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# CHICKEN WELFARE AS INDICATED BY LESIONS ON CARCASSES IN SUPERMARKETS

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# ABSTRACT

1. The extent of visible lesions in British broiler carcasses was investigated in order to discover the extent of any poor welfare. It is well established that hock burn and some other injuries can occur during housing of broiler chickens, whilst other injuries can occur during handling.

2. Three hundred and eighty-four whole conventionally-reared British Farm Standard Grade A chickens were scrutinised in supermarkets to assess the frequency of fifteen kinds of lesions. Six lesions were analysed histopathologically and this showed that hock burn would have occurred several days pre-mortem, red alular and wrist bruise were very likely to have occurred pre-mortem, whilst red parson's nose and scratches were likely to have occurred pre-mortem.

3. Many broiler carcasses in the supermarkets had dermal lesions: 0.82 had hock burns, 0.45 a red parson's nose, 0.32 a red alular, 0.21 wrist bruises and 0.21 had at least one scratch on a leg. The frequency of the larger hock burns increased with body weight. 'Organic' chickens had half as many hock burns as conventionally-reared broilers, perhaps because of differences in litter quality or leg strength.

4. The sample studied indicates that painful lesions which would result in poor welfare are frequent in broilers slaughtered in the U.K. The Grade A chickens observed exclude birds with obvious visible defects since these birds would have had the blemishes removed and the carcass would have been portioned. Hence the frequencies of lesions in farmed birds would be higher than those reported here.



*Key Words*: broiler chickens, welfare, pain, lesions, hock burn.


# INTRODUCTION

Many factors are known to contribute to poor welfare of broiler chickens. As a consequence of housing conditions and management methods, the birds often suffer from leg disorders (Weeks et al. 2000, Bradshaw et al. 2002), genetic, respiratory or other diseases (E.U. Scientific Committee 2000). Rough handling and transportation conditions can lead to stress, fear, tissue lesions and bruising (Knowles and Broom 1990).

This investigation focuses on the prevalence of dermal lesions in broiler chickens in English supermarkets and the extent of the injuries to the birds as an indicator of their welfare. Injuries which occurred pre-stunning are distinguished from carcass damage which could have occurred after stunning by carcass investigation, including histopathology, and reference to published papers. A small-scale comparison with 'organic' chickens was also carried out.

# MATERIALS AND METHODS

The subjects of the study were the carcasses of British broiler chickens available in supermarkets. Following a pilot study to determine which injuries to record, those listed below were selected. Injuries which might be evident on broiler carcasses are described and histopathological analyses were performed on carcasses with selected injuries. All carcasses studied were of fresh whole chickens of British Farm Standard (BFS) Grade A quality except for a small number of carcasses marked as 'organic' which are described separately. The carcasses were recognised by supermarket (sm) and, from the label, weight, plant registration number (abattoir no.) and date of use.

**Lesions recorded**

The frequencies of the following lesions were recorded:

*Leg cut off (lco)*: Any substantial part of the leg cut off in addition to the normal cut directly under the intertarsal joint. (This was not seen.)

*Hock mark (hm)*: Reddish area at a chicken's dorsal intertarsal joint, including the metaphysis of the tarso-metatarsus.

*Hock haemorrhage (hh)*: Red or dark red rounded area at the back of a chicken's intertarsal joint.

*Hock burn (hb)*: One or more scabs located on the plantar scales of a chicken's intertarsal joint, including the metaphysis of the tarso-metatarsus. The affected area on one or both legs was categorised as either *small* (shb) (less than 0.3 x 0.3 cm = 0.09 $cm^2$ of scabs in total), *medium* (mhb) (0.09 $cm^2$ to 0.3 $cm^2$) or *large* (lhb) (more than 0.3 $cm^2$).

*Scales removed from legs*: Some of the scales which are normally present on the lower leg are absent.

*Metatarsus bruise (mb)*: Red area along the inner lateral diaphysis of the chicken's tarso-metatarsus.

*Drumstick bruise (db)*: Discoloured area at the diaphysis of the chicken's tibiotarsus above the intertarsal joint.

*Scratch*: Yellowish or brownish scab in form of a line on the skin of the leg (ls), back or abdomen/lower back or vent region of a chicken.

*Breast blisters (bb)*: Patch on the skin of a chicken's breast.

*Breast cut off (bcp)*: Substantial amount of skin or muscle removed from the ventral part of a chicken. (This was not seen.)

*Red alular (ra)*: Red coloured skin at the distal part of the alular digit of a chicken's wing.

*Red phalanx (rp)*: Red coloured skin at the distal part of the major distal or proximal phalanx digit of a chicken's wing.

*Wrist bruise (wb)*: Discoloured area at the caudal radio-radiocarpal joint of a chicken.

*Elbow bruise (eb)*: Discoloured area at the chicken's anconeal joint.

*Red parson's nose (rpn)*: Red skin at the distal part of a chicken's parson's nose with a minimum discoloured area of 0.3 cm (measured from the apex along the side).

**Data collection in supermarkets**

Supermarkets in England were visited between 29/09/2003 and 22/10/2003 and British Farm Standard chickens visually examined. In order to ensure that the

chickens studied in the supermarkets had been selected according to normal supermarket and supplier methods the supermarkets were not informed of the study. Data were recorded using a concealed tape-recorder so as not to attract attention.
For the assessment of the lesions in each bird the chickens were selected according to a random list. This collection of data in the supermarkets started at the top left of the shelves going down diagonally towards the bottom right of the shelves to ensure a wide range of weights of the chickens.

Each chicken was judged without handling by noting down whether the area on the bird where the lesion would be was: 1. visible and a lesion present, 2. visible and no lesion present, or 3. not visible. The lesions on legs and wings were recorded distinguishing between right and left limbs. In supermarkets having more than three shelves with chickens in a row behind each other, only the front layer was taken into account because of difficulty in sampling.

316 chickens were observed during visits to eleven supermarkets belonging to eight companies. Having visited all eleven supermarkets once, each one of them was revisited in a random order but after a sufficient time to ensure that no chicken was present on more than one visit. This was checked using the latest date of use of recorded chickens. In total, chickens were chosen on three occasions in each retail outlet. If no chickens were available in a shop, the acquisition of data was stopped for that day and the same shop was visited the following day, before continuing with the random order of supermarkets. A further 68 birds were observed, using the same methods, in other supermarkets, belonging to the same eight companies but visited only once, making a total of 384 birds.

A number of British Farm Standard Grade A chickens were selected randomly from amongst the eleven supermarkets and bought for closer examination including histopathology.

Additionally, the same methods were used in the same supermarkets for 26 organic chickens (BFS grade A) between 11/10/2003 and 22/10/2003.

## Histopathology

In order to investigate cellular changes associated with six lesions in broilers, birds with the following lesions were bought:

a) hock burn and hock haemorrhage
b) red parson's nose
c) wrist bruise
d) red alular
e) a scratch on the back
f) an abdominal scratch

One sample of each lesion was prepared by cutting at right angles into the surface of the skin and fixing the tissue in 10% neutral buffered formalin for approximately 48 hours. After being cut into sections of 1-3mm thickness, these were processed mechanically (Shandon Citadel 2000). Firstly, the tissue was dehydrated with methylated spirits (75%, 95% and 100%) for the removal of aqueous fixative and tissue water. Then clearing was performed with chloroform, before impregnating the slices with paraffin wax (Surgipath, Tissue-TEK III Embedding Centre). To hasten solidification for trimming and reduce the tendency to large crystal formation in the wax, the samples were directly cooled and the embedded tissue was then sliced into pieces of 4$\mu$m.

All sections were stained with haematoxylin and eosin. They were dewaxed with xylene and methylated spirits, before applying Harris's haematoxylin (Shandon Linistan GLX). After further processing the samples with acid alcohols and Scott's reagent, the tissue was counter-stained with eosin, finishing the preparation with absolute alcohol and xylene.

All sections were then examined with a light microscope.

## Statistical analyses

The relationship between the weight of chickens and hock burn size was tested with the Spearman rank correlation. Differences between conventionally- and organically-reared chickens were calculated using the Chi-squared test with the Bonferroni correction for multiple testing.

# RESULTS

## 1. Frequencies of lesions in conventionally-reared chickens

The 384 conventionally-reared broiler carcasses ranged in weight from 1.00 kg to 3.36 kg with a median of 1.55 kg. No birds with legs cut off or breast cut off were found.

The absolute frequencies of each of the dermal lesions measured in conventionally-reared broiler chickens, are shown in Table 1. These include chickens from supermarkets visited once and supermarkets visited three times since these did not differ at the $p<0.05$ level for any lesions for which a Chi-squared test was valid: red parson's nose, hock mark, no hock burn, small hock burn, medium hock burn, large hock burn, red alular, wrist bruise and leg scratch. The sample size shown in Table 1 for each lesion was the total for three times visited and once visited supermarkets (384), less any chickens where the whole of the relevant area of the bird was not visible due to the packaging.

**Table 1**. Frequencies of lesions of conventionally-reared British Farm Standard broiler chickens in supermarkets (* n was small so proportion less reliable).

| LESION | Number of birds where area visible | Total frequency | Proportion of birds with lesion |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Red parson's nose** | 329 | 147 | 0.45 |
| **Hock mark** | 364 | 290 | 0.80 |
| **Small hock burn** | 370 | 145 | 0.39 |
| **Medium hock burn** | 370 | 92 | 0.25 |
| **Large hock burn** | 370 | 65 | 0.18 |
| **Total hock burns** | 370 | 302 | 0.82 |
| **Hock haemorrhage** | 370 | 7 | 0.02 |
| **Scales removed from legs** | 370 | 12 | 0.03 |
| **Drumstick bruise** | 376 | 13 | 0.04 |
| **Metatarsus bruise** | 7 | 1 | 0.04* |
| **Red alular** | 198 | 64 | 0.32 |
| **Red phalanx** | 19 | 7 | 0.37* |
| **Wrist bruise** | 376 | 77 | 0.21 |
| **Elbow bruise** | 370 | 15 | 0.04 |
| **Breast blisters** | 8 | 2 | 0.25* |
| **Leg scratch** | 384 | 81 | 0.21 |

The broilers were categorised into four groups: small (1.0-1.2 kg), medium (1.3-1.5 kg), large (1.6-2.1 kg) and extra large (2.2-3.4 kg). Fig. 1 shows the proportion of hock burns of the different sizes for each of the bird weight categories.

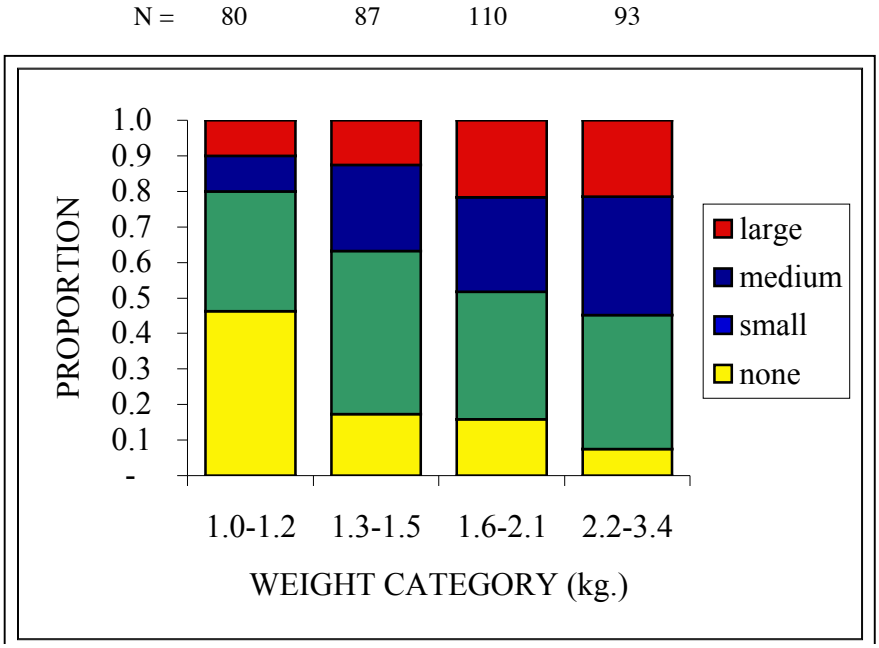

**Figure 1.** Cumulative proportion of hock burn sizes (none, small, medium and large) in four weight categories of broiler chickens: small (1.0-1.2 kg, $\chi^2$ 33.4, $p<0.001$), medium (1.3-1.5 kgm $\chi^2$ 4.05, $p=0.26$), large (1.6-2.1 kg, $\chi^2$ 16.3, $p=0.001$) and extra large (2.2-3.4 kg, $\chi^2$ 12.6, $p=0.06$).

Fig. 1 shows that the frequency of large and medium-sized hock burns increased with body size whilst chickens in the smallest weight category were more likely to have no hock burns than larger birds. Weight is positively correlated with likelihood of hock burn (Spearman rank correlation $r_s=0.353$, $N=370$, $p<0.001$).

**Lesions of conventionally-reared broilers in different supermarkets**

In order to investigate whether some injuries occur more in some retail outlets than in others, the frequencies of lesions were calculated for each of the eleven supermarkets used for data collection (Table 2). Some injuries are not included because the sample size of birds per supermarket was not large enough.

**Table 2.** The proportion of chickens with the different lesions in each of eleven supermarkets.

| | **Lesion** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Supermarket** | Red parson's nose | Hock Mark | Hock Burn | Drumstick Bruise | Red Alular | Wrist Bruise | Elbow Bruise | Leg Scratch |
| 1 | 0.71 | 0.68 | 0.64 | 0 | 0.75 | 0.51 | 0.16 | 0.16 |
| 2 | 0.51 | 0.89 | 0.74 | 0 | 0.41 | 0.18 | 0 | 0.33 |
| 3 | 0.57 | 0.89 | 0.97 | 0.02 | 0.56 | 0 | 0 | 0.13 |
| 4 | 0.33 | 0.33 | 0.66 | 0.34 | 0 | 0 | 0 | 0 |
| 5 | 0.25 | 0.98 | 0.64 | 0 | 0.56 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 0.11 | 0.74 | 0.97 | 0 | 0 | 0.38 | 0 | 0.25 |
| 7 | 0.45 | 0.67 | 0.86 | 0 | 0 | 0.23 | 0 | 0.08 |
| 8 | 0.48 | 0.80 | 0.83 | 0 | 0.32 | 0.22 | 0.04 | 0.11 |
| 9 | 0.67 | 0.88 | 0.84 | 0.04 | 0.49 | 0.39 | 0.10 | 0.16 |
| 10 | 0.30 | 0.84 | 0.77 | 0.05 | 0.26 | 0.22 | 0.07 | 0.21 |
| 11 | 0.51 | 0.89 | 0.84 | 0.03 | 0.27 | 0.08 | 0.03 | 0.33 |

The variation amongst supermarkets is substantial. That for hock burn (small, medium and large) varied greatly but there was also variation in the weight of the birds so no statistical comparison could be made.

## 2. Histopathology of lesions

The histopathological analyses of six injuries of broiler chickens reveal a number of significant alterations of the tissue.

a) In the section of the *hock burn* there was thickened keratin tissue (hyperkeratosis). In both hock burn and hock haemorrhage, hyperplasia of live cells as well as rebuilding tubules and vacuolation were evident.

b) In a sample of a *red parson's nose* red granulae, inflammatory cells, lymphocytes and thickening of the collagen tissue could be seen.

c) The histological section of a *wrist bruise* exhibited vessels packed with blood cells and red blood cells infiltrating into the tissue as well as mild oedema. The collagen around the blood vessels appeared pale.

d) The *red alular* had one ulcerous rupture of the epidermis. More detailed microscopical examination showed erosion underneath, leakage of fluid, infiltrating red blood cells, inflammatory cells and lymphocytes as well as necrosis underneath the ulcer.

e) Analysis of a *scratch* at the back of a chicken revealed a crust and an infiltrate of red blood cells as well as heterophilic and neutrophilic cells. The damaged tissue had no proper architecture.

f) A section of an *abdominal scratch* of a broiler carcass showed tissue where the skin was not present but containing macrophages and lymphocytes.

## 3. Comparision of conventional and 'organic-reared' chickens

The weight of the 26 'organic' broilers ranged from 1.19 to 1.62 kg with a median of 1.39 kg. The frequencies of each lesion were calculated as for conventionally-reared birds.

Fig. 2 shows comparisons of organic and conventionally-reared chickens wherever the observation of at least 23 'organic-reared' chickens was possible. The conventionally–reared birds were those in the same weight range (1.19 to 1.62 kg).

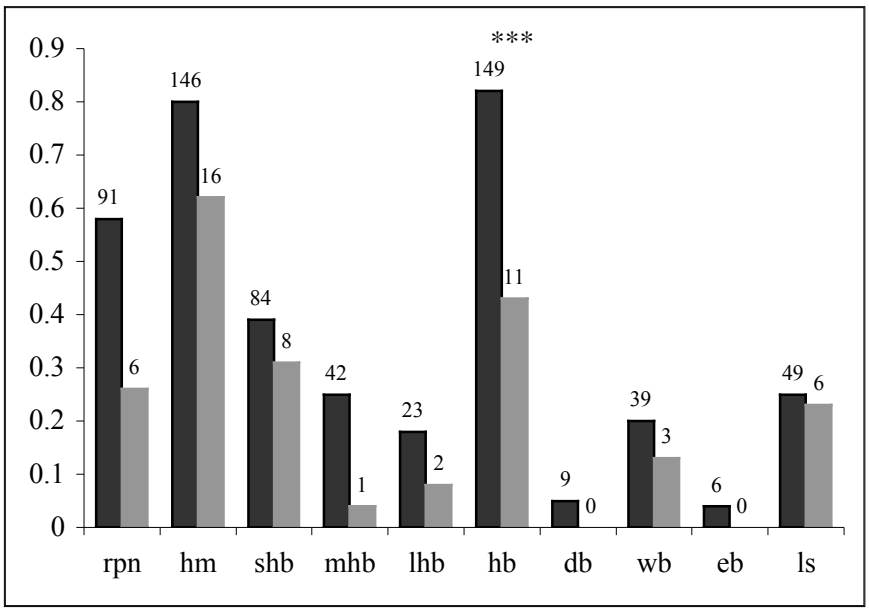


**Figure 2.** Proportions of conventionally-reared (black) and 'organic-reared' (grey) broilers in supermarkets which had each lesion. Numbers above bars indicate the number of affected birds. rpn (red parson's nose), hm (hock mark), shb/ mhb/ lhb (small/ medium/ large hock burn), hb (all hock

burn), db (drumstick bruise), wb (wrist bruise), eb (elbow bruise), ls (leg scratch). ***p<0.001 Chi-squared test with Bonferroni correction.

The numbers of birds with hock burn were greater in conventionally-reared than in 'organically-reared' broiler chickens ($\chi^2$=18.78, N=210, df=1, p<0.001).

# DISCUSSION

Many of the Grade A broiler carcasses sampled from British supermarkets had lesions in the skin. A key issue is whether the lesions were produced after stunning rendered the birds unconscious or whether they resulted in poor welfare of chickens during rearing or during pre-slaughter handling (Goksoy et al 1999). The histological analyses are therefore discussed below. Some lesions result in the carcasses being used for sale of pieces of chicken rather than being sold as whole birds. The proportion of birds rejected completely or rejected for sale as whole birds is not known. There was no evidence that the practice of cutting off leg or breast areas before sale as whole birds occurs. No birds in our sample had such damage. A few birds had scales removed from their legs, either deliberately in order that hock burn is not evident or as a consequence of processing.

## Histopathology

The histological analyses of the samples are valid because neither processing nor storing the meat changed the quality of the sections, even though the architecture of some slices was less well maintained due to cutting and processing the tissue.

The analyses of *hock burn* and *hock haemorrhage* revealed alterations in the tissue, which indicate that the injury occurred in the living animal, and thus affected the welfare of chickens with this lesion. The vacuolation can be an artefact from cutting, as can oedema but most changes in hock burn show the inflammation and the lesion to be some days old at the point of death.

The granula and inflammatory cells in the prepared tissue of *red parson's nose* indicate an injury occurring pre-mortem, and the lymphocytes indicate chronic inflammation. The extent of effect on the welfare of the living animal would depend also on the amount of damage to the skin. There is a possibility that the tissue damage occurs at the time of stunning but this seems unlikely.

The vessels packed with blood cells in the prepared slice of the *wrist bruise* could indicate either a haemorrhage during life or an artefact from cutting the tissue. The same applies to the infiltrating red blood cells, which could be an indicator of a haemorrhage or an artefact from stunning the bird in the electrical water bath, and hence a body response to heat and electricity without impact on the welfare of chickens. The pale area around blood vessels in the oedematous area suggests changes in the skin during life rather than after death. Taking all these alterations in the tissue into account, it is most likely that the wrist bruise developed while the animal was still alive and hence involved poor welfare. Wrist bruises are likely to be a result of handling rather than housing conditions.

The *red alular* revealed significant changes in the tissue like necrosis, oedema and infiltrations. Therefore, this dermal lesion is most likely to have been present pre-mortem.

The *scratches* on the back and abdomen of chickens could have occurred pre-mortem but further analyses of tissue architecture would be necessary to be certain of this. It is likely that most of the scratches were a result of handling.

In general, the tissue of the samples was well preserved with small artefacts despite the processing and storage of the meat, so such analyses are a good method for investigation. The major lesion, hock burn, would appear to have occurred during housing whilst red alula, red parson's nose, wrist bruise and scratches were likely to have occurred either during housing or during handling and hence to have been associated with poor welfare in the chickens. The intensity of effect of each injury on poor welfare of a chicken is not known. This could be associated in a linear, exponential or other way to the size, depth and duration of the lesion. Hyperkeratosis,

for example, "may have painful fissures or ulcers" (Thomson 1988) so would involve poor welfare.

**Lesion frequencies in conventionally-reared broilers**

A large number of broilers were affected with *hock burns* (82%) which are caused by ammonia and other substances in the litter and are known to cause poor welfare (Bradshaw et al. 2002). The size (small, medium, large) of this lesion increased with weight (Spearman rank correlation $r_s$=0.353, N=370, p<0.001). Most birds without ammonia burns on the hock were the ones in the smallest weight category. Thus the total frequency of hock burns, especially large ones, is likely to be higher than determined in this study because birds with large hock burns would not be used as whole carcasses or scales would be removed. Observations at farms or the abattoir would be needed to get a better estimate.

The lesion *hock mark*, with which 80% of broilers were found to be affected, could start from an ammonia burn or from processing and storing the bird in the supermarket. With alterations of temperature, changes in the colouration of the skin occur easily. Histological analyses might help to detect the differences. However, no conclusions can be drawn from our data on hock marks. The *hock haemorrhage*, which was found in seven chickens, could result from poor handling.

48% of birds had a *red parson's nose* which seems likely to have occurred pre-mortem. Further histological analyses and inspection of birds on farms would help to determine how this injury occurs. Possible explanations for this injury could be that chickens lie on the ground and get an inflammation from the ammonium level or other broilers step on them. The lesion could also be a result of abrasion on the floor during transport, or possibly a reaction to cold air in the outer parts of the lorry while transporting.

The phalanxes of broilers are rarely visible in the supermarkets due to packaging but red alulars are a good hint to red wing tips. With 32% of birds having this lesion, it seems to be relatively widespread. The *red alulars* might occur whilst birds flap on the shackling line in the abattoir or may arise during transport or on broiler farms where the birds might use the wings to support part of the body weight. A further investigation of this injury, e.g. on broiler farms, is needed to explain its causation.

There were 21% of broilers with *scratches* on at least one leg. This lesion could occur from birds standing on each other, rough handling or transportation (Herenda and

Franco 1996). The scalding water temperature and rubbing intensity of the defeathering machines are directly associated with the removal of crusts on the skin (Greene and Cracken 1985). The stocking density during rearing does not seem to affect the incidence of scratches (Feddes et al. 2002) but is shown to increase the development of cellulitis (Norton et al. 1999) or other infections, and hence poor welfare. The numbers of birds per crate during transport might affect the incidence of scratches.

Additionally, in many birds a dislocation of the elbow was seen in supermarkets. This could be machine damage post-mortem but a more detailed investigation of how it occurs and whether there is any effect on the welfare of chickens would be useful.

There are other factors which might influence the recorded frequency of each lesion. It could be that a small number of customers choose the better looking chickens first, thus increasing the proportion of chickens that were detected as damaged. However, any such effect is likely to be small as most customers selected chickens without looking closely at them. It would be of interest to study the injuries of chickens in abattoirs.

The current UK Assured Chicken Production standards allow up to 15% of broilers with hock burns. This study shows that there are far more broilers affected (82%) with at least one small hock burn. Counting only medium and large hock burns, there were 42%, not including the number of birds with removed scales. A hock burn, may go on to cause ulcers which discharge, and become covered with litter and faecal material (Greene and Cracken 1985). Personal communications from some veterinary inspectors indicate that, in some abattoirs only ammonia burns resembling the large hock burns in this study are recorded and no attention is paid to smaller sized hock burns.

**Effects of supermarkets, conventional versus 'organic' rearing and other possible factors.**

There appear to be large differences among supermarkets in the numbers of broilers with injuries. Some differences would have been caused because chickens of certain weights were sold out in some of the supermarkets and there are supermarkets which had chickens in only one weight category. However, it is likely that in the welfare of birds on suppliers' farms will vary so the effects on carcasses in the various supermarkets will also vary.

The sample size for 'organically-reared' chickens (N=26) was not large but differences in the occurrence of hock burns ($p<0.001$) were found. Had the samples been larger, other differences might have been found.

Differences amongst supermarkets and between conventional and 'organic' production may include management methods, space allowance per bird, genetic lines used, extent of use of antibiotics and carcass selection methods. The extent of injuries is likely to depend on the farms the chickens were reared on and perhaps the actual flock in which they grew up. Ekstrand and Carpenter (1998b) reported significant clustering of food-pad dermatitis in Swedish broilers with regard to geographical region and time. Thus this is likely to be the case for other dermal lesions as well. High stocking density, for example, results in more foot and hock burns (Sorensen et al. 2000), and abdominal scratches are positively correlated with stocking density at all ages (Elfadil et al. 1996). Some "organic" chickens are kept in smaller groups at lower stocking densities than conventionally-reared birds. Some have access to the outside and grow to slaughter weight in nine weeks rather than in five to six weeks. However, there is variation in the management conditions used for birds labelled as "organic". It is likely that many of the birds which are labelled in this way rest on drier litter, and have stronger legs as a consequence of management differences, but the actual factors leading to the differences reported here are unknown.

The guidelines for the management of rearing chickens used in the various production companies probably differ. Relative humidity, for example, influences the incidence and severity of food pad burn (Weaver and Meijerhof 1991), and different food has been shown to influence the strength of the skin (Pinion et al. 1995). Therefore, some birds might be less susceptible to dermal lesions than others. White Leghorn layers

reared on wet litter and wet perches show a higher incidence of foot pad dermatitis (Wang et al. 1998) and the wetness is likely to increase the amount of hock burns.

The supermarkets also have guidelines for production and management of chickens and these affect the quality of chickens sold to customers. Thus BFS Grade A varies in itself and it is not known whether these guidelines differ by location of the supermarket.

The recorded frequency of certain lesions could be affected by the genetic strain of the broilers (Kramer et al 2003), their sex and age at slaughter. The susceptibility to some diseases is known to increase with age and differ by sex but might also be due to the weight of the birds. Dermal lesion frequency can vary with breed (Nielsen et al. 2003). Renden et al. (1994) reported Grade A carcasses of one broiler strain to have more back-bruising and breast blisters than the other one studied, and Kestin et al. (1999) showed differences in the prevalence of foot pad and hock burns among genotypes. Furthermore, the bird's age at slaughter is known to be significantly associated with the total foot-pad score in Swedish broilers (Ekstrand and Carpenter 1998), and could have an impact on the extent of the lesion.

The sample studied indicates that painful lesions which would result in poor welfare are frequent in broilers slaughtered in the U.K. The Grade A chickens observed exclude birds with obvious visible defects since these birds would have had the blemishes removed and the carcass would have been portioned. Hence the frequencies of lesions in farmed birds would be higher than those reported here.

Dermal lesions not only increase poor welfare in chickens but are a concern for human aesthetics. Serious lesions will result in down-grading of carcasses, thus increasing the economic losses of the chicken industry. Visible lesions, like those described in the study, are ignored by some consumers but may affect the likelihood of purchase by others.

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## References

BRADSHAW, R.H., KIRKDEN, R.D. and BROOM, D.M. (2002). A Review of the aetiology and pathology of leg weakness in broilers in relation to welfare. *Avian Poultry Biology Review*, **13:** 45-103.

European Union Scientific Committee (2000). The Welfare of Chickens kept for Meat Production (Broilers). *Report of the Scientific Committee on Animal Health and Animal Welfare*. European Commission, Health and Consumer Protection Directorate-General. Adopted 21 March 2000.

EKSTRAND, C. and CARPENTER, T.E. (1998). Using a tobit regression model to analyse risk factors for foot-pad dermatitis in commercially grown broilers. *Preventive Veterinary Medicine*, **37:** 219-28.

EKSTRAND, C.and CARPENTER, T.E. (1998). Spatial aspects of foot-pad dermatitis in Swedish broilers. *Acta Veterinarian Scandinavica,* **39:** 273-80.

ELFADIL, A.A., VAILLANCOURT, J.P. and MEEK, A.H. (1996). Impact of stocking density, breed, and feathering on the prevalence of abdominal skin scratches in broiler chickens. *Avian Diseases*, **40:** 546-52.

FEDDES, J.J., EMMANUEL, E.J., ZUIDHOFT, M.J. (2002). Broiler performance, body weight variance, feed and water intake, and carcass quality at different stocking densities. *Poultry Science,* **81:** 774-9.

GOKSOY, E.O., MCKINSTRY, L.J., WILKINS, L.J., PARKMAN, I., PHILLIPS, A., RICHARDSON, R.I. and ANIL, M. H. (1999). Broiler stunning and meat quality.

*Poultry Science,* **78:** 1796-800.

GREENE, J.S. and CRACKEN, A. (1985). Contact dermatitis of broilers: clinical and pathological findings. *Avian Pathology,* **15:** 23-38.

HERENDA, D. and FRANCO D. (1996). *Poultry Disease and Meat Hygiene*. Iowa University Press, Ames.

KESTIN, S.C., SU G. and SORENSON, P. (1999). Different commercial broiler crosses have different susceptibilities to leg weakness. *Poultry Science,* **78 :**1085-90.

KNOWLES, T.G. & BROOM, D.M. (1990). The handling and transport of broilers and spent hens. *Applied Animal Behaviour Science,* **28:** 75-91.

KRAMER, J., VISSCHER, A. H., WAGENAAR, J.A., CORNELISSEN, J.B. and JEURISSEN, S.H. (2003). Comparison of natural resistance in seven genetic groups of meat-type chicken. *British Poultry Science,* **44:** 577-85.

NIELSEN, B.L., THOMSEN, M.G., SORENSON, J.P. and YOUNG, J.F. (2003). Feed and strain effects on the use of outdoor areas by broilers. *British Poultry Science,* **44:**161-9.

PINION JL, BILGILI S F, ECKMAN M K and HESS J B. (1995). The effects of halofuginone and salinomycin, alone and in combination, on live performance and skin characteristics of broilers. *Poultry Science*, **74:** 391-7.

RENDEN, J.A., MORAN E. and KINCAID, S.A. (1994). Lack of interactions between dietary lysine or strain cross and photo-schedule for male broiler performance and carcass yield. *Poultry Science*, **73:** 1651-62.

SORENSON, P., SU, G. and KESTIN, S. C. (2000). Effects of age and stocking density on leg weakness in broiler chickens. *Poultry Science,* **79:** 864-70.

THOMSON, R.G. (1988). *Special Veterinary Pathology*. Decker, Toronto.

WANG, G., EKSTRAND C. and SVEDBERG J. (1998). Wet litter and perches as risk factors fort he development of foot-pad dermatitis in floor-housed hens. *British Poultry. Science,* **39:** 191-7.

WEAVER, W. D. and MEIJHOF, R. (1991). The effect of different levels of relative humidity and arif movement on litter conditions, ammonia levels, growth, and carcass quality for broiler chickens. *Poultry Science,* **70:** 746-55.

WEEKS C.A., DANBURY T.D., DAVIES H.C., HUNT P and KESTIN S.C. (2000). The behaviour of broiler chickens and its modification by lameness. *Applied Animal. Behaviour Sci*ence, **67:** 111-125.