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Animal Welfare 2008, 17: xxx-xxx
ISSN 0962-7286

Welfare implications of nipple drinkers for broiler chickens

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Abstract

Commercially reared broiler chickens are commonly supplied with drinking water through lines of nipple drinkers that are positioned above the birds' heads to avoid water leaking and spoiling the litter underfoot. This means that the birds have to peck upwards to obtain water, an action that is very different from the 'scoop' action of natural drinking seen when birds drink from troughs or puddles. In this study we investigate the welfare implications of this unnatural drinking behaviour imposed by nipple drinkers. We show 1) that chickens have no apparent aversion to the taste of tap water, 2) that they prefer bell drinkers and troughs over nipple drinkers, 3) that the stereotyped 'scoop' action is seen even when birds are drinking from bowls of different heights, 4) that chickens have a strong preference for drinking from nipples that are lower rather than higher and, 5) that when offered a choice between bowls and nipples of the same height, the chickens are indifferent to the method of water presentation. We conclude that the height at which water is presented to chickens is more important to them than whether they can drink with the natural 'scoop' action. While this might suggest that chicken welfare could be improved by lowering the drinker lines, wet litter causes welfare issues of its own through its effect on hock burn and pododermatitis. We suggest that drinker systems should be designed so that both aspects of welfare (birds able to drink in their preferred way and clean litter) are possible.

Keywords: *animal welfare, broiler chickens, drinking behaviour, litter quality, nipple drinkers, preference*

Introduction

Commercially reared broiler (meat) chickens (*Gallus gallus*) are frequently supplied with drinking water through lines of nipple drinkers, which the birds have to peck or press to release water (Appleby *et al* 1992). To avoid spillage and the consequent spoiling of the litter underneath, the nipple line is positioned above the birds' heads and gradually raised as the birds grow so that, at all ages, they have to stretch upwards (Ross 2002; Figure 1[a]). This means that the water drips down into the birds' throats but it also means that the action of taking in water is very different from the natural drinking behaviour of chickens (Lott *et al* 2001). In particular, the 'scoop' action, in which the bird lowers its head, takes water into its bill and then raises its head again (Dawkins & Dawkins 1973; McLelland 1979; Ross & Hurnik 1983; van der Leeuw *et al* 2001) is completely missing. Bell drinkers (Figure 1[b]), which are sometimes used as an alternative to nipple drinkers (Appleby *et al* 2004), allow birds to drink more naturally but are also much more liable to spillage which can have an impact on air and litter quality (Jones *et al* 2005). As wet litter is thought to be a major contributor to health problems such as pododermatitis and hockburn (Martrenchar *et al* 2002; Broom & Reefman 2005), nipple drinkers are much more widely used, despite evidence of lower daily water consumption from nipple drinkers than bells (May *et al* 1997) and of increased weight gain in birds supplied with open drinkers as opposed to nipples (Lott *et al* 2001). Nipple drinkers (particularly with small cups underneath each nipple to catch drips [Appleby *et al* 2004]) may be the most spillage-free method of providing water for chickens but it is not clear that the present design is the best way of doing so in terms of health, welfare or even production (Michel *et al* 1998).

Chickens kept on commercial, free-range farms are also commonly provided with water through nipple drinkers inside their houses but are free to drink from puddles outside (Figure 1[c]). Puddles are likely to be contaminated with *Campylobacter* and other organisms that are potentially hazardous to the health of chickens and humans (Pearson *et al* 1993; Leclerc *et al* 2002; Cools *et al* 2003; Bull *et al* 2006; Kijlstra & Eijk 2006), therefore 'persuading' chickens not to drink from them, by providing a more attractive alternative, could make a major contribution to bird health and human food safety in organic and free-range systems.

From many points of view, therefore, it would be desirable to develop new methods of providing clean drinking water to chickens that 1) allow birds to drink adequate quantities of water, 2) are sufficiently preferred by the chickens themselves that it discourages free-range birds from drinking from contaminated puddles and 3) do not waste water or spill it onto litter. To aid the development of such systems,

Figure 1(a)

Chicken drinking from nipple drinker.

Figure 1(b)

Chicken drinking from bell drinker.

Figure 1(c)

Chicken drinking from puddle.

Figure 1(d)

Chicken drinking from bowl.

Figure 2

The apparatus used for the preference tests as set up within the broiler houses. Birds were kept in the triangular holding pen and then released in pairs into the square test arena.

we carried out a series of experiments aimed at showing what and how chickens actually prefer to drink. We argue that a drinker design that, at its core, provides birds with what they want and then, subsequently, solves the mechanical and logistical problems that may arise, would be of value not only to free-range and organic farmers but to the health and welfare of billions intensively-housed birds.

Experiment 1 — Chicken preference for clean mains water or puddle water

Free-range chickens frequently drink from rainwater puddles outside, despite having clean water inside the houses (Figure 1[c]). If chickens prefer the taste of puddle water, then attempting to improve drinker design inside the houses will have little effect on outside drinking. We therefore set up a direct test of the hypothesis that chickens prefer to drink water taken from puddles over chlorinated water taken from the nipple line by giving them a choice of the two sorts of water presented in identical ways.

Materials and methods

Animals and housing

The tests were carried out in commercial free-range broiler houses belonging to the Food Animal Initiative at Wytham, Oxford. Each house had a floor area of 52 m^2 with an outside range area of 1,627 m^2 and contained approximately 670 Ross 308 female broiler chickens. Each house was equipped with a single line of Dutchman nipple drinkers and 16 Dutchman pan feeders. The height of the nipple line was gradually raised by the farm staff as the chicks grew so that at all ages they had to reach up and peck. As young chicks, all birds had also experienced water from round, red, flat bowls (32.5 cm diameter) and were also given access to them again a few days before the tests to make sure they were familiar with them.

The chickens were part of a commercial operation in which 1,300 birds (ie two housefuls) were sold to a supermarket chain each week. This meant that a constant supply of similarly aged, identically reared birds was available each week. For logistical purposes, the tests were carried out over a period of two weeks, all on birds that were 53–56 days old at the time of testing. By this time, the line of nipple drinkers in the house was 40–42 cm from the floor.

Procedure

Preference tests were carried out inside the home broiler houses using hinged wooden frames (101 × 61.5 cm; length × breadth) covered in plastic/wire mesh to construct a moveable triangular holding pen and a square test pen (see Figure 2). Chickens to be used in tests were selected from those present in the house by going to a pre-set part of the house and rounding up 6–10 birds at a time into the holding pen, where they were left undisturbed for approximately 30 minutes before their test. At the start of a test, the two adjacent corners of the holding pen and the test pen were opened sufficiently to allow two chickens from the holding pen to move to the test pen. Birds were tested in pairs to reduce stress of isolation but data from only one was collected.

Two identical round, red bowls (32.5 cm diameter) were placed in the test pen, one with 150 ml of water taken from an outside puddle and one with 150 ml of water drawn directly through the nipple line. The birds had a tendency to put their feet on the edge of the bowl and tip it up and to prevent this, the bowl was tied onto a 4.15 cm tall, concrete slab, so that the lip of the bowl was approximately10 cm above the ground (Figure 1[d]). After each test, the bowls were emptied, cleaned and refilled. The left/right position of each drinker was balanced across the tests.

A test began when the two birds entered the test pen. The first chicken to drink became the focal bird and a stopwatch used to time its behaviour. Each test lasted for 10 minutes and during this time, the following were recorded: the time from entering the pen to first drink (latency); the bowl chosen first; the duration of each drinking bout and which bowl it was from. A drinking bout was defined as an unbroken series of drinks, so that a bout ended when the bird started other behaviour such as walking away. The proportion of time spent drinking from each of the two bowls was subsequently used as a measure of preference After testing, both the focal bird and the companion bird were marked with non-toxic commercial sheep spray to make sure they were not re-tested and released back into the main house. After each test, the bowls were emptied, cleaned and refilled. A total of 10 pairs of chickens were tested. All birds were 53–56 days old at time of testing and the line of nipple drinkers in the house was 40–42 cm from the floor.

Statistical analysis

One bird from each pair was used for analysis to ensure independence. Preference was measured in two ways: (a) the number of test birds choosing each bowl first; this gave a measure of preference before any drinking took place. The binomial test (one-tailed) was used because the data was measured as a dichotomous variable (Siegel & Castellan 1988). Results are presented as n = number of test birds and k = number of birds in the smallest category. And, (b), the amount of time spent drinking each type of water in a 10 minute test. This gives a measure of preference after the birds had tasted the water. The two amounts (time spent drinking puddle water and time spent drinking mains water) are not independent because time spent at one type of water will automatically affect the time available for the other. It is therefore necessary to use a single data point for each chicken. We did this by taking the difference (d_i) between the time each bird spent drinking puddle water and the time it spent drinking mains water taken from the nipple line. These scores were analysed with the non-parametric Wilcoxon test, which can handle ordinal d_i scores without making any assumptions about underlying distribution of the data (Siegel & Castellan 1988). Results are given as the median d_i with associated T values for the Wilcoxon test.

Results

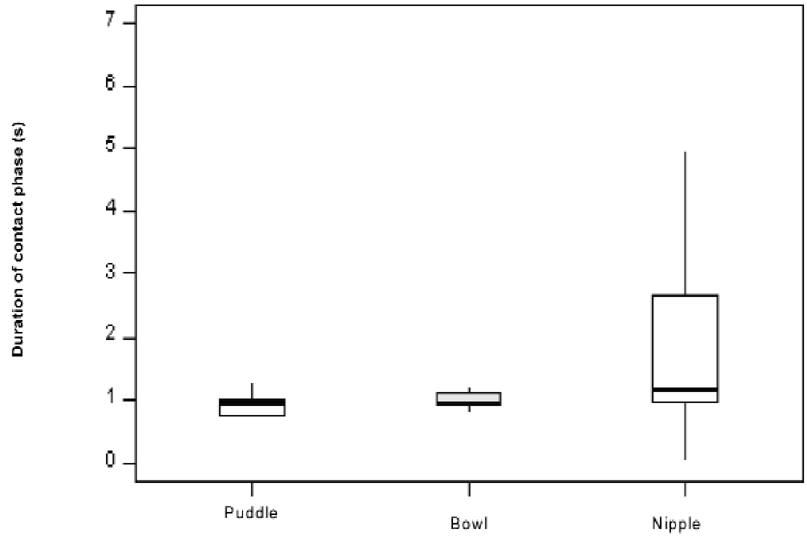
For (a) there was no significant preference for puddle water as indicated by first choice. (k = 3 [puddle]; $P > 0.05$; n = 10, binomial test). In (b) there was no significant preference for puddle water as measured by the duration of drinking from the two types of water (median d_i = –395.5 seconds; T = 11, n = 10; $P > 0.05$, Wilcoxon test). The minus sign indicates that the median for the predicted preference (puddle water) was lower than for the mains water.

Discussion

The complete lack of preference for puddle water on any measure suggests that free-range chickens do not drink from puddles because they prefer the taste of the water to that they can obtain from nipple drinkers. The lack of preference on first choice is not surprising as it confirms the birds saw or smelt no difference. However, the median duration of drinking, after the birds had tasted the water, also failed to support the hypothesis that puddle water was preferred quite spectacularly. The median time spent drinking was actually higher for the mains water. This suggests that it should be possible to persuade even free-range birds to drink clean water, provided the water is delivered to them in an acceptable fashion. We next looked at how chickens respond to some of the different methods by which drinking water is currently delivered to them.

Figure 3

Median duration of time when beak was 'in contact' with water when chickens were drinking from nipples, bowl or puddle. The boxes show standard deviations (n = 100); the whiskers show the range.



Experiment 2 — Chicken preference for different types of drinker

We first wanted to know how broiler chickens responded to the two drinker types both found in commercial systems — nipple drinkers and bell drinkers — in comparison with drinking from an open bowl. Response was measured in two ways: a) preference tests in which birds were given choices between different drinker types and b) frame-by-frame video analysis of the details of the behaviour of chickens drinking. We tested the hypothesis that the birds would have a preference for drinker types that allowed them to drink in the most natural way, as judged from the video.

Materials and methods

Animals and housing

These were similar to those used in experiment 1, except that, in addition to the line of nipple drinkers, a bell drinker (35 cm diameter, 25 cm high) was placed in the house from the time the birds were 4 weeks old. This was to make sure that they were familiar with both nipples and bells. As there were only 670 chickens in each house, all birds had plenty of opportunity to drink from both. As before, birds were also given water in the red bowls during the week previous to a test.

Preference tests

There were three tests (nipple versus bowl, nipple versus bell or bowl versus bell) and birds were presented with a choice of two drinker types at a time. As before, the preference tests were carried out inside the home broiler houses using the wooden frames (Figure 2). The two drinker types being compared were placed approximately 15 cm from each other, in the centre of the test arena. With tests involving nipple drinkers, the frames were arranged so that the nipple line ran front-to-back through the test pen, making ten nipples available. The left/right position of each drinker was balanced across the tests. As in experiment 1, there were two measures of preference; a) first choice and b) duration of drinking.

Procedure was similar to that described for experiment 1. A total of 30 pairs of chickens (10 pairs per test) were tested from a total of three different houses. All birds were 53–56 days old at time of testing.

Video analysis

A Panasonic NVGS5 camcorder was used to record the behaviour of chickens drinking from the three different drinker types and also from puddles outside on the range. At least 10 drinks from 10 different individuals were recorded for each drinking condition. The chickens recorded were not the same individuals as those used in the preference tests, but they were of the same breed, sex and age range. Recordings were made so that the chicken was viewed from the side and from chicken level. The tapes from the camcorder were transferred to VHS tapes via a clock that inserted a time stamp to 0.01 second. Drinking from bowls, puddles and bells is difficult to compare with that from nipple drinkers because the actions are so different and variable between individuals. We therefore chose one aspect to compare: the amount of time that the beak was in contact with the water. For bowls, puddles and bell drinkers, this corresponds to the 'inwater' phase (Dawkins & Dawkins 1973), but for nipple drinking, the beak cannot be scooped into water and so the contact time was defined as the time the bird spent pecking a nipple before it paused and allowed water to trickle down its throat.

Statistical analysis

As in experiment 1, the binomial test was used for a) first choices and the Wilcoxon test was used for b) duration of drinking. For the video analysis, the difficulty of comparing a 'drink' to a nipple with that to a bowl meant that this analysis was more suitable for a non-parametric analysis than a parametric one and so a Kruskal-Wallis one-way analysis of variance by ranks was used as it did not make assumptions about underlying distribution of the data (Siegel & Castellan 1988).

Results

Preference tests

In (a) no significant differences were seen in the first drinker type chosen in any of the three tests. Six out of ten nipples were chosen in the nipple versus bell test, 3/10 nipples were chosen in the nipple versus bowl test and 3/10 bowls were chosen in the bowl versus bell test. (In all cases $P > 0.05$, binomial test).

However, in (b) the proportion of time spent drinking at the three drinker types was clearly different. For the nipple versus bell test, median $d_i = -264$ seconds, ($T = 1$, n = 10, $P < 0.01$), the minus sign indicating a preference for the bell. For the nipple versus bowl, median $d_i = -228$ seconds ($T = 3$, n = 10, $P < 0.01$), with a preference for the bowl. Only for the bowl versus bell test was there no significant preference. Median $d_i = 102$ s ($T = 16$, n = 10, $P > 0.05$).

Video analysis

The median amount of time the beak was in contact with water was very similar for puddle, bowl and nipple drinking (Figure 3) but the variation was much greater for nipple drinking: some birds spent a lot of time in contact with the nipple and others only a small amount.

Discussion

Nipple drinkers were the least preferred method of drinking, as judged by the proportion of time birds spent drinking when given the opportunity of drinking from an alternative source of water, such as open bowls or bell drinkers. The birds seemed to spend, on average, similar amounts of time with their beaks in contact with water with nipples as they did with open water, but this time was much more variable between individuals for this contact time with nipple drinkers. This is in accordance with previous reports that individual birds develop their own techniques for extracting water from nipple drinkers (Appleby *et al* 2004). Both bowls and bell drinkers allow birds to drink with the natural 'scoop' action that nipple drinkers do not. We decided, therefore, to test the hypothesis that chickens prefer to drink in ways that are closest to their natural method of drinking by attempting to disrupt the drinking action and predicting that the birds would prefer the least disrupted, most natural action.

Experiment 3 — Chicken preferences for drinking from bowls at different heights

We attempted to distort the natural drinking action of chickens by making them drink from bowls (Figure 1[d]) placed at different heights. The aim of this was to affect both the downstroke and the upstroke by varying the distance between the water surface and the resting position of the beak. The height of the bowl might also be expected to make it more difficult for the bird to take water into the beak and so distort the 'inwater' or contact phase as well. We tested the hypothesis that chickens would exhibit a preference for drinking water presented to them at the heights that allow them to drink in the most natural way. We used choice tests to measure preference and video analysis to measure the degree of difference of the drinking action that was imposed by changing the height of the water.

Materials and methods

The animals, apparatus and procedure were similar to those used in experiments 1 and 2. Water was presented in identical, circular, red, plastic bowls (32.5 cm diameter, 7 cm edge height) at three heights, designated low (4.15 cm) medium (8.30 cm) and high (12.45 cm). The difference in height was achieved by raising the bowls on various numbers of stacked 4.15 cm concrete paving slabs. The bowls were attached securely to the pile of slabs so that they could not be disturbed or upturned by the birds. At the start of every test, each bowl was rinsed and filled with 450 cm of water from the clean supply inside the house.

Three preference tests were carried out, representing all pairwise combinations (ie low versus medium, medium versus high and low versus high). In each case, the two bowls were placed equidistantly from the entrance to the pen and its walls. Ten different pairs of chickens received each test.

Video analysis

Each drink was divided into four phases (Dawkins & Dawkins 1973): downstroke (from the time the head begins to move downwards toward the water to when it strikes the water); inwater (from the time the beak hits the water to when it is raised out of the water); upstroke (from when the beak is raised from the water until the head is returned to pre-drink position) and interdrink (from the end of one upstroke to the beginning of the next downstroke). The puddles were defined as having a height of 0.0 cm. The low medium and high bowls were 4.15, 8.30 and 12.45 cm high, respectively.

Statistical analysis

As in experiments 1 and 2, preference was measured (a) by first choice using a binomial test and (b) as by duration of drinking analysed by a Wilcoxon test. For the video analysis, the data were log transformed so that they satisfied the assumptions of a GLM analysis (normality of error, homogeneity of variance and linearity and were analysed with an analysis of covariance [ANCOVAR] using a Minitab software package [Release 14]).

Results

Preference tests

In a) there was no significant preference for any of the three bowl heights as measured by the first bowl drunk from in a choice test; for low versus medium 5/10; for medium versus high 6/10 and for low versus high 6/10. In all cases $P > 0.05$, binomial test.

Table 1 Video analysis of the different phases of the drinking action.

	Downstroke	Inwater	Upstroke	Interdrink
Effect of dish height (ANCOVAR)	$F_{3,28}$ = 1.59	$F_{3,28}$ = 6.25, P = 0.002	$F_{3,28}$ = 0.18	$F_{3,28}$ = 0.135
CV individual means	0.389	0.371	0.196	0.838
CV condition means	0.164	0.257	0.032	0.33

For b) there was no significant difference in the amount of time spent drinking from bowls of different heights. For low versus medium, median d_i = 119 s (T = 22; n = 10, P > 0.05). For medium versus high, median d_i = 178 s (T = 19; n = 10, P > 0.05). For low versus high, median d_i = 347 s (T = 19; n = 10; P > 0.05).

Video analysis

Drinker height had a significant effect only on the inwater phase (Table 1) yet had no significant effect on the downstroke, upstroke or interdrink phases. Interestingly, the upstroke appeared to remain very constant in duration, (see Table 1), despite the fact that the beak had less far to travel with the high drinker than the low drinker or puddle. The constancy of the upstroke was quantified by using the coefficient of variation (SD/mean) of the different phases of the drink. The upstroke shows the least variation, both overall and between different heights.

Discussion

Despite being subjected to a range of drinker heights, the upstroke remained remarkably similar in duration (cf Dawkins & Dawkins 1973). In other words, the chickens took the same amount of time to let the water trickle down their throats whether the beak had to travel all the way up from the ground or started half-way up the bird's body. The chickens seemed to be able to keep this part of their behaviour 'natural' despite our attempts to disrupt it. This may explain why no significant preference for bowls at different heights was apparent: the chickens successfully resisted our attempts to make them drink in an unnatural way.

Even the highest bowl in this experiment, however, was considerably lower than the nipple lines used commercially. These are usually positioned above the birds' heads (Figure 1[a]). We therefore looked next at the preference for drinking from nipples within the height range common in commercial practice (Ross 2002). We tested the hypothesis that broiler chickens have a preference for drinking from lower rather than higher drinker lines.

Experiment 4 — The effect of nipple line height on the drinking preferences of broiler chickens

The effect of lowering the nipple drinker line was measured in three ways: a) by assessing the preferences of individual birds; b) by scanning whole houses and comparing the number of birds drinking when the nipple line was high and when it was low and c) video analysis of individual bird drinking behaviour.

Materials and methods

Individual preferences

Preference tests were carried out inside the broiler houses using similar apparatus to that described for experiments 1–3. However, due to there being only one drinker line per house, it was not possible to present birds with a simultaneous choice between high and low nipple lines. In order that the comparison was a successive one we measured the amount of time spent drinking during a 10 minute test when the nipple line was high (52 cm) with a comparable test in which the drinker line was 15 cm lower. For commercial purposes, the farm no longer reared free-range Ross 308 broilers used in the previous experiments, but now used free-range JA 57 broilers, reared to 81 days. Apart from the fact that these birds were slower growing and at least two weeks older at the time of testing, other details of husbandry were similar to those described earlier. For this experiment, birds were tested when they were between 61 and 63 days old. Eight different individual pairs of chickens were used, four pairs for each of the two drinker heights. The drinker line height was balanced between pairs to ensure that both heights were tested under similar temperatures and times of day.

Statistical analysis

A non-parametric test for independent samples (Mann-Whitney U test) was used to analyse the data.

Whole house preferences

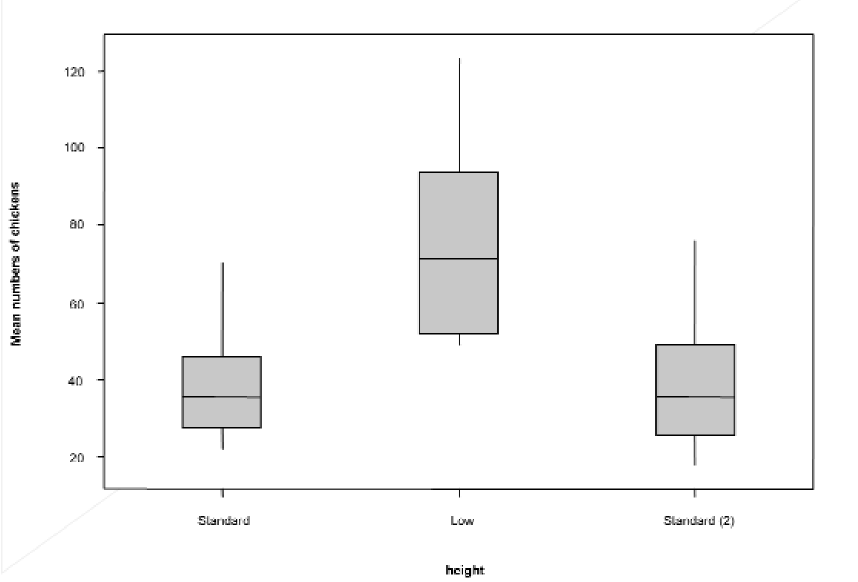
The observer entered the house and waited quietly to allow the birds to settle down. After five minutes, the number of birds drinking from the standard height (52 cm) nipple drinker line was recorded. The entire nipple drinker line was then lowered 15 cm. After five minutes, the number of birds was recorded again. Finally, the drinker line was raised to its previous level and, after five minutes, the number of birds drinking was again recorded (Figure 3). This procedure was repeated in 12 different houses (ie 12 completely different flocks of approximately 600 birds). An age range of 43–77 day old birds was used. External temperature data were obtained from the Wytham Automatic Weather Station, courtesy of the Environmental Change Network and given as hourly means.

Statistical analysis

The data satisfied the assumptions of a GLM (normality of error, homogeneity of variance and linearity) and so a General Linear Model (GLM) was produced of the number

Figure 4

Mean numbers of chickens drinking from nipple drinkers when the drinker line was at its standard height (high), then lowered by 15 cm (low), then raised again (standard 2). The boxes represent standard deviations and the whiskers the range.



of birds drinking at the two heights, age of birds and interaction between drinker height and age. Temperature was also included in the model.

Video analysis

Video footage was taken with the equipment and in the manner described previously. Sixty-one to sixty-three day old broiler chickens were recorded drinking from nipples at the standard (high) height and low heights. Six drinking bouts were recorded for each of 29 individual birds drinking from standard height nipples and 25 from lowered nipples. The video footage was taken between 0900–1100h and 1400–1600h over three days. Approximately equal numbers of broilers were recorded at each of these times of day for the two drinker heights. A nipple drinking bout was defined as beginning with the first contact of the beak with a nipple and ending when the bird did not drink within two seconds of the previous drink.

For each chicken, the number of steps during and between drinking bouts was recorded, as a measure of a loss of balance. Leans and stumbles were also recorded. These measurements allowed us to test the hypothesis that higher nipples caused the birds to overbalance.

Results

Individual preferences

The chickens spent significantly more time drinking during the 10 minute period when the nipple drinker line was lower (37 cm) than when it was higher (52 cm). (Mean lower = 3.35 minutes; mean higher = 1.3 minutes [$U = 10.0$, $n_1 = 4$, $n_2 = 4$, $P < 0.05$]).

Whole house preferences

The number of chickens drinking from the lowered nipple drinker line was significantly greater than the standard 'high' nipple line (Figure 4; n = 12, $F_{2,32} = 39.78$, $P < 0.001$, GLM). This suggests that broilers have a strong preference for lowered nipple drinkers over those at standard height (Figure 4).

A two-sample *t*-test revealed no significant difference between the number of birds drinking when the nipple drinker line was at the initial standard height and when the nipple drinker was returned to the standard height after being lowered (n = 12, $t = -0.31$; $P > 0.05$). This suggests that the number of birds drinking from the nipple drinker is not affected by the novelty of a change in height.

The number of birds drinking from the nipple drinkers was significantly correlated with bird age ($F_{1,27} = 52.64$, n = 12, $P < 0.001$, GLM), with fewer birds drinking as age increased. The adjusted R^2 value (ie the variation explained by the model) with age and height as explanatory variables is high (78.68%). Temperature had a significant effect on the numbers of birds drinking with more birds drinking as temperature increased ($F_{1,31} = 5.13$, n = 12, $P < 0.05$). However, even when the effect of temperature is statistically eliminated, height and age are both still significant.

There is a significant interaction between the height of the nipple line and age of the birds ($F_{2,30} = 4.07$, n = 12, $P < 0.05$). As age increases, the difference between the two drinker heights decreases.

Video analysis

There was no evidence of the birds showing more natural drinking behaviour (ie the 'scoop' action) with lowered nipple drinkers. Out of all the records examined with more than 170 nipple drinking episodes, no instances of scoop drinking were seen, even with the lowered drinker line. With the lowered nipple line, chickens tended to bend their necks so that they were still looking up at the nipple, as they did for the higher nipples.

Drinking bout length was significantly longer when chickens were drinking from lower nipple drinkers ($F_{1,52} = 50.29$, $P < 0.001$), but there was no difference in the number of steps taken either between bouts ($W = 861.0$, $P > 0.05$, Mann-Whitney U test) or within bouts ($W = 863.0$, $P > 0.05$). Four birds were observed to stumble when drinking from the standard height drinker, whereas none stumbled when drinking from the low nipple line.

Discussion

Both the individual preference and the whole house preference tests indicated that broiler chickens have a clear preference for lower nipple drinkers over the higher ones normally used commercially. In the whole house tests, more chickens drank when the nipple line was lowered, suggesting that the birds were highly motivated to drink but that the overhead nipple discouraged them.

The video analysis suggests that the preference for lowered nipple drinkers is not due to an increased ability to drink 'naturally'. There was no evidence of natural 'scoop' drinking at either drinking height. Thus, the preference for lowered nipple drinkers does not seem to be due to birds being able to perform more natural drinking actions. It is more likely to be due to the fact that the birds can drink in a more stable position. The chickens drank for longer, with shorter periods between drinking bouts when the nipples were lowered. The standard (high) nipple drinker line forced the chickens to raise their beaks, stretch their necks and drink from the beak tip. The lowered drinker allowed them to drink from the side of the beak without stretching upwards, a position that may be more comfortable for them (Lott *et al* 2001).

The preference for lowered nipple drinkers does not, however, preclude the possibility that chickens might have an even stronger preference for low level drinkers that also allowed them to drink in a more natural way than is possible with nipple drinkers at any height. We decided, therefore, to examine drinking behaviour when nipple drinkers were presented at the same height as a bowl. If the main factor affecting chicken drinking preferences is the naturalness of the drinking action, the bowl should be clearly preferred to the nipples but if the main factor is drinker height, then the birds should be indifferent to the method of water delivery. Either way, this would be an important piece of evidence about their preferred method of drinking and an aid to designing better drinking systems.

Experiment 5 — Preference for nipple drinkers and bowls presented at the same height

Materials and methods

The apparatus, procedure and statistical analysis were similar to those described for experiments 1–3. The birds were similar to those described for experiment 4.

Two choices were presented to the birds: a choice between nipple drinkers and a bowl, both presented at 20 cm (low) and a choice between nipple drinkers and a bowl, both presented at 40 cm (high). A total of 16 pairs of birds were used (ten for the low test and six for the high test). All birds were 63–64 days old at the time of the tests.

Results

Preference tests

For first choices (a) there was no significant preference for either nipples or the bowl when both were presented at 20 cm (8/10 chose nipples; $k = 2$; n = 10; $P > 0.05$, binomial test). There was, however, a significant preference for nipples when both were presented at 40 cm (6/6 chose nipples; $k = 0$; n = 6; $P < 0.02$).

In (b), duration of drinking, a similar result was obtained using time spent drinking as the measure of preference. There was no significant difference between time spent drinking from nipples compared to bowls when both were presented at 20 cm (low) (median $d_i = 113.2$ s; $T = 39.0$, n = 10; $P > 0.05$) but there was a significant preference for nipples in the high (40 cm) test. When both nipples and bowl were high, all the birds drank exclusively from the nipples (median $d_i = 402$ s ; $T = 21$; n = 6; $P < 0.02$).

Discussion

These results further support the hypothesis that chickens find nipple drinkers an acceptable means of drinking, provided they are at a height that the birds find comfortable and convenient. When nipple drinkers are presented at the same height as a bowl of water, then nipple drinkers are either preferred or there is no significant preference. The importance of comfort and ease of drinking is emphasised by the finding that when both the bowl and nipples are raised and the birds have to stretch to drink from either one, stretching to peck at a nipple drinker is preferred to stretching to drink at a highly unusual angle from a bowl.

General discussion

This series of five experiments is an investigation into the method of delivering water to broiler chickens that is most preferred by the birds themselves. Birds seem to be quite willing to drink chlorinated tap water, provided it is presented to them in an acceptable way (experiment 1) Although nipple drinkers make chickens drink in an apparently unnatural fashion, ie very differently from the 'scoop' action seen in birds drinking from open troughs or puddles (experiments 2 and 3), our evidence suggests that this is not as aversive to the chickens as the fact that nipple drinkers are commonly positioned such that birds have to peck upwards (experiments 4 and 5). The most likely interpretation of our results taken as a whole, is that pecking at a high nipple drinker is uncomfortable for a broiler chicken, as suggested by Lott *et al* (2001). As birds get older and the breast muscles become heavier, they may find it difficult to stretch and balance to get sufficient water. Indeed, our results on the effects of lowering the drinker line (experiment 4) show that birds immediately start drinking, suggesting that they were previously somewhat water-deprived. Water intake in broilers can be increased by lowering the nipple line (Lott *et al* 2001) and we have shown that this is reflected in the preferences and behaviour of individual birds.

Animal welfare implications

This study has highlighted the importance of the chickens' own preferences in water intake and has shown that lower nipple drinkers are preferred. This is in line with previous findings that lower nipple drinkers lead to an increase in water intake and increase growth (Lott *et al* 2001). It might be thought that the growth and welfare of commercially reared broiler chickens could therefore be easily improved by simply lowering the nipple drinker lines, with no need to change drinker type at all. However, the situation is more complex than this for commercial farmers. Nipple drinker lines are positioned above the birds' heads for several good reasons: they prevent leakage and waste and help to preserve the quality of the litter (Ross 2002); they prevent large numbers of birds perching on them and they effectively increase the amount of floor space by allowing birds to use the space under the nipples. Wet litter is one of the major causes of foot and leg lesions in broiler chickens (Martrenchar *et al* 2002; Broom & Reefman 2005) and so there is a potential conflict between two welfare requirements: lowering nipple drinkers would give chickens a more preferred method of drinking but there would be an in increased risk of pododermatitis and hock burn.

On the other hand, the apparent willingness of chickens to drink from nipple drinkers positioned correctly suggests that it may not be too difficult to provide a commercially acceptable method of delivering water that also satisfies the needs of the birds. It does not seem to be necessary to provide open water drinkers (bells or troughs) to give the birds water in the form that they find acceptable. As improved water provision also improves bird health (Carpenter *et al* 1992; Michel *et al* 1998), we hope that the design of the next generation of drinkers will incorporate this information about how the chickens themselves prefer to drink.

Acknowledgements

We would like to thank Ruth Layton and the farm staff at the Food Animal Initiative for their help and support throughout this study.

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