EFFECT OF CATCHING BROILERS BY HAND OR MACHINE ON RATES OF INJURIES AND DEAD-ON-ARRIVALS

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Abstract

Catching of broilers is the first stage in the transfer of birds to the slaughterhouse. The catching process entails a high risk not only of stress but also of injury and death to the birds. Associated injury and mortality rates have important implications not only for animal welfare but also for the economics of the procedure. Catching machines are advantageous with regard to labour costs and standards, and they may also reduce damage to the birds. In the present investigation the use of a sweeper-type catching machine was compared with manual catching under commercial conditions, data being collected during 43 mechanical and 40 manual catching events evenly distributed over one year. Dead-on-arrival rates were recorded, and 108 068 mechanically caught and 87 916 manually caught birds were examined for injuries on the shackles at the processing plant. Injury rates of all types were significantly reduced after mechanical catching. This improvement was highest with respect to leg injuries. There was no significant difference in the number of dead-on-arrivals except during the spring period, when there were higher losses of birds caught mechanically; this was thought to be attributable to climatic conditions. The loading of the transport containers with equal numbers of birds and the initial familiarisation period of the catching team with the machine are potentially problematic factors with potential for improvement. The catching machine investigated here, with its lower risk of injury to broilers than commercial manual catching, has the potential to limit impairment of bird welfare during catching.

Keywords: *animal handling, animal welfare, broiler, catching machine, dead on arrival, injury*

Introduction

Pre-slaughter broiler-catching in Germany is typically carried out by hand. Birds are usually caught by one leg, inverted, carried with three or four birds per hand, and dropped into the transport container, as described for the UK by Bayliss and Hinton (1990). Such catching conditions result in considerable rates of injuries to the birds. Broilers suffer from bruises of the breast, wings and legs, as well as from fractures and dislocations of the extremities (Mayes 1980; Jespersen 1982; Griffiths & Nairn 1984). It can be assumed that such damage is associated with pain in the birds. The resulting rejection rates after slaughter range from 5% to 30% (Jespersen 1982; Kettlewell & Turner 1985; Gerrits *et al* 1985). Moreover, a substantial proportion of transport losses are due to the severe injuries inflicted on the birds during catching (Bayliss & Hinton 1990; Gregory & Austin 1992).

Mainly because of labour costs and health standards at work, but also in order to decrease rejection rates, numerous attempts have been undertaken to mechanise catching. These include systems for herding animals towards a conveyor belt for further carriage to the transport units, suction vacuum systems, fork-like scoops to pick up the broilers from the floor, or mat-pulling systems using long fabric mats laid in the broiler house and later rolled up with the birds on them. All of these systems have proven to be too slow or too expensive, or have resulted in high injury rates, so they have not become commercially widespread (Gerrits *et al* 1985; Kettlewell & Turner 1985; Bayliss & Hinton 1990). Sweeping systems with soft rubber fingers or pads are the only systems now commercially available in several versions (Parry 1989; Moran & Berry 1992). One category of broiler-catching machines, constructed in Italy, Finland and the USA, is based on a sweeping system with three vertical rotors developed at the Silsoe Research Institute in the UK (Berry & Kettlewell 1997). It consists of long rubber fingers mounted on three counter-rotating pick-up heads. These move the birds onto a conveyor belt which takes the broilers to a loading unit (Parry 1989; Berry & Kettlewell 1997).

Broiler-catching machines of this type are now being introduced in Germany. However, insufficient information is available for the evaluation of these machines in terms of animal welfare. From small-scale experiments it appears that mechanical catching and carrying has advantages with respect to induction of fear in the broilers (Duncan *et al* 1986; Duncan 1989), as has been confirmed for mechanical carrying of laying hens (Scott & Moran 1992). However, Duncan (1989) showed that the final dropping of birds into crates might lead to problems. Depending on the height from which the birds are dropped, there is an increased risk of stress and injury because of their wing-flapping response. Moreover, in laboratory investigations (Duncan *et al* 1986), the speed of catching was lower (about 4500 birds per hour) than the usual commercial rate (about 8000 birds per hour). Regarding damage inflicted to broilers, statements from practice (Möbius 1996) and data from unspecified sources with unknown sample size (Gracey 1986) indicate that the use of a catching machine may reduce both dead-on-arrival (DOA) rates and numbers of broken limbs and bruises. The data presented by Gracey (1986) relate to a harvesting machine with a horizontal rotor. Lacy and Czarick (1998) found significantly fewer leg or hock bruises in broilers caught mechanically in four samples each of 50 birds. On the other hand, Ekstrand (1998) reports from a large observational cohort study higher frequencies of dead birds on arrival and of bruises resulting from the catching machine. It must be noted, however, that the manual catching method applied in this study, and more generally in Sweden, is the simultaneous picking up of only two birds held in an upright position, which is a much more gentle treatment than that used in most other places.

Considering the inconclusive scientific evidence on welfare aspects of mechanical broiler catching, it was the aim of the present study to compare mortality and injury rates associated with mechanical and manual catching under commercial conditions, and to perform a welfare assessment of the investigated catching machine on this basis.

Materials and methods

Investigations were carried out over a period of one year. Observations were evenly distributed over the four seasons: autumn (September–November), winter (December–February), spring (March–May) and summer (June–August) with 10 recording days and catching events per catching method and seasonal period, with the exception that mechanical catching was observed on 13 days in the spring. Therefore, the total sample size was 40 for manual and 43 for mechanical catching methods, with a total of 869 738 and 1 112 419 birds caught manually and mechanically, respectively. Broilers were examined at a commercial slaughterhouse in northwest Germany, where about 8000 to 9000 broilers are slaughtered per hour and about 145 000 per day. The 52 broiler houses selected for this study contained flocks of about 13 000 to 42 000 birds, with a total of 15 000 to 120 000 birds per farm. The broilers were Cobb and Ross hybrids and the flocks were of mixed sex (as hatched). All houses were windowless facilities with forced ventilation and were suitable for use of the catching machine. They were situated within a distance of 1–90 km from the processing plant, so that driving times were in the range 5–105 min. The birds were aged 31–35 days, with weights of 1300–1750 g. The investigators had no influence over the allocation of the different broiler houses to a specific catching method. On two days per week, we observed the commercial catching process where catching took place in facilities which satisfied our general selection criteria (flock size, house design and suitability for both catching methods, and transport distance). As far as possible, we observed manual and mechanical catching on alternating days, and in any case we observed each method for at least 10 days per seasonal period. During the one-year investigation period, this resulted in several farms being repeatedly involved. On 15 farms, both mechanical and manual catching methods were observed; on 16 farms, mechanical catching only was observed; and on 21 farms, manual catching only was observed. Furthermore, for each catching method, nine farms were observed twice, two farms three times and one four times. At each observation, however, different flocks, feed, climatic conditions and so on were involved. For instance, the lighting level during catching could differ more within the same farm during different seasons than between farms during the same season. Therefore, we decided to neglect any farm effect and treat all samples as independent.

Catching was the responsibility of one company with two catching teams, one of which was predominantly responsible for the machine method, the other for the manual catching method. In cases of machine failure and sometimes for organisational reasons the 'machine team' also caught by hand, which was the case 14 times during our investigation. Before the investigation started the team had been working with the machine for two months.

The catching machine, 'Chicken Cat' (Jydsk Transport Teknik, Denmark; import: Claus Ohlsen & Sohn OHG, Geltorf, Germany), had a three-rotor pick-up head with soft rubber fingers, two conveyor belts and a loading platform carrying the container systems at the rear of the machine. The first conveyor belt was adjustable in length from 15 m to 20 m and was connected via a joint to the second conveyor belt, which could be varied in height by hand and which carried the birds to the transport containers. The machine was operated by one person using a remote control. Two persons at the loading platform controlled the transfer of birds into the drawers. Blue light illuminated the pick-up head and the loading platform at the rear of the machine. The machine had a potential pick-up capacity of 8000–10 000 broilers per hour.

The transport modules were 'Easyload-Containers' (Anglia Autoflow, UK). Each module consisted of 12 plastic open-topped unrestrained drawers in a metal frame. The drawers were perforated for ventilation on the bottom and sides. Each drawer could accommodate 30–32 birds with mean weights of 1.5 kg. The modules were moved by a fork-lift truck and stacked in two rows on the transport vehicle. The modules were unloaded by fork-lift at the slaughterhouse, the drawers were automatically set onto a conveyor belt and the birds hung by hand on the shackles.

Before examining carcasses at the slaughterhouse, we observed catching in the broiler house for 1–2 h. Notes and measurements on catching conditions were made, including climate and lighting levels in the broiler house, speed of the catching machine's conveyor belt, and stocking density in the containers. Information on the number of animals, mortality rates during fattening and possible medical treatments were obtained from the documentation of the broiler farms. Liveweights of the birds were ascertained by the slaughterhouse.

On each observation day, about 10% of the birds from one broiler house were visually and if necessary palpatorily examined at the shackles after evisceration. This resulted in examination of a total of 108 068 and 87 916 birds caught mechanically and manually, respectively. Observations were evenly distributed over the slaughter process. Injuries were classified as bruises on the breast, back, wings or legs, as fractures of wings or legs, or as dislocations of wings or legs, and they were recorded using a hand-held computer (Psion Organiser LZ64, Psion PLC, London, UK). In order to exclude as far as possible injuries causally unrelated to catching, we did not record bruises with greenish colouration and fractures with no signs of bleeding. Greenish colouration of bruises indicates that they developed before catching (Hamdy *et al* 1961) and lack of bleeding in fractures points to a post-mortem origin (Jespersen 1982). Furthermore, bruises were only recorded if they were a minimum of about 2 cm in diameter and of solid colour, in order to exclude dubious cases and those probably related to the stunning process. The number of DOAs was ascertained by the slaughterhouse workers when hanging the birds on the shackles.

Injury and DOA rates are presented as means with standard deviations. As most data were not normally distributed, in general the Mann-Whitney *U*-test of Statistica for Windows 5.1 (StatSoft Inc 1996) was used for comparisons. The same software package was used for Spearman's rank correlation analysis.

Results

There were no significant differences between mechanical and manual catching relating to background data, ie average flock size, mortality during the housing period, light levels during catching, broiler weight and age at slaughter, transport times, and average temperature and humidity per season (Table 1).

Table 1 Background data for mechanical and manual catching.

	Mechanical catching n = 43	**Manual catching n = 40**
Flock size	24 720 ± 7317 broilers	21 798 ± 6561 broilers
Mortality during housing	3.53 ± 1.34%	3.27 ± 0.97%
Light level	4.82 ± 7.46 lux	4.36 ± 6.04 lux
Liveweight at slaughter	1537 ± 87 g	1520 ± 101 g
Age at slaughter	32.8 ± 0.90 days	33.0 ± 0.89 days
Transport time	47.84 ± 21.21 min	43.63 ± 23.79 min
Outdoor temperature, autumn	11.86 ± 8.28°C	6.10 ± 4.17°C
Outdoor humidity, autumn	73.77 ± 12.26%	84.35 ± 3.82%
Outdoor temperature, winter	6.40 ± 3.74°C	4.14 ± 3.48°C
Outdoor humidity, winter	88.76 ± 7.04%	94.30 ± 9.63%
Outdoor temperature, spring	10.30 ± 5.36°C	7.61 ± 3.74°C
Outdoor humidity, spring	79.41 ± 25.03%	77.70 ± 9.96%
Outdoor temperature, summer	20.30 ± 5.20°C	18.48 ± 4.51°C
Outdoor humidity, summer	58.75 ± 15.14%	59.16 ± 15.83%

Initially, the loading time for 8000 birds was 75–80 min for mechanical catching, but decreased over the first half of the investigation to 55–60 min. In comparison, manual catching with six catchers took about 40–50 min for 8000 birds. The speed of the conveyor belt was down-regulated from an initial 1.4–1.6 m s^{-1} to 0.8–1.2 m s^{-1} in the second half of the investigation period. Within this range, loading time and speed of the conveyor belt were unrelated.

Percentages of DOAs over the whole investigation period did not significantly differ between catching treatments, although there was a trend for higher losses after mechanical catching with 0.54 ± 0.60% compared to 0.39 ± 0.42% after manual catching ($P = 0.07$). This was mainly attributable to higher losses in the spring ($P \leq 0.05$, Table 2).

All types of injuries could be found significantly more often in broilers caught manually than in those caught mechanically, and the proportion of birds showing one or more injuries was significantly higher after manual catching (Table 3).

Table 2 Percentages of birds recorded as DOA in the different seasons. ns, not significant.

	Mechanical catching %	n	Manual catching %	n	*P*-value
Autumn	0.40 ± 0.44	10	0.23 ± 0.12	10	ns ($P = 0.17$)
Winter	0.31 ± 0.18	10	0.30 ± 0.21	10	ns ($P = 0.55$)
Spring	0.76 ± 0.80	13	0.45 ± 0.16	10	$P \leq 0.05$
Summer	0.61 ± 0.45	10	0.69 ± 0.69	10	ns ($P = 0.73$)

Table 3 Percentages of birds with different types of injuries.

	Mechanical catching % n = 43	Manual catching % n = 40	*P*-value
Breast bruises	0.23 ± 0.12	0.30 ± 0.13	$P \leq 0.01$
Back bruises	0.18 ± 0.06	0.26 ± 0.11	$P \leq 0.001$
Wing bruises	0.93 ± 0.27	1.27 ± 0.29	$P \leq 0.001$
Leg bruises	0.62 ± 0.15	1.20 ± 0.35	$P \leq 0.001$
Wing fractures	0.66 ± 0.21	0.77 ± 0.24	$P \leq 0.05$
Leg fractures	0.03 ± 0.04	0.10 ± 0.05	$P \leq 0.001$
Dislocation of wings	0.47 ± 0.17	0.59 ± 0.22	$P \leq 0.05$
Dislocation of legs	0.01 ± 0.02	0.02 ± 0.03	$P \leq 0.05$
Birds with one or more injuries	3.07 ± 0.48	4.38 ± 0.77	$P \leq 0.001$

In the first investigation period (autumn) there was numerically a higher percentage of wing fractures in birds caught mechanically (0.61% ± 0.19%) than in those caught manually (0.58% ± 0.16%). This also applied to breast bruises (0.35% ± 0.17% vs 0.30% ± 0.19%), but differences were not significant ($P = 0.76$ and $P = 0.43$, respectively).

Whereas for manual catching there was no correlation between progress of the investigation and injury rates in general ($r = 0.010$, $P = 0.95$, $n = 40$), for mechanical catching a significant negative correlation with time was found ($r = -0.587$, $P < 0.001$, $n = 43$). This means that there was a trend for injury rates to decrease with increasing time of use of the machine. This was mainly due to declining rates of wing and breast bruises ($r = -0.694$ and $r = -0.523$, respectively).

Wing bruises were the most frequent type of injury for both catching methods, followed by leg bruises in birds caught manually and wing fractures in those caught mechanically

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(Figure 1). In general, wing injuries were most frequent, at 65.8% (mechanical catching) and 58.4% (manual catching); 21.1% (mechanical) and 29.2% (manual) of the injuries affected the legs. Most injuries were bruises (62.6% mechanical, 67.3% manual), followed by fractures (22.1% mechanical, 19.3% manual) and dislocations (15.3% mechanical, 13.5% manual).

When summing up percentages of injuries and DOAs as a measure of total damage inflicted to the birds, use of the catching machine caused significantly less damage (3.67%) than manual catching (4.89%, $P \leq 0.01$; Figure 2).

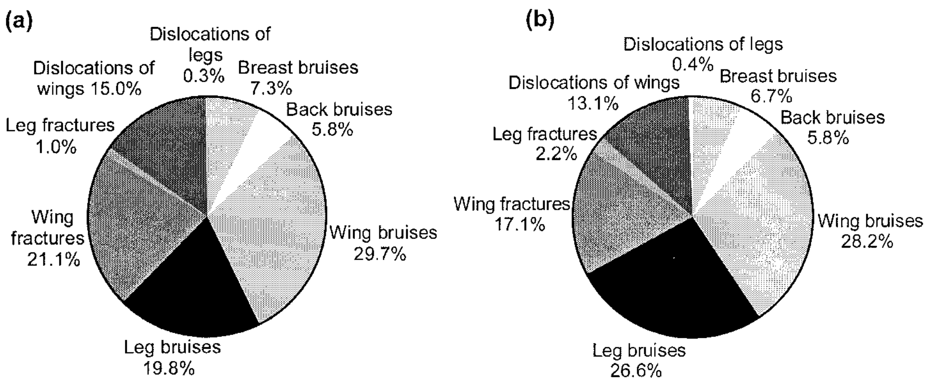

Figure 1 **Relative proportions of different types of injury after (a) mechanical or (b) manual catching.**

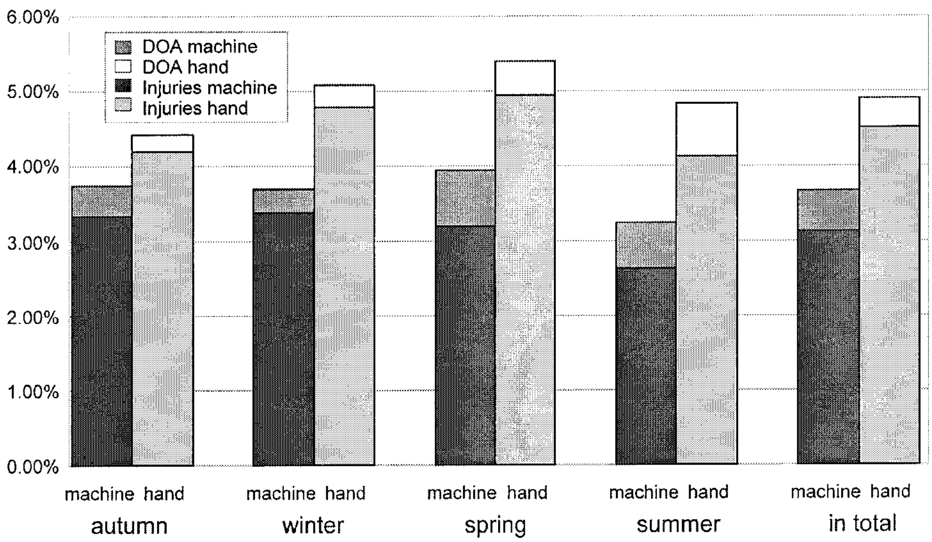

Figure 2 **Total amount of damage in mechanically and manually caught birds.**

Discussion

At the start of the investigation, at which point the machine had been in use for two months, the familiarisation period of the catching team with the machine had obviously not been concluded, and this is reflected in a number of problems encountered. For instance, distances between the three pick-up rotors must be properly adjusted to suit the size of the chickens, and shortcomings in this area for a time led to broilers escaping the pick-up head and being run over by the wheels of the machine. This occurred although the wheels were covered with shields which were otherwise effective in protecting the birds from such accidents. Setting the appropriate speed of the conveyor belt was another important factor that required experience and that very probably contributed largely to the improvements in injury rates over time (Gocke 2000). There were considerable difficulties in achieving constant stocking densities in the transport containers, and although the catching process in general improved over time, unequal numbers of birds in the drawers remained a problem. Consequently an additional person was made responsible for checking stocking densities in the drawers during catching. However, the disadvantage of this density control was a further increased risk of injury during opening and closing of the drawers. In order to improve mechanical catching it would be desirable to develop a technical counting or weighing device for density control during loading of the transport containers.

Despite these problems, catching by machine caused markedly fewer injuries than hand catching, which was true for all types of injuries. The clearest effect was on leg injuries, with a reduction of 50%, while wing and rump injuries were reduced by about 22% and 27%, respectively. Initial problems with the machine may have been reflected in the slightly but not significantly higher percentages of broken wings and bruised breasts in broilers caught mechanically during the first investigation period. Furthermore, the constant improvement over the entire investigation period, reflected in declining injury rates particularly of wing and breast bruises, shows that the machine's full potential was only gradually exploited.

Ekstrand (1998), on the contrary, found more bruises and fractures in birds caught mechanically with a similar type of catching machine, compared to manual catching. This may be related to the different method of manual catching in Sweden by which fewer birds are collected at one time and are held in an upright position, which theoretically poses a lower risk of injury in itself. However, in general, frequencies were substantially lower than in our study, with 0.036% bruises and 0.041% fractures in birds caught mechanically and 0.022% bruises and 0.021% fractures in those caught manually (Ekstrand 1998). In comparison, we found 1.96% bruises and 0.69% fractures after mechanical catching and 3.03% bruises and 0.87% fractures after manual catching. The effects of different transport containers, transport conditions, methods of unloading at the slaughterhouse or recording criteria must also be taken into account, but nevertheless the differences are extraordinarily high.

On the other hand, the data collected by Lacy and Czarick (1998) deviate in the opposite direction. In four samples each of 50 birds, they found bruising in 22.0% (mechanical catching) and 31.5% (manual catching). These rates appear to be unacceptably high. However, it may be that Lacy and Czarick did not set a lower size limit for the recording of bruising and that the small samples came from the start or end of the catching process, when higher injury rates are to be expected. Gracey (1986) presents widely varying values for manual catching (5.05–10.04% for fractures, 8.43–11.85% for bruises) and for mechanical catching (2.82% for fractures, 1.34% for bruises). Variation was not that high in our investigation. The total percentage of injuries ranged from 1.84% to 4.64% for the machine and from 2.78% to 5.92% for manual catching. Both papers report decreased injury rates through use of a catching machine, which is in agreement with our results, although Lacy and Czarick (1998) found differences only for leg/hock bruises, whereas Gracey (1986) provides no statistical data. The high absolute differences in injury rates between the studies illustrate not only how important it is to clearly describe recording methods and environmental conditions during investigation, but also that there is considerable scope for improvements in the catching and transport process.

The relative proportions of the different types of injury can be affected by the catching method, and also by other factors such as transport systems. While we found wing bruises to be the predominant type of injury both in mechanical and manual catching, the next most frequent injury was leg bruising in birds caught manually and wing fractures in those caught mechanically. This again underlines the fact that the greatest benefit of the machine was in the reduced number of leg injuries, which were higher in manual catching because the birds are grasped and carried by the legs (Wilson & Brunson 1968; Gregory & Austin 1992). Other authors give some different orders of dominance of injury types, but this may be related to use of different transport systems. For example, breast bruises are described as the most frequent damage in investigations involving transportation in loose crates (Hamdy *et al* 1961; Griffiths & Nairn 1984). For fixed crates, Jespersen (1982) found that the proportion of wing fractures was relatively low. On the other hand, the absolute percentage of bruising was quite high (15.9%). This may be related to the long carrying distances to the fixed crates which probably led to more bruises, pain and exhaustion of the birds, causing them to perform less wing-flapping when eventually dropped into the crates. Gregory and Wilkins (1990) describe hip dislocation as a very frequent type of damage, while this was the least frequent injury for both catching methods in the present investigation. One explanation could be that this kind of serious damage often causes death of the birds during transport and these birds, therefore, are not recorded on the shackle (Gregory & Wilkins 1992; Gregory 1994). However, in random samples of DOAs from a nearly identical data set, we found hip dislocations in only 0.99% of 1110 birds caught mechanically and in 1.18% of 1016 birds caught manually (Schneider 2000). It also has to be considered that hip dislocations are difficult to distinguish from femur fractures on the shackle and that possibly some dislocations were recorded as fractures. However, it is unlikely that this alone accounts for the differences between the investigations.

Although carried out under commercial conditions with two different catching teams and under the influence of varying environmental factors, the transport, stunning and processing conditions were in principle similar for birds caught mechanically and manually. Therefore, any damage during transport, unloading, hanging the birds on the shackles, stunning, plucking and evisceration (Gregory & Wilkins 1990) should have been approximately equivalent for both methods. Hence, we assume that the differences we found can truly be attributed to the different catching methods.

The line or breed of broilers was not a selection criterion for the observations and was not recorded in detail. We cannot rule out the possibility that there are line differences in temperament or susceptibility to disease or stress. However, as both lines were fast-growing broilers, differences should be negligible. Moreover, we can see no reason why the two lines should have been differently allocated to the different catching methods.

For organisational reasons, the person examining the broilers also had to carry out the observations in the broiler houses and therefore knew during the examinations which catching method had been applied. This was a methodological disadvantage, as it implies a limitation of objectivity. That there was only one examiner over the whole investigation period was advantageous for consistency in classification standards. Nevertheless, it is possible that at the beginning of the study recording of all injuries was not as complete as it became with increasing practice. However, recordings alternated regularly between the two catching methods, so this possible effect would have been similar for both groups. Reliability testing was not practicable because the lack of available space at the slaughter line and the high processing speed made it impossible to be certain that two persons had examined exactly the same birds. However, the slaughterhouse kept its own records on injuries on 2–10% of the birds from one broiler house, and these data confirmed that there were fewer injuries in birds caught mechanically.

Unlike Gracey (1986), we did not find any decline in DOA rates through machine catching; on the other hand, neither did we find a significant general increase in DOAs. Such an increase was reported by Ekstrand (1998) in the last of three investigation periods; in fact, however, the difference between mechanical and manual catching in this period was not caused by increased numbers of DOAs through mechanical catching but rather by decreased numbers after manual catching, compared to the other periods. We agree with Ekstrand that DOA rates appear to be more closely related to the health status of the flock and to environmental factors such as transport conditions or climate than to the catching method. Indeed, in the spring, when we found higher mortality rates in birds caught mechanically, there were some exceptionally hot days during which mechanical catching was observed. The results of these observations contributed largely to the higher DOA means (Gocke 2000). Ekstrand (1998) moreover suggests that the use of a catching machine may lower the possibility of finding and culling sick or underweight birds at catching. It might even be the case that dead birds are picked up by the machine, and it was our subjective impression that more dead birds remained in the pen after manual catching than after mechanical catching.

For mechanical catching, DOA rates were higher than those recorded by Ekstrand (1998) — 0.54% compared to 0.39% — but rates were rather similar for manual catching — 0.38% compared to 0.32%. In general, this is within the reported range of 0.1–0.6% (Bayliss & Hinton 1990).

It is possible that the presence of the observer may have influenced the way the teams worked. This would probably have affected manual catching the most, because there is more direct contact between catchers and birds. However, catching on the farm was observed for only a limited time (1–2 h), while at the processing plant all birds from one facility were taken into account. Moreover, it is expected that the catching teams habituated to the observer's presence over the one-year investigation period. If there was any effect at all, it is likely that the recorded damage rates through manual catching were lower than under the usual conditions with no outside observation.

Animal welfare implications

We conclude that use of the type of broiler-catching machine investigated here can lead to a considerable reduction in the risk of injury to the birds, as compared with the manual catching method currently used commercially in Germany and in many other countries. As injuries are associated with pain and stress, this is an important contribution to the limitation of impaired welfare during the catching process. Although the number of birds dying during catching and transport appears not to be affected by the catching method, the total amount of damage (ie injury and deaths) inflicted to the birds can be significantly reduced with mechanical catching. Nevertheless, some aspects of machine catching are potentially problematic and provide room for further improvement. This applies in particular to the loading of the transport containers with acceptable stocking densities, for which some further technical development is necessary. Additionally, proper training of the catching team before commercial implementation is of great importance. It can be estimated that at least three months are necessary for the initial training and familiarisation period. Comparison of the results of different investigations shows that there is still considerable scope for improvement in the damage and pain inflicted to the birds during pre-slaughter handling, not only by selection of the catching method but also by its proper and gentle application.

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References

Bayliss P A and Hinton M H 1990 Transportation of broilers with special references to mortality rates. *Applied Animal Behaviour Science 28*: 93-118

Berry P S and Kettlewell P J 1997 The development of the Silsoe Broiler Harvester. In: Bottcher R W and Hoffs S J (eds) *Livestock Environment V, Proceedings of the Fifth International Symposium* pp 348-354. American Society of Agricultural Engineers: St Joseph, USA

Duncan I J H 1989 The assessment of welfare during the handling and transport of broilers. In: Faure J M and Mills A D (eds) *Proceedings of the 3rd European Symposium on Poultry Welfare* pp 93-107. World's Poultry Science Association: Tours, France

Duncan I J H, Gillian S S, Kettlewell P J, Berry P S and Carlisle A J 1986 Comparison of the stressfulness of harvesting broiler chickens by machine and by hand. *British Poultry Science 27*: 109-114

Ekstrand C 1998 An observational study of the effects of catching method on carcase rejection rates in broilers. *Animal Welfare 7*: 87-96

Gerrits A R, De Koning K and Mighels A 1985 Catching broilers. *Poultry 1*: 20-23

Gocke A 2000 *Untersuchung über den Einsatz einer Hähnchenfangmaschine in Mastbetrieben in Norddeutschland*. Veterinary Dissertation, School of Veterinary Medicine, Hannover, Germany [Title translation: Investigation of the use of a broiler catching machine at commercial farms in North Germany]

Gracey J F 1986 *Meat Hygiene, Edn 8* pp 455-458. Baillière Tindall: Eastbourne, UK

Gregory N G 1994 Pathology and handling of poultry at the slaughterhouse. *World's Poultry Science Journal 50*: 66-67

Gregory N G and Austin S D 1992 Causes of trauma in broilers arriving dead at processing plants. *Veterinary Record 131*: 501-503

Gregory N G and Wilkins L J 1990 Broken bones in chickens: effect of stunning and processing in broilers. *British Poultry Science 31*: 53-58

Gregory N G and Wilkins L J 1992 Skeletal damage and bone defects during catching and processing. In: *Bone Biology and Skeletal Disorders in Poultry, 23rd Poultry Science Symposium* pp 313-328. World's Poultry Science Association: Edinburgh, Scotland, UK

Griffiths G L and Nairn M E 1984 Carcase downgrading of broiler chicken. *British Poultry Science 25*: 441-446

Hamdy M K, May K N, Flanagan W P and Powers J J 1961 Determination of the age of bruises in the chicken broilers. *Poultry Science 40*: 787-789

Jespersen M 1982 Injuries during catching and transportation of broilers. In: Moss R (ed) *Transport of Animals Intended for Breeding, Production and Slaughter* pp 39-44. Martinus Nijhoff: The Hague, The Netherlands

Kettlewell P J and Turner M J B 1985 A review of broiler chicken catching and transport systems. *Journal of Agricultural Engineering Research 131*: 93-114

Lacy M P and Czarick M 1998 Mechanical harvesting of broilers. *Poultry Science 77*: 1794-1797

Mayes F J 1980 The incidence of bruising in broiler flocks. *British Poultry Science 21*: 505-509

Möbius C 1996 In Deutschland in den Anfängen, in Dänemark schon gang und gäbe. *DGS Magazin 31/96*: 16-18 [Title translation: In Germany at its beginning, in Denmark already quite usual]

Moran P and Berry P S 1992 Mechanised broiler harvesting. *Farm Buildings and Engineering 91*: 24-27

Parry R T 1989 Technological developments in pre-slaughter handling and processing. In: Mead G C (ed) *Processing of Poultry* pp 65-101. Elsevier: Amsterdam, The Netherlands

Schneider V 2000 *Einfluß der Fang- und Transportbedingungen auf die Transportverluste bei Masthühnern*. Veterinary Dissertation, School of Veterinary Medicine, Hannover, Germany [Title translation: Influence of catching and transport conditions on transport losses of broiler chickens]

Scott G B and Moran P 1992 Behavioural responses of laying hens to carriage on horizontal and inclined conveyors. *Animal Welfare 1*: 269-277

StatSoft Inc 1996 *Statistica for Windows*. Computer program manual. StatSoft Inc: Tulsa, OK, USA

Wilson J G and Brunson C C 1968 The effects of handling and slaughter method on the incidence of haemorrhagic thighs in broilers. *Poultry Science 47*: 1315-1318