 2011). The type and level of response often depend on the production system. In order to understand the underlying mechanisms it is important to observe behaviour as well as stress-indicating blood parameters, and to relate these indicators to animal characteristics as well as animal management at the abattoir.

The objective of the current study was, therefore, to evaluate relationships between stress-related physiological and behavioural variables and a series of individual animal data as well as management factors. In detail, this included the evaluation of the effects of sex, breed type, and carcass weight under abattoir conditions.

2. Animals, material and methods

2.1. Animals

A total of 192 cattle (*Bos taurus primigenius*) arriving at a commercial abattoir in Switzerland and slaughtered on 25 November 2009 were observed. Arrival time at the abattoir, time of stunning, internal abattoir number, and carcass weights were collected at the abattoir. The animal identification number provided information of each animal's sex, breed type, farm of origin, birth date, and carcass grading for conformation and fatness according to the CH-TAX scheme. Dairy breeds represented about 16% and beef breeds about 37% of the animals sampled. The remaining animals were mostly crosses of dairy and beef breeds. Table 1 summarises the number of animals observed in the categories of sex, breed type, age, body weight, and prodding counts. The animals were categorised into three subgroups depending on their breed type. Exact data on travelling distance could not be obtained. However, transport of each animal did not exceed 6 h from the beginning of loading to the end of unloading at the abattoir assuming that the strict Swiss animal protection act (TSchG, 2005) was followed.

2.2. Slaughter procedure, blood sampling and analysis

Animals were delivered between 6:47 and 13:27 h and confined in lairage pens after arrival. Cattle from different transport wheelers were not mixed during lairage. The difference between arrival time at the abattoir and time of stunning, i.e. the lairage time, was 35 min (SE = 15.9). Animals were driven forward with electric prodders (KAWE, version 21, with automatic shut off after 2 s of pushing, 2 × 1.5 V batteries) when considered necessary by the staff. All animals were restrained in the stunning box and, after captive bolt stunning (Accles & Shelvoke, Type Magnum 9000S, bore 22, 4.5 g cartridge), the animals slid out of the side of the stunning box and were elevated by one hind-leg. Suspended cattle were exsanguinated by chest-sticking.

Blood samples (ca. 300 ml) were collected from the sliced major blood vessels (mainly the *Truncus brachiocephalicus*) during exsanguination (Warner et al., 2007). The blood samples were immediately transferred into heparinised plastic tubes for cortisol analysis and into fluoridated plastic tubes for glucose and lactate analysis (Vacuette, Greiner Bioone, St. Gallen, Switzerland). Blood samples were processed as described in Probst et al. (2012). Cortisol concentration was analysed using a Cortisol Enzyme Immunoassay Kit (Assay Designs, LuBio, Lucerne, Switzerland). Lactate was measured calorimetrically with a dry clinical chemistry analyser (Vitros®, Ortho Diagnostics, Rochester, United States) (Marx and Gressner, 1991). Glucose concentrations were analysed using a hexokinase method (Knedel et al., 1986).

Table 1
Number of animals in the categories sex, breed type, and electric prodding.

Categories	*n*	Average age (d)	SE	Mean carcass weight (kg)	SE
Sex (*n* = 192)					
Bulls	45	393	87.6	278	45.3
Heifers	86	401	192.6	211	40.4
Steers	61	310	27.4	224	26.1
Breed type (*n* = 192)					
Beef cattle[a]	70	347	9.9	228	5.8
Crossbreds[b]	92	325	7.2	226	4.4
Dairy cattle[c]	30	559	43.8	255	8.5
Electric prodding (*n* = 192)					
0 Prods	47				
1–3 Prods	120				
4–9 Prods	25				

[a] 39 Limousin, 13 Simmental, 11 Angus, 3 Hereford, 2 Raetian Grey, 1 Blonde d'Aquitaine, 1 Piemontese.
[b] Mainly crosses of dairy and beef breeds.
[c] 22 Red Pied, 7 Brown Swiss, 1 Holstein.