AN OBSERVATIONAL COHORT STUDY OF THE EFFECTS OF CATCHING METHOD ON CARCASE REJECTION RATES IN BROILERS

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Automatic broiler catching machines have been developed for several reasons. Manual catching is expensive, often rough and may cause injury to the birds. Apart from animal welfare considerations, the demand for good quality meat means that rejection rates must be kept at a low level. The poor working conditions for manual catching teams are also an important factor. Only a few scientific studies on the effects of catching machines on bird health and welfare have been published. In this study, the carcase rejection rates in relation to manual and mechanical catching were compared at a poultry abattoir following a change of loading and unloading systems. The effect on the level of birds found 'dead on arrival' at the slaughterhouse initially varied considerably, regardless of catching method. During the last 3-month period of the study however, mechanically caught flocks showed significantly higher frequencies of dead birds on arrival than manually caught flocks. During the same last period, when running-in problems should be regarded as solved, the prevalence of bruises was also still significantly higher in the mechanically caught flocks, whereas the prevalence of fractures did not differ significantly between the two groups. This suggests that there are still opportunities for further improvements of the machine, although in Sweden it has now been accepted for commercial use in accordance with Swedish animal welfare legislation, under the supervision of the National Board of Agriculture.

Keywords: *animal welfare, automatic, downgrading, harvester, machine, manual*

Introduction

Development of automatic broiler catching machines has been considered necessary for many different reasons. Manual catching is often rough and may cause injury to the birds (Bayliss & Hinton 1990). Manual catching is also labour-intensive, which makes it expensive, and it is usually carried out at night-time (Bayliss & Hinton 1990) when workers' wages are higher. Apart from animal welfare considerations, the demand for good quality meat means that rejection rates must be kept at a low level (Jee 1986), and it has been suggested that mechanical catching would result in lower rejection rates than manual catching. The poor working conditions for the manual catching teams, with strenuous, repetitive work in a dusty environment, are also an important factor (Bayliss & Hinton 1990; Berry *et al* 1990; Bingham 1986a).

In most countries, manual catching of broilers involves catching the birds by a leg and carrying three or four birds in each hand, to be placed in crates (Gerrits *et al* 1985; Moran & Berry 1988; Bayliss & Hinton 1990). In some cases, the catcher takes a bird around the body and uses both hands to hold a pair of birds upright on the way to the crates (Gerrits *et al* 1985). This way of catching the birds, which has been widely used in Sweden for several years, is recommended in order to reduce the risk of injuring the birds and subsequent downgrading of the meat (Parry 1989) and requires gentle handling of the birds during catching, loading, transport and unloading (Berry *et al* 1990). Manual catching may result in low levels of injuries if all catchers are careful, conscientious and well-supervised (Kettlewell & Turner 1985; Berry *et al* 1990).

Experiments on the effects of light intensity during catching, have shown that the birds are calmer and less affected by the catching process if they are handled in darkness (Duncan 1989). This was found to be the case for both manual and mechanical catching and loading.

Over the years, a considerable number of technical innovations have been presented, all aiming at facilitating the catching of birds before slaughter: some herding systems have been constructed to move the birds onto a belt conveyor in the rearing compartment (Reed 1974); others have tried to lift the broilers from the floor using a scoop mounted on a tractor; there have been experiments on mat-pulling systems, where fabric mats have been put out and later rolled up, bringing the birds to a conveyor in one end of the house (Gerrits *et al* 1985; Berry *et al* 1990); and some companies have worked with vacuum systems, but these have led to injury problems (Scott 1993). None of these systems became commercially widespread, as they were too expensive, clumsy or slow, and in some cases did not handle the birds acceptably from an animal welfare point of view (Kettlewell & Turner 1985; Berry *et al* 1990). Another alternative is to rear the broilers in cages with a moving floor (Kettlewell & Turner 1985). This system has rather high investment costs and, although it minimizes the need for manual handling, may be considered 'extreme' from an animal welfare point of view (Scott 1993). It is not allowed in Sweden for this reason. Since the beginning of the 1980s, worldwide interest has been focused on sweeping systems with rubber paddles or fingers (Bingham 1986b; Parry 1989).

A sweeping system with three vertical rotors has been developed by researchers at the AFRC Silsoe Research Institute in England (Jee 1985; Parry 1989; Berry *et al* 1990). Soft rubber fingers are mounted on three slowly rotating pick-up heads, and a conveyor belt takes the birds to a loading unit at the rear of the machine (Parry 1989). The pick-up head is mounted on the end of a telescopic sweeping arm which allows the machine to work near columns or extend into the corners of a building in order to harvest birds (Berry *et al* 1990; Moran & Berry 1992). This type of machine is commercially available today in several different versions (Moran & Berry 1992).

Under Swedish legislation, new systems for rearing or handling of live animals must be approved from an animal welfare point of view before commercial introduction. The aim of this study was to identify and compare the distribution of carcase rejection rates, for damage related to handling during manual and mechanical catching of broilers, in order to provide information for an evaluation of the catching machine from an animal welfare point of view.

Materials and methods

This study was carried out at one of the major Swedish broiler processing plants located in the east of the country. The birds involved were between 36 and 41 days old, and were all of the Ross hybrid variety. It focused on the percentage of birds 'dead on arrival' and the percentage of birds showing traumatic injuries (bruises and fractures) resulting in rejections or downgradings. The number of birds found 'dead on arrival' was recorded when the birds were removed from the container modules at the slaughterhouse. The causes of carcase condemnations (bruises and fractures) for each flock were recorded routinely, according to the legislative standards set by the Swedish National Food Administration. Directly after evisceration, when hanging on the shackles, each bird was examined visually by trained and experienced veterinary assistants and any injury recorded. This examination, classification and record-keeping did not differ from standard practice at this and other Swedish broiler abattoirs. Two veterinary assistants were assigned to this task, acting as observers during the study. The observers were not aware of the catching method for the flocks which they classified.

At the start of the study period, in October 1995, the processing plant introduced the Dutch Laco container module system (supplied by Meyn Machinefabriek BV, PO Box 16, 1510AA, Oostzaan) instead of smaller plastic crates, and at the same time the catching machine was brought into use. The container modules were of a metal frame type containing 10 compartments (114x123x28cm), each holding approximately 42 chickens. The modules were driven to the transport vehicle on a fork lift. The unloading system at the abattoir was modified by installing a mechanical rotor device for emptying the containers. This device had rubber fingers similar to those of the catching machine described below. It pushed the birds horizontally to the opening at the front of the container and onto a conveyor belt ending in a carousel, from which the birds were lifted onto shackles.

The catching machine was a so-called sweeping catcher, manufactured under licence by the Finnish company, AR Tekniikka Oy, (details obtainable from AR Tekniikka Oy, Tapiolantie 9, FIN-60720 Tuomikylä). It had a three-rotor pick-up head with rubber fingers, and two consecutive conveyor belts. The machine could be connected to a trailer carrying the container system. The machine was diesel-driven and manoeuvred by a person walking beside the pick-up head using a joystick device. The machine (excluding the trailer) was approximately 10m long, 1.5m wide and weighed 850kg. Catching and loading were carried out during night-time and in dim light. The pick-up head was equipped with a blue-coloured light focused on the birds, and another blue light illuminated the rear parts of the machine, where the birds were transferred to the modules. Under optimal conditions, the machine was used at an average pick-up rate of 5000-6000 birds per hour. The exact pick-up rate for every flock was not recorded. The speed of the rotors was constant and any variations in pick-up rate were mainly due to practical issues, such as delays related to the truck transferring the containers to the transport lorry.

Data were collected from all flocks slaughtered for 9 months after the change of catching method, and then divided into three, 3-month periods. Period 1 ran from October to December, period 2 from January to March and period 3 from April to June. The division into shorter periods facilitated the identification of time-related changes, eg in the experience of the handling teams. The data represent 387 flocks, and a total of nearly 5.2 million birds

(Table 1). The prevalence of bruises, fractures and 'dead on arrivals' were calculated for each flock, and group means and standard deviations were calculated for each period.

Table 1 Distribution of flocks according to catching methods at a Swedish broiler processing plant during a 9-month observational study of the effect of catching method on carcase rejection rates in broilers.

Group	Method of catching at production site	Type of transport boxes	Method of unloading at abattoir	Number of flocks	Total number of birds
AM	catching machine	container modules	mechanical	258	3 856 829
MM	manual catching	container modules	mechanical	129	1 302 900

The flocks were divided into two groups, AM (automatic catching, modules) or MM (manual catching, modules). This allocation was not entirely random since some flocks were caught manually because they were either reared in houses with obstacles (such as feed troughs, low eaves or fan boxes), scheduled for slaughter when the machine was occupied elsewhere, or slaughtered when the machine was temporarily out of order.

Rejection levels were analysed using the Mann-Whitney U test, with a significance level of 95 per cent. Normally distributed data on background factors were analysed using a two-tailed unpaired t-test, with a significance level of 95 per cent.

Results

Background data

The average flock size (AM: 14 949 ± 7224, MM: 10 100 ± 5685) differed significantly ($P < 0.001$) between the two groups. However, a stratification on flock size using the median value for all flocks (12 400) as a cut-off point showed no significant difference between large and small flocks for any of the variables analysed. The mean age at slaughter did not differ significantly ($P > 0.05$) between the two groups (AM: 37.9 ± 1.6days, MM: 37.4 ± 2.1 days). Time in transport varied from 30min to 4h in both groups. Due to incomplete data it was not possible to calculate the mean time in transport for the two groups.

Rejection rates

The percentage of 'dead on arrivals' was higher in group AM than in group MM during the first period after the change of catching method. This difference, however, was not significant due to the large variation between flocks in mortality regardless of catching method (Table 2). During the last period of the study, the variation between flocks in group MM was small, and there was a significant ($P < 0.001$) difference between the groups caught manually and the groups caught using the machine, the latter groups showing higher levels of 'dead on arrivals'.

Bruising, which occurred mainly on the wings, showed a large variation during periods 1 and 3 (Table 3). During periods 2 and 3, levels were significantly higher in flocks caught using the machine than in flocks caught manually ($P < 0.001$ and $P < 0.05$ respectively). There was a tendency for the prevalence of bruised birds to increase during period 3 regardless of catching method.

Table 2 **Percentage of birds (mean ± standard deviation) recorded as 'dead on arrival' at the processing plant during consecutive 3-month periods after changing the catching and unloading methods, (n = number of flocks; ns-not significant).**

	MM (manual, modules), %	n	AM (automatic, modules), %	n	*P* value
Period 1	0.35 ± 0.74	40	0.50 ± 1.15	87	$P > 0.05$ ns
Period 2	0.47 ± 1.28	49	0.30 ± 0.27	80	$P > 0.05$ ns
Period 3	0.095 ± 0.076	40	0.36 ± 0.65	91	$P < 0.001$
Periods 1-3	0.32 ± 0.90	129	0.39 ± 0.79	258	$P > 0.05$ ns

Table 3 **Percentage of birds (mean ± standard deviation) with bruises recorded at the processing plant during consecutive 3-month periods after changing the catching and unloading methods, (n = number of flocks; ns-not significant).**

	MM (manual, modules), %	n	AM (automatic, modules), %	n	*P* value
Period 1	0.023 ± 0.026	40	0.030 ± 0.030	87	$P > 0.05$ ns
Period 2	0.013 ± 0.011	49	0.029 ± 0.018	80	$P < 0.001$
Period 3	0.032 ± 0.037	40	0.047 ± 0.036	91	$P < 0.05$
Periods 1-3	0.022 ± 0.027	129	0.036 ± 0.030	258	$P < 0.001$

Table 4 shows that during the first two periods after the change of catching methods, the levels of fractures were significantly higher in flocks caught automatically than in flocks caught manually ($P < 0.05$ and $P < 0.01$, respectively). The difference between the groups decreased during the study and during period 3 there was no significant difference between them. Wing fractures were the only type of fracture recorded in group MM and though they dominated in group AM, a small proportion of leg fractures was also seen (less than 5% of the total number of fractures recorded in this group).

Table 4 **Percentage of birds (mean ± standard deviation) with fractures recorded at the processing plant during consecutive 3-month periods after changing the catching and unloading methods, (n = number of flocks; ns-not significant).**

	MM (manual, modules), %	n	AM (automatic, modules), %	n	*P* value
Period 1	0.036 ± 0.054	40	0.078 ± 0.10	87	$P < 0.05$
Period 2	0.008 ± 0.013	49	0.018 ± 0.020	80	$P < 0.01$
Period 3	0.022 ± 0.028	40	0.028 ± 0.024	91	$P > 0.05$ ns
Periods 1-3	0.021 ± 0.036	129	0.041 ± 0.067	258	$P < 0.001$

Discussion

Over the last 15 years, several reviews on broiler catching have been published (for example, Gerrits *et al* 1985; Kettlewell & Turner 1985; Parry 1989; Scott 1993), and studies have been carried out in order to compare the stressfulness of machine and manual harvesting (Duncan *et al* 1986). However, few scientific studies have investigated the effects of catching machines on bird health (carcase rejection), although claims of reduced damage when different types of catching machines have been used are widely quoted in the commercial poultry press (for example, Anonymous 1983; Anonymous 1986; Anonymous 1988).

To achieve a high external validity in tests of new agricultural techniques, the Swedish National Board of Agriculture specifically requires that on-farm observations of the techniques are carried out under commercial conditions – as was the case for the project described in this paper. In observational studies the 'treatment' is, by definition, not randomized, so the different groups cannot be expected to be totally equal with regard to baseline data. Although the allocation of flocks to groups AM or MM was not entirely random, some of the factors that may have influenced the allocation, such as engine failure, should not have systematically influenced the rejection levels. Other factors, such as housing conditions, might possibly have had an indirect influence if flocks reared in old-fashioned houses with vertical columns and narrow gates (and therefore caught manually) generally have higher rejection levels. We found nothing to indicate that this was the case, and the percentage of flocks (approximately 5%) reared under those conditions was not large enough to substantially influence the results of this study.

Time in transport is a possible source of bias, for which we were not able to control in this study. The mean flock size also differed significantly between the two groups and this could have been a another possible source of bias. Yet, as the stratification by flock size showed no significant differences between large and small flocks for any of the recorded variables, these analyses do not take flock size into account.

There is a possibility that weather conditions may have influenced the temperature during transport and thus the number of 'dead on arrivals'. However, all live birds regardless of catching method, were transported to the abattoir in air-conditioned lorries in which the air temperature should not have been affected by the outdoor temperature. The abattoir has not seen any seasonal variation in the percentage of birds found 'dead on arrival' or bruised during previous years (Marie Norén personal communication 1996), and therefore the differences seen over time in this study are unlikely to be due to seasonal effects.

Two different observers were assigned to the task of classifying the carcases during the study. As each bird was only classified by one person there was a risk of observer bias, if the two observers differed in their standards. Although no inter-rater agreement evaluation was performed within this study, both the observers had received the same education in how to classify carcase quality. The fact that the observers were unaware of the catching method should have also reduced the risk of bias.

The birds were examined when hanging on the shackles directly after evisceration. As plucking and evisceration can be major causes of bone breakage (Gregory & Wilkins 1990) this study would probably have been more sensitive if the recording of injuries had been made before these procedures. However, these types of processing fractures mainly affect the pubis, ischium and furculum, not the legs or wings (Gregory & Wilkins 1990) and there is no reason to suspect that the processing should have affected the two catching groups differently.

The use of catching machines may impair the possibilities of finding and culling sick or underweight birds at catching. This may, in turn, lead to an increase in the number of dead birds in crates or of downgraded/rejected birds, even if the damage is not caused by the machine per se. The results of several investigations into the level of 'dead on arrivals', show that a mortality of between 0.1 to 0.6 per cent is usual. The variation in figures can result from variations in methods of catching and loading, the age and health status of the broilers at start of transport, and the climate and season (Bingham 1986a; Parry 1989; Bayliss & Hinton 1990; Yogaratnam 1995). Stuart (1985) quoted a decrease in the incidence of 'dead on arrivals' from 0.54 per cent to 0.2 per cent when a company changed from using fixed crates to a drawer-type module system. Aitken (1985) reported a decrease from approximately 0.33 per cent to 0.12 per cent in a 5-year period, during which changes from crate to modular handling took place.

When comparing manual catching with automatic catching, the results of this study are somewhat inconsistent. The average level of birds recorded as 'dead on arrival' over the entire study period following the change of unloading method at the abattoir was 0.32 per cent for the flocks caught manually, and 0.39 per cent for the flocks caught mechanically. During periods 1 and 2 no significant differences were found, but during period 3 the level of birds found 'dead on arrival' was significantly higher in the mechanically caught flocks (0.36% versus 0.095%). This contrasts with Gracey (1986) who reported incidences of between 0.29 per cent and 0.56 per cent for manually caught flocks and 0.24 per cent for mechanically caught flocks. The catching system was unlikely to be a major factor in determining the mortality rate during transport, since other factors (which were not controlled for in this study), such as the health status of the flock prior to transport, the number of birds per load and the length of waiting period at the abattoir (Bayliss & Hinton 1990) are more likely to have been associated with the reported mortality rates.

It is commonly believed that most bruising is sustained during the catching and loading of birds prior to slaughter (Gerrits *et al* 1985; Bingham 1986a,b; Bayliss & Hinton 1990; Scott 1993). Factors that influence the level of downgradings, include the attitude and care of the personnel handling the birds, the age of the birds, the number of birds per crate and the length of time spent in the crates or modules (Bingham 1986a). In our study, there was no significant difference between the ages of the birds in the two groups. The effect of personnel cannot be differentiated from the effect of catching method, as the staff who handled the machine were not involved in the manual catching, and vice versa. If the birds are dropped into the crates or modules from any height they are likely to sustain wing injuries as they wing-flap during the fall (Duncan 1989). In crates with lids and in sliding containers there is a risk of birds getting trapped and injured during loading (Mitchell & Kettlewell 1993). The type of container system did not differ between the two groups in this study, but the way in which the birds entered the containers did differ due to catching method, and this is one of the possible causes of the differences in the percentage of traumatic injuries found in this study. Some types of fractures may arise during stunning at the abattoir, and these injuries must be distinguished from those arising during catching and loading (Gregory & Wilkins 1990). Post mortem injuries were not recorded in this study.

Cited figures for the levels of birds with downgradings or rejections due to bruises or fractures vary considerably, ranging from 0.5 per cent to 20 per cent (Mayes 1980; Griffiths & Nairn 1984; Bingham 1986a; Elson 1986; Moran & Berry 1988). This large range in the level of downgradings is partly due to the same factors as the variations in the level of 'dead on arrivals', but is probably also due to the subjectivity of carcase grading and differences between different abattoirs (Knowles & Broom 1990). In our study, the summed levels of downgradings due to bruises and fractures were comparably low, regardless of catching method (0.077% in group AM and 0.043% in group MM).

The relatively high and irregular level of rejections due to traumatic damage (bruises and fractures) during the first period after the change of both catching and unloading system was partly due to technical problems with the unloading system at the processing plant. This was noted by the staff at the plant, and is supported by results showing that the levels of rejections were high in both AM and MM groups during this period. The prevalence of traumatic injuries was significantly higher in group AM than in group MM when analysed over the entire study period, and this is interpreted as mainly being an effect of the use of the catching machine. However, the difference between manually and mechanically caught flocks in the prevalence of fractures decreased markedly over time, and was small and not significant during period 3. One possible interpretation is that the fractures during period 1 and 2 were partly caused by an inexperienced crew handling the catching machine - and that rejection levels decreased as the crew learnt to handle the machine correctly in order to avoid injuring the birds. However, other factors not investigated in this study, such as the transport driver, might also have influenced these results.

Animal welfare implications

Studies have shown that both manual and mechanical catching and handling are stressful to the birds, but that the effects are of short duration (Duncan *et al* 1986). The same authors compared the stressfulness of harvesting broilers using mechanical and manual methods and concluded that stress could be reduced by a carefully designed machine (Duncan *et al* 1986). The effect of the experience, knowledge and dedication of the crew is important, regardless of catching method. From an animal welfare point of view, it is also important to remember that machines are not infallible, and therefore it must always be possible to quickly muster a manual catching team (Jee 1985).

In our study, the effects on animal welfare were measured by using rather rough parameters (injuries and transport mortality). The results showed that the injury levels were higher in the mechanically caught flocks than in the manually caught flocks, although these differences were not consistently significant during all parts of the study period. Our findings suggest an impaired welfare situation for the mechanically caught birds compared to the manually caught birds, when using the relatively careful method of manual catching currently applied at the farms in question.

After evaluating the results of this study, comparing the rejection levels with those of other slaughterhouses, and also taking into consideration other investigations on this type of machine (for example on stressfulness and noise levels), the Swedish National Board of Agriculture has concluded that, when properly handled, the sweeping catcher described in this study is acceptable from an animal welfare point of view. Therefore, the machine has now been accepted for commercial use according to the Swedish animal welfare legislation, under the following conditions: a set maximum conveyor belt speed of 0.8m s^{-1} is not exceeded; the personnel handling the machine are properly trained; and that during the first year of operation the processing plant keeps records of rejection levels of all flocks, manually or mechanically caught, and on request shows these to the authorities involved.

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