Pre-publication copy

O'Driscoll, K.K.M. and Broom, D.M. 2011. Does access to open water affect the health of Pekin ducks (*Anas platyrhynchos)? Poultry Science,* 90, 299-30. DOI: 10.3382/ps.2010-00883

Does Access to Open Water Affect the Health of Pekin Ducks (*Anas platyrhynchos)*?

Keelin K. M. O'Driscoll[*1] and Donald M. Broom[*]

[*]Centre for Animal Welfare and Anthrozoology, Department of Veterinary Medicine, University of Cambridge, Madingley Road, Cambridge CB3 0ES, United Kingdom

[1]Corresponding Author: Keelin O'Driscoll, Tel: +44 (0)1223 330842, Fax: +44 (0) 1223 330886, Email: keelin.odriscoll@gmail.com

Scientific Section: Physiology, Endocrinology, and Reproduction

ABSTRACT

. Access to open water is considered good for the welfare of Pekin ducks. These studies investigated the effect water resource type provided over either straw bedding or a plastic mesh, on measures of duck health. Pekin strain ducklings (n=2600) were managed in pens of 100 on straw over a solid concrete floor. In study 1, one of 2 water resources, nipple (NIP; n = 5 pens) or wide lip bell drinker (WIDE; n= 5 pens) were located directly over the straw. In study 2 one of 3 water resources (Narrow lip bell drinker; n = 6 pens, TROUGH; n = 5 pens, and BATH; n = 5 pens) were located over a rubber mesh. On d16, d24, d29, d35 and d43 (study1) or d21, d29, d35 and d43 post-hatch (study 2), ten birds were selected from each pen, weighed, then feather hygiene, foot pad dermatitis (FPD), eye health, gait score and nostril condition scores taken. There was no effect of treatment on live weight in either study, but in study 2 ducks in the open water treatments overtook NARROW ($P < 0.001$) by d43. In study 1 there was no effect of treatment on hygiene scores, but scores increased over time ($P<0.001$). In study 2 ducks in the NARROW treatment were dirtier than BATH ($P=0.01$) with TROUGH intermediate. In both studies, ducks with bell drinkers had worse gait scores than the other treatments (Study1; $P < 0.01$: Study 2; $P < 0.05$). There was no effect of treatment on eye health score. However, ducks were less likely to have dirty nostrils with more open water resources in both studies ($P < 0.01$), or to have blocked nostrils in TROUGH and

BATH than in NARROW in study 2 (P=0.01). Provision of open water, in particular over a properly constructed drainage area, improved some aspects of duck health (improved feather hygiene, and live weight, and fewer dirty and blocked nostrils). However, further work is needed to investigate these treatments at a commercial scale.

. **Keywords:** duck, health, welfare, water, hygiene

INTRODUCTION

In the UK, ducks are primarily raised for meat consumption. The species most commonly used is the domesticated mallard duck, *Anas platyrhynchos*, which is a type of waterfowl. The market for duck meat is steadily increasing, and consumption has doubled in the past 15 years (SAC, 2009). In 2006 there were 18 million ducks slaughtered in the UK, and duck accounts for 5% of the poultry meat market (British Poultry Council, 2008). Ducks are usually housed in large sheds, and types of flooring used include straw-bedding on solid floors, wire mesh, or slats. Current UK government recommendations state that ducks should be provided with adequate fresh feed and water (DEFRA, 2008). The Council of Europe (1999) also recommends that ducks should be able to dip their heads in water and spread water over their feathers. Although DEFRA (2008) have published recommendations that state that 'consideration should be given to the provision of water troughs which are deep enough to allow the ducks to get their heads completely under water', there are no legal requirements for duck farmers. Thus, nipple drinkers that do not provide opportunity for ducks to immerse any parts of the body can still be used to manage ducks through the entire life cycle.

A key aspect of welfare is health as any increase in disease or injury means that welfare becomes poorer (Broom 2006, 2008). Access to open water is considered good for duck health, in particular for eye and nostril health, and hygiene of the plumage (Knierim et al., 2004). Jones et al. (2009) found evidence that duck welfare is related to the nature and extent of their access to water; ducks that were only provided with nipple drinkers were unable to keep their eyes, nostrils and feathers fully clean. Access to water is necessary for several of the behaviours that are part of a duck's natural behaviour e.g. head dipping and wing flapping in association with water. Some of these behaviours have a direct impact on duck health, because they are part of the duck's repertoire of preening behaviours, and the quality and quantity of preening behaviour is likely to affect plumage hygiene.

However, provision of open water that ducks can enter to perform preening behaviour could have negative consequences for bird health. In the UK, it is recommended that the maximum stocking rate for commercially-reared ducks is 8 ducks/m^2 between 3 and 8 weeks of age (DEFRA, 2008). At this stocking density, an open water resource could possibly become contaminated with bedding and faeces. This could lead to bacterial growth, which in turn could have a negative impact on duck health. There is also an economic cost associated with provision of open water, because of the labour required to clean the receptacles, the cost of increased water use, and treatment and disposal of the water. Thus a method of providing open water that reduces any risk to health, and that reduces the volume of water used, should be investigated.

It is unclear whether it is the presence and appearance of open water in itself, or if it is contact of water with the bird's bill, or on the feathers, that stimulates preening behaviour, and a consequent improvement to feather hygiene. It is possible that an open water resource that permits head only or beak only access, as opposed to whole body access, could be sufficient to promote a level of preening behaviour that keeps feathers clean. Thus chicken and turkey plassons, which allow the bird to dip it's beak into the water, or a narrow trough, which permits head and beak access, could promote preening behaviour at a level that is sufficient to maximise bird hygiene, satisfy the birds' needs to show certain behaviours, and could minimise contamination and use of water. Moreover, dirty water may not be such a problem with regard to bird health in these systems, because the birds cannot enter with their entire bodies. Ducks show preferences to enter water but we lack information on the preferences of ducks for different water depths.

There is a dearth of published scientific information on the effect that water resource types have on bird health. It is important to increase knowledge on the effect that access to water has on duck health to develop sustainable systems that ensure high standards of animal welfare across the industry. The aim of this study was to investigate the effect that access to water has on duck health, depending on the level of access that is provided. Specifically, the study used five different resource types (nipple, chicken plasson, turkey plasson, trough and bath) provided over two types of flooring (straw bedding or plastic mesh). We investigated the effects of the level of access to water on eye, nostril and plumage hygiene, and liveweight. Also, the effects of provision of water over straw bedding on plumage and foot pad dermatitis were studied.

MATERIALS AND METHODS

Animals and husbandry

Study 1: Nipples and wide (turkey) plassons

One thousand Cherry Valley Pekin breed ducklings were hatched on 6 January 2009, then managed in groups of 100 ducklings (n = 10 groups) in pens constructed on a concrete floor in a shed with forced ventilation. Ducklings had access to a gas heater until 12 d post hatch, and were managed on straw litter that was topped up daily. Pens measured 8.01m × 3.05m (total floor area $24.43m^2$). Ducklings were restricted to a sub-section of the pen for the first 14 d post hatch. From d1 post hatch they had access to red plasson drinkers (diameter = 230mm, height = 120mm, water depth (to lip) = 40mm, water width = 45mm), and hopper style feeders (88.90cm width, 144.78cm length) with a feed space of 284.4cm (i.e. 2.84cm per bird). At 14 d the ducklings were provided with access to the entire pen. They were fed a standard commercial duck feed appropriate for their age. Throughout the experiment drinkers were located above a perforated drainage pipe sunk into a channel in the concrete floor, which ran the width of each pen.

Treatments and replication

Each pen was assigned to one of two treatments relating to access to water: access to 1) a nipple line (NIP; n = 5) or 2) wide plasson drinkers (WIDE; n = 5). Birds in the NIP treatment had access to water through a nipple line (n = 15 nipples per pen), with red hammocks under each nipple. The nipple line was available to the birds from d 1 post hatch. Water was provided to WIDE birds through 2 turkey plasson drinkers (diameter, 460mm, height, 380mm, water depth (to lip), 70mm, water width, 90mm) that were installed in the pens from d xx. The circumference of each plasson was 1445mm, providing a space allowance of 29mm per bird. Each plasson was individually connected to the mains water supply, and was self-filling, with water level controlled by ballcocks. They were emptied, cleaned and refilled with clean water each day.

Study 2: Chicken (narrow) plasson, trough and bath

One thousand six hundred Cherry Valley Pekin ducklings were hatched on 6 January 2009, then managed in groups of 100 ducklings (n = 16 groups) in a shed with forced ventilation. Pens measured 7.47 m × 3.05 m (total floor area 22.78m^2). Each pen had a straw bedded area on a solid concrete floor (5.66 m × 2.95 m = 16.70 m^2), as well as a grooved concrete ramp (0.7 m × 2.95 m = 2.07 m^2) that led to a drainage area with a rubber-slatted floor (1.25 m × 2.95 m = 3.69 m^2). The total floor area was 22.45 m^2. Ducklings had access to a gas heater until 12 d post hatch, and were managed on straw litter which was topped up daily. They were restricted to a sub-section of the pen for the first 14 d post-hatch. Immediately after hatching, ducklings had access to red plasson drinkers (diameter, 230mm, height, 120mm, water depth (to lip), 40mm, water width, 45mm) and hopper style feeders (88.90cm width, 144.78cm length) with a feed space of 284.4cm (i.e. 2.84cm per bird). At 14 d the ducklings were provided with access to the entire pen. They were fed a standard commercial duck feed appropriate for their age. Throughout the experiment drinkers were located above the rubber drainage area.

Treatments and replication

At 21 d post-hatch, each pen was assigned to one of three treatments relating to access to water: access to 1) chicken plasson (NARROW), 2) trough (TROUGH), or 3) bath (BATH). Birds in the NARROW treatment had access to water through 2 chicken plasson drinkers (diameter = 350mm, height = 375mm, water depth (to lip) = 40mm, water width = 45mm) per pen. The circumference of each plasson was 1010mm, providing a space allowance of 20mm per bird. Each plasson was individually connected to the mains water supply, and was self-filling, with water level controlled by ballcocks. They were emptied, cleaned and refilled with clean water each day. Birds in the TROUGH treatment had access to water via 1 trough (width = 150mm, length = 1600mm, total height = 140mm; water depth (to lip) = 100mm) per pen. Access to one end was not provided, due to the ballcock fittings, and thus there was a space allowance of 34mm per bird. Birds in the BATH treatment had access to water via a bath (width = 550mm, length = 1000mm, total height = 150mm; water depth (to lip) = 100mm). Access to part of one side was blocked by the ball-cock housing (205mm). Thus there was a space allowance of 29mm per bird. Water resource equipment in each pen was located over the rubber-slatted drainage area.

Birds in both studies were managed to have a target weight at slaughter of 3.7 kg, which meant that the maximum stocking density in each pen was 15.16 kg/m^2 (i.e. at the time of slaughter).

Experimental measures

Environmental measures

Temperature and relative humidity (RH)

Ambient air temperature and RH were recorded using Gemini Tinytag Extra Dataloggers, TGX-3580 (Gemini dataloggers (UK) Ltd., Chichester, West Sussex, UK) between 10 February and 19 February. A datalogger was suspended at a height of 180 cm at four points distributed throughout the shed in both experimental sheds (Study 1: between pens 1 and 2, pens 4 and 5, pens 6 and 7 and pens 9 and 10; Study 2: between pens 1 and 2, pens 7 and 8, pens 9 and 10 and pens 15 and 16). Data were recorded at 1min intervals.

Bedding dry matter (DM) %

Straw bedding samples were taken from each replicate pen in study 1 on d 16, d 24, d 29, d 35 and d 43 post-hatch, and in study 2 on d 21, d 29, d 35 and d 43 post-hatch. Samples were collected from three areas of the pen in study 1 (bed area, feed area, and water resource area) and from two areas of the pen in study 2 (feed area and bed area). Samples were gathered into sealable plastic bags using latex gloves, and, then frozen on the day of collection at -20°C until analysis. 5-6 grab samples were used in each total sample.

For analysis of DM, samples were initially defrosted entirely, then placed in a plastic mixing bowl and mixed. A portion of each sample was placed in a foil tray, weighed, then placed in a convection oven at 100°C for 24h (prior to analysis, this amount of time was determined to be sufficient to obtain a constant weight). Samples were re-weighed immediately on removal from the oven, and proportion DM calculated.

Animal measures

All experimental measures were recorded in the bird's home pen. Measures were recorded in study 1 on d 16, d 24, d 29, d 35 and d 43 post-hatch. Measures were recorded in study 2 on d 21, d 29, d 35 and d 43 post-hatch. Ten birds were randomly selected and confined together in a corner of the pen. Each bird was individually inspected for each of the following measures; feather hygiene, foot pad dermatitis score, eye health and nostril blockage according to the scores listed in Table 1. They were then weighed (accurate to 0.2g), and placed back in their home pen, where they were gait scored. Gait scoring was carried out using a modified version of the scoring system developed by Kestin et al. (1992; Table 1). The same two observers scored birds on all occasions. In a situation where observers disagreed over scores, scores were discussed and a consensus reached. Total percentage mortality for each pen during the experimental period was also calculated.

Statistical analysis

Data were analysed using the Statistical Analyses System (SAS, V9.1). Prior to analysis, all data were examined for normality by examination of histograms and normal distribution plots (Proc Univariate).

Straw DM %, temperature and RH were analysed using the Mixed procedure. For analysis of DM %, fixed effects were treatment, date, area of the pen, and interactions. Date was considered a repeated effect, and pen a random effect. Temperature and RH recordings were averaged for each hour of each day, to create one recording per hour. Fixed effects in the analyses were location (in the shed), date and hour, as well as interactions. Hour was considered a repeated effect.

Mean values per pen for bird liveweight, feather hygiene score and foot pad dermatitis score were calculated prior to analysis, and the pen was considered the experimental unit. Data were analysed using the Mixed procedure. Fixed effects were treatment, age (d), and the interaction. Recordings from d 16 were used in analysis as a covariate in study 1, and from d 21 in study 2. Age was considered a repeated effect, and pen a random effect.

Gait scores were square root transformed. Models were re-run using raw data to obtain least square means for presentation but p-values were calculated using transformed data.

Differences in eye and nostril health scores were investigated using a logistic regression model (Proc Genmod). Eye scores of greater than 1 were classified as severe, and of 0 and 1 as non-severe. Nostril scores were categorised in one of 2 ways; first any dirt in either nostril (i.e. scores of 1 and 2) were classified as 1 and clean nostrils 0; then blocked nostrils were classified as 1 and non-blocked nostrils 0. The cumulative logit of the probability that severe eye scores, dirty nostrils, or blocked nostrils was greater in each treatment was investigated. Odds ratios (OR) and 95% confidence interval (CI) were calculated as the exponent of the model solutions. The pen was included as a repeated effect. Treatment and test day were forced into the model as class variables. The initial inspection day and nipple treatment were used as the reference classes in study 1, and the initial inspection day and plasson drinkers in study 2. Mortality in each pen was recorded, but not statistically analysed.

RESULTS

Study 1

Environmental measures

Temperature and RH

Temperature and RH results can be seen in Table 2. There were no interactive effects. There was an effect of time of the day ($P < 0.001$; Figure 1).

Bedding DM%

The DM % of the bedding in the WIDE treatment was lower than in NIP (47.0 ± 1.3 % *v's* 51.6 ± 1.3%; $P < 0.05$). There was also an effect of area within the pen ($P < 0.001$). DM % of bedding was lowest in the water resource area (37.2 ± 1.2 %), and this was lower than in either the feed area (54.7 ± 1.2 %; $P < 0.001$) or the bed area (56.1 ± 1.2 %; $P < 0.001$).

There was an effect of date on bedding DM % ($P < 0.001$). The DM % was higher on the first inspection day (22 January; 60.8 ± 1.2 %) than on 30 January (51.9 ± 2.1; $P < 0.05$), 4 February (44.1 ± 2.1; $P < 0.001$), 10 February, (41.3 ± 2.1; $P < 0.001$), and on 18 February (48.9 ± 2.9; $P = 0.001$). The DM % on 30 January tended to be higher than on 4 February ($P = 0.08$), and was higher than on 10 February ($P = 0.01$). There were no other differences between dates.

Animal measures

There was no effect of treatment on bird liveweight but there was an effect of time ($P < 0.001$; Figure 1A).

There was no difference in feather hygiene score between WIDE (2.94 ± 0.09) and NIP (2.75 ± 0.09; $P = 0.16$) but here was an effect of time ($P = 0.001$). In general, hygiene scores increased (i.e. feathers got dirtier) over time, and scores on d 43 (3.31 ± 0.12) were higher than on d 35 (2.76 ± 0.12; $P < 0.05$), d 29 (2.77 ± 0.12; $P < 0.05$) and d 24 (2.54 ± 0.12; $P < 0.001$).

Ducks in the WIDE treatment had higher gait scores (0.32 ± 0.03) than ducks in the NIP treatment (0.20 ± 0.03; $P < 0.01$) (Figure 2). There was also an effect of time ($P < 0.01$) on gait score. In general, gait scores increased over time, and scores on d 43 (0.38 ± 0.04) were higher than on d 29 (0.18 ± 0.04; $P < 0.01$).

Both treatment ($P = 0.1$) and time ($P = 0.08$) tended to have an effect on foot pad dermatitis score. Ducks in the NIP treatment tended to have higher dermatitis scores (0.97 ± 0.11) than ducks in the WIDE treatment (0.72 ± 0.11). However there was no difference between dermatitis scores on any pair of days. There was an interaction between treatment and time ($P < 0.05$), and on d 35, dermatitis score of ducks in NIP (1.22 ± 0.16) tended to be higher than in WIDE (0.48 ± 0.16; $P = 0.06$).

There tended to be an effect of treatment on eye score (OR = 0.71, CI = 0.44 – 1.13; $P = 0.1$) and there was an effect of time ($P = 0.05$). In particular, the odds of a duck having a severe eye score tended to be lower on d 29 than d 16 (OR = 0.37, CI = 0.12 – 1.18; $P = 0.09$). However, ducks were more likely to have a severe eye score on d 43 than on d 16 (OR = 13.15, CI = 4.55 – 38.02; $P < 0.001$).

There was an effect of treatment ($P < 0.01$) but no effect of time ($P > 0.05$) on the odds of a duck having dirty nostrils. The percentage of ducks in each treatment that had dirty nostrils on each day is shown in Table 2. The odds of dirty nostrils were lower in WIDE than in NIP (OR = 0.44, CI = 0.31 – 0.62; $P < 0.001$). There was no effect of treatment or time ($P > 0.05$) on the odds of a duck having blocked nostrils.

Average mortality in the NIP and WIDE treatments were 1.4% and 2.4% respectively.

Study 2

Environmental measures

Temperature and RH

Temperature and RH results can be seen in Table 2. There were no interactive effects. There was an effect of time of the day ($P < 0.001$; Figure 1).

Bedding DM%

There was no effect of treatment on bedding DM % ($P > 0.05$). The DM % in NARROW, TROUGH and BATH was 50.9 ± 0.9, 49.5 ± 1.0 and 50.4 ± 1.0, respectively. However, DM % in the bed area (47.1 ± 0.8) was lower than in the feed area (53.4 ± 0.8; $P < 0.001$). Likewise there was an effect of date ($P < 0.001$). The DM % on 27 January (59.3 ± 1.1) was higher than on 4 February (51.9 ± 1.1; $P < 0.001$), 10 February (45.4 ± 1.1; $P < 0.001$) and 18 February (44.4 ± 1.1; $P < 0.001$). The DM % on 4 February was higher than on 10 February ($P < 0.001$) and 18 February ($P < 0.001$), but there was no difference between DM % on the latter two dates.

Animal measures

There was an effect of time on bird liveweight ($P < 0.001$; Figure 1B) and an interaction between time and treatment ($P < 0.001$; Figure 1A). Although ducks in the NARROW treatment had the highest liveweight at 29d and 35d, at 43d they had lower liveweight than ducks in the other two treatments.

There was an effect of treatment on bird dirtiness score ($P < 0.05$). The dirtiness score of birds in the NARROW treatment (2.31 ± 0.13) was higher than that of birds in the BATH treatment (1.69 ± 0.14; $P = 0.01$), with birds in the TROUGH treatment (2.05 ± 0.14) intermediate. There was also an effect of time ($P < 0.01$), with dirt score on d 35 (2.36 ± 0.12) higher than either d 29 (1.95 ± 0.12; $P < 0.05$) or d 43 (1.74 ± 0.12; $P < 0.01$).

There was an effect of treatment ($P < 0.01$) and time ($P < 0.001$) on gait scores. Ducks in the NARROW treatment had higher scores (0.28 ± 0.03) than ducks in either TROUGH (0.15 ± 0.04; $P < 0.05$) or BATH (0.11 ± 0.04; $P < 0.01$), although there were no differences between individual treatments. There was no difference between gait scores at d 29 (0.09 ± 0.04) or d 35 (0.10 ± 0.04; $P > 0.05$) examinations, but gait score at d 43 (0.35 ± 0.04) was higher than on either of these days ($P < 0.001$ for both).

There was no effect of treatment on foot pad dermatitis scores ($P > 0.05$). However, there was an effect of time ($P < 0.001$). Dermatitis score tended to be lower on d 29 (0.58 ± 0.10) than on d 35 (0.84 ± 0.10; $P =0.1$) and was lower than on d 43 (1.30 ± 0.10; $P < 0.001$). Dermatitis score on d 43 was also greater than on d 35 ($P < 0.01$).

There was no effect of treatment on the odds of a duck having a severe eye score ($P > 0.05$). However, there was an effect of time ($P < 0.01$). The odds of a duck having a severe eye score was lower on d 29 than d 21 (OR = 0.09, CI = 0.01 – 0.75; $P < 0.05$). However, ducks tended to be more likely to have a severe eye score on d 43 than on d 21 (OR = 2.51, CI = 0.81 – 7.77; $P = 0.1$).

There was an effect of treatment ($P < 0.01$) and tended to be an effect of time ($P = 0.07$) on the odds of a duck having dirty nostrils. The percentage of ducks in each treatment that had dirty nostrils on each day is shown in Table 3. The odds of dirty nostrils was lower in TROUGH than in NARROW (OR = 0.44, CI = 0.31 – 0.63; $P < 0.001$) and lower in BATH than NARROW (OR = 0.31, CI = 0.20 – 0.48; $P < 0.001$). The odds of dirty nostrils was lower on d 43 than on d 21 (OR = 0.37, CI = 0.17 – 0.81; $P = 0.01$). There was also an effect of treatment ($P = 0.01$) on the odds of a duck having blocked nostrils, although no effect of time ($P > 0.05$). The odds of having blocked nostrils was less in TROUGH ducks than NARROW (OR = 0.30, CI = 0.16 – 0.56; $P < 0.001$) and less in BATH ducks than NARROW (OR = 0.27, CI = 0.12 – 0.59; $P = 0.001$).

Average mortality in the BATH, TROUGH and NARROW treatments were 1.6%, 4.2% and 2.8% respectively.

DISCUSSION

Although ducks are waterfowl, there are very few published papers that examine the effect of water resource type on duck health, and in particular in commercial systems. Recently, Jones et al. (2009) investigated the effect that a trough, bath, nipples and shower have on duck welfare, using several of the health measures included in this paper. However, ducks in that study were managed in groups of four, and thus the results may not be transferable to situations where birds are managed in larger groups, and with much less space per duck at the resource (e.g. in that study ducks had a space allowance of 800mm and 538mm per bird, at a bath and trough respectively). DEFRA (2008) and RSPCA (2009) guidelines state that there must be space of at least 5mm per duck at the water resource, and Dawkins (2008) reported an average of between 5.3mm and 6.1mm per duck currently in use in the UK duck industry. The treatments in our study are thus more representative of commercial conditions, and provide important information about how facilities that are currently in use in the UK duck industry can impact upon the health, and consequently the overall welfare of the birds.

Although there was a significant effect of location in the shed on temperature and RH in both studies, the actual differences were so small that they probably had limited biological effect on the ducks in different areas of the sheds. The temperature and RH recordings were taken during week 6 of the growth period, and the recorded values are similar to average temperatures during week 6 in winter, calculated by Dawkins (2008) (approx 10 ºC and 81%). Thus conditions in the sheds during these studies were comparable to industry norms.

Even though bedding was topped up daily, in both studies the DM % of the bedding decreased over time, probably due to a build-up of faecal matter. However, in Study 1 there was no difference in DM% on dates subsequent to 4 February, and in Study 2, subsequent to 10 February, indicating that the practice of providing fresh bedding each day was sufficient to prevent further deterioration in bedding DM%. In Study 1 the DM% of bedding located in the water resource area was lower than both other areas, which could have implications for duck hygiene, because ducks spend time resting in the vicinity of the water resource (Jones et al., 2009). There was no interaction between treatment and area of the pen, indicating that even in the pens provided with nipples the straw near the water resource was significantly wetter than straw in the other pen areas. However, overall the DM% of straw in the nipple treatment was higher than in the plasson treatment in this study. These results illustrate the negative effect that even a water resource that permits limited access to water can have on bedding DM%. The lack of a treatment effect in Study 2, where treatments ranged from whole body access to beak only access to water, shows how a properly constructed drainage area can greatly reduce contamination of bedding with water from even an open water resource.

During both studies, liveweight in all treatments increased to approximately 4kg, and mortality rates were below 5%. Thus none of the treatments appeared to have a negative impact on production, compared with industry norms (Dawkins, 2008). Although there was no effect of treatment on liveweight in study 1, in study 2, birds with access to both of the resources that permitted at least whole head access to water (i.e. trough and bath) overtook the narrow plasson treatment with regard to liveweight, so that by the end of the study liveweight in the BATH treatment was significantly higher than in the NARROW. Erisir et al. (2009) also found that ducks that had access to a water pool (similar in dimension to the one used in our study) had a higher liveweight after six weeks than ducks without access to open water. In particular, this was the case when ducks had access to an outdoor exercise area. That paper concluded that a management system that was more ‘natural’,i.e. outdoor access, combined with a facility that permitted expression of normal water associated behaviours, resulted in the increased growth.

However, in an intensive system, access to a pool had a numerically negative effect on duck liveweight (Erisir et al., 2009). The authors hypothesised that provision of open water in this situation resulted in negative environmental consequences such as increased ammonia concentration and poor litter quality, and caused this result. Dawkins (2004) concluded that the most likely environmental factors that have a negative effect on broiler chicken welfare, including growth rate, are litter moisture and ammonia concentration. Our finding that the bedding study 1 became very wet indicates that environmental conditions could have been less favourable for these birds than in the dryer nipple treatment. Thus any positive impact on bird health of increased access to water, compared with nipples, must be carefully monitored when the water resource is located directly on the bedding. In study 2 there was no difference in bedding DM even between the bath and narrow plasson treatments, probably because the water resources were all located over a drainage area separate from the bedding.

In study 1, our finding that ducks with access to the wide lip plassons were less clean than ducks in the nipple treatment was unexpected, because we hypothesised that the greater level of access to water would enable the birds to preen more effectively. However, the lower DM of the straw in this treatment could have contributed to higher (ie.poorer) hygiene scores. Behavioural observations carried out in a sister study to this one, indicate that ducks spend much time resting in the vicinity of the water resource. This is in agreement with Jones et al. (2009), who found that ducks with access to nipples only did not rest near the water resource, whereas ducks with access to showers, baths and troughs did. Wet bedding has also been linked to increased dirtiness in dairy cattle (O'Driscoll et al., 2008), and thus probably the cause of poorer plumage hygiene in the wide plasson treatment. Moreover, dirtiness of birds in both treatments in study 1 increased over time, which indicates that the level or quality of preening activity was not sufficient even to maintain a constant level of hygiene throughout the study, but that dirt continued to accumulate on the feathers over time.

During study 2, however, an increase in level of access to water resulted in a corresponding reduction in feather dirtiness score. This could be because the position of the water resources over a drainage area meant that when ducks rested next to the resource they were not exposed to wet bedding. Moreover, dirtiness scores in all three treatments were lower on d 43 than on d 35, again in contrast to results from study 1, where dirtiness scores continued to increase over time. Briese et al. (2009) found that preening bout duration, and the percentage of ducks interacting with a water resource, either a shower or a modified plasson, increased with age, as do preliminary results from a sister study to this one, using similar treatments. It is likely that increased interaction with the water resource as ducks age could explain the improvements in duck hygiene over time.

In both studies, birds that were provided with water using plasson drinkers had worse gait scores than birds in the other treatments. It is not intuitively clear why this should be the case. However, what is evident is that gait scores in these treatments do not appear to be related to foot-pad dermatitis scores, because there was no significant effect of treatment on these scores in either study. The plassons in both studies were suspended by an individual support, and thus were able to swing from side to side, which could possibly have injured some birds. However, further work is necessary in order to determine whether this is the case.

Contact dermatitis is a skin condition in poultry that is associated with wet bedding and the chemical effect of ammonia, which is generated from urea in the bedding (Haslam et al., 2007; McIlroy, 1985). The disorder manifests itself as ulcerations to the feet (foot pad dermatitis), hocks (hock burn) and breast (breast burn), and is likely to cause pain, due to tissue trauma. During this study we did not see any evidence of hock- or breast-burn, and lesions were usually scored as 1. In fact, during study 1, when there was a tendency for birds in the plasson treatment to have higher average scores than birds in the nipple treatment, the frequency of score 2 was 10 in the plasson treatment and 9 in the nipple treatment. This is out of a total of 1,000 feet examined. Thus, none of the water facilities within the management systems utilised appeared to result in bedding conditions that could have an important adverse effect on skin health.

There was no effect of treatment on eye score in either study, which was unexpected, because we hypothesised that birds that had access to open water would have better eye health than birds with limited access, as has been reported in previous studies (Jones et al., 2009; Graham and Sandilands, 2001). In both studies, average eye scores decreased (improved) on the second examination day, then gradually increased (deteriorated) until the end of the experiment. When scoring the birds, it was noted that eye score could have been affected by the emergence of adult plumage.

In both studies, more ducks had dirty nostrils in the treatments with the most restricted access to water (i.e. the nipple and chicken plasson treatments). However, in study 2, ducks in the plasson treatments also had more blocked nostrils than birds in the other two treatments, which permitted whole head access to water. Moreover, in that study, more ducks had clean nostrils as the study progressed, implying that overall, these treatments improved the ability of the birds to keep their nostrils clean. Thus although chicken and turkey plassons provide the birds with an opportunity to wet their beaks, it seems that immersion of the head under water is necessary to ensure that nostrils remain unblocked, and improves nostril cleanliness over time. Jones et al. (2009) also found that ducks with only access to nipples had dirtier beaks than ducks that had access to troughs, baths and showers.

CONCLUSION

Overall, provision of water in a trough or bath appears to improve duck welfare, indicated by improved feather hygiene, fewer blocked and dirty nostrils, and increased liveweight. However, access to open water resources should be provided over a properly constructed drainage area in order to minimize contamination of bedding with excess water. Further work should be carried out to investigate the feasibility of provision of water in troughs and baths at a commercial scale.

ACKNOWLEDGMENTS

We thank Cherry Valley Ducks for supplying animals, facilities and practical help, Sophie Bridges for help with data collection and Dr Andreas Briese for advice on methodology.

REFERENCES

British Poultry Council. 2008. Sector groups – duck sector. http://www.poultry.uk.com/who_duck01.htm Accessed 2 July 2008.

Briese, A., Hansch, F. and Hartung, J. 2009. Water provision for muscovy ducks – behaviour at duck showers and modified plasson drinkers. Berliner und Münchener Tierärztliche Wochenschrift. 122:302-313.

Broom, D.M. 2006. Behaviour and welfare in relation to pathology. Applied Animal Behaviour Science 97: 71-83.

Broom, D.M. 2008. Welfare assessment and key ethical decisions: key concepts. Annual Review of Biomedical Sciences 10: T79-T90

Dawkins, M. 2008. Study to assess the welfare of ducks housed in systems currently used in the uk. DEFRA Research Project Final Report.

http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=12671 Accessed 15 October 2009.

Dawkins, M.S., Donnelly, C.A. and Jones, T.A. 2004. Chicken welfare is influenced more by housing conditions than by stocking density. Nature 427:342-344.

DEFRA. Department for Environment, Food and Rural Affairs. 2008. Codes of recommendations for the welfare of livestock – ducks. http://www.defra.gov.uk/foodfarm/farmanimal/welfare/onfarm/othersps/duckcode.htm Accessed 15 October 2009.

Erisir, Z., Poyraz, O., Onbasilar, E.E., Erdem, E. and Kandemir, O. 2009. Effect of different housing systems on growth and welfare of Pekin ducks. Journal of Animal and Veterinary Advances 8:235-239.

Graham, R.-L. and Sandilands, V. 2001 A comparison between two water delivery systems for laying ducks. British Poultry Abstracts 4:15-16.

Haslam, S.P., Knowles, T.G., Brown, S.N., Wilkins, L.J., Kestin, S.C., Warriss, P.D. and Nicol, C.J. 2007. Factors affecting the prevalence of foot pad dermatitis, hock burn and breast burn in broiler chicken. British Poultry Science 48:264-275.

Kestin, S. C., T. G. Knowles, A. E. Tinch, and N. G. Gregory. 1992. Prevalence of leg weakness in broiler chickens and its relationship with genotype. Veterinary Record 131:190–194.

Knierim, U., Bulheller, M.A., Kuhnt, K., Briese, A. And Hartung, J. 2004. Water provision for ducks kept indoors – a review on the basis of the literature and our own experience. Deutsche Tierärztliche Wochenschrift 111:115-118.

Martland, M.F. 1985. Ulcerative dermatitis in broiler chickens: the effects of wet litter. Avian Pathology 1:353–364.

Jones, T.A., Waitt, C.D. and Dawkins, M.S. 2009. Water off a ducks back: Showers and troughs match ponds for improving duck welfare. Applied Animal Behaviour Science 116:52-57.

O'Driscoll, K., Boyle, L., French, P. Meaney, B. and Hanlon, A. 2008. The effect of out-wintering pad design on dirtiness score, somatic cell score and mastitis incidence in dairy cows. Animal 2:912-920.

RSPCA. Royal Society for the Prevention of Cruelty to Animals. 2009. RSPCA welfare standards for domestic/common ducks. April 2009. http://www.rspca.org.uk/servlet/Satellite?blobcol=urlblob&blobheader=application/pdf&blobkey=id&blobtable=RSPCABlob&blobwhere=1137587641378&ssbinary=true Accessed 15 October 2009.

SAC (Scottish Agricultural College). 2008. Ducks for the table http://www.sac.ac.uk/consultancy/farmdiversification/database/novellivestock/ducksforthetable Accessed 2 July 2008.

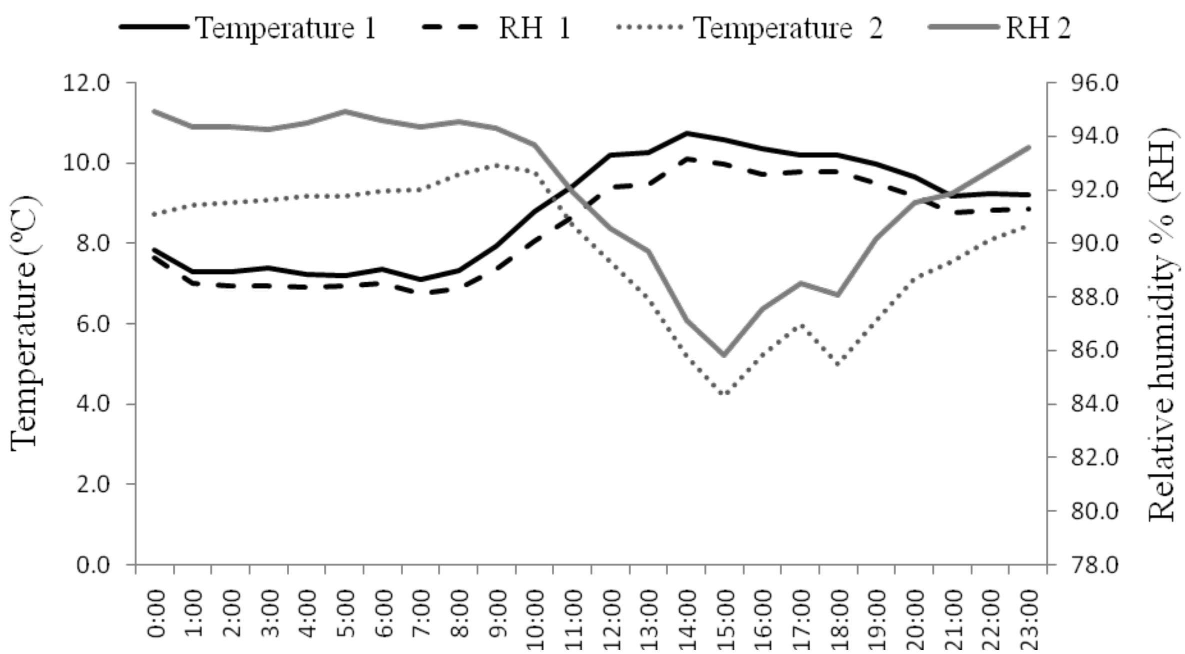

Figure 1. Least Squares mean temperature (ºC) and Relative Humidity (RH) (%) in both studies between 10 and 19 February.

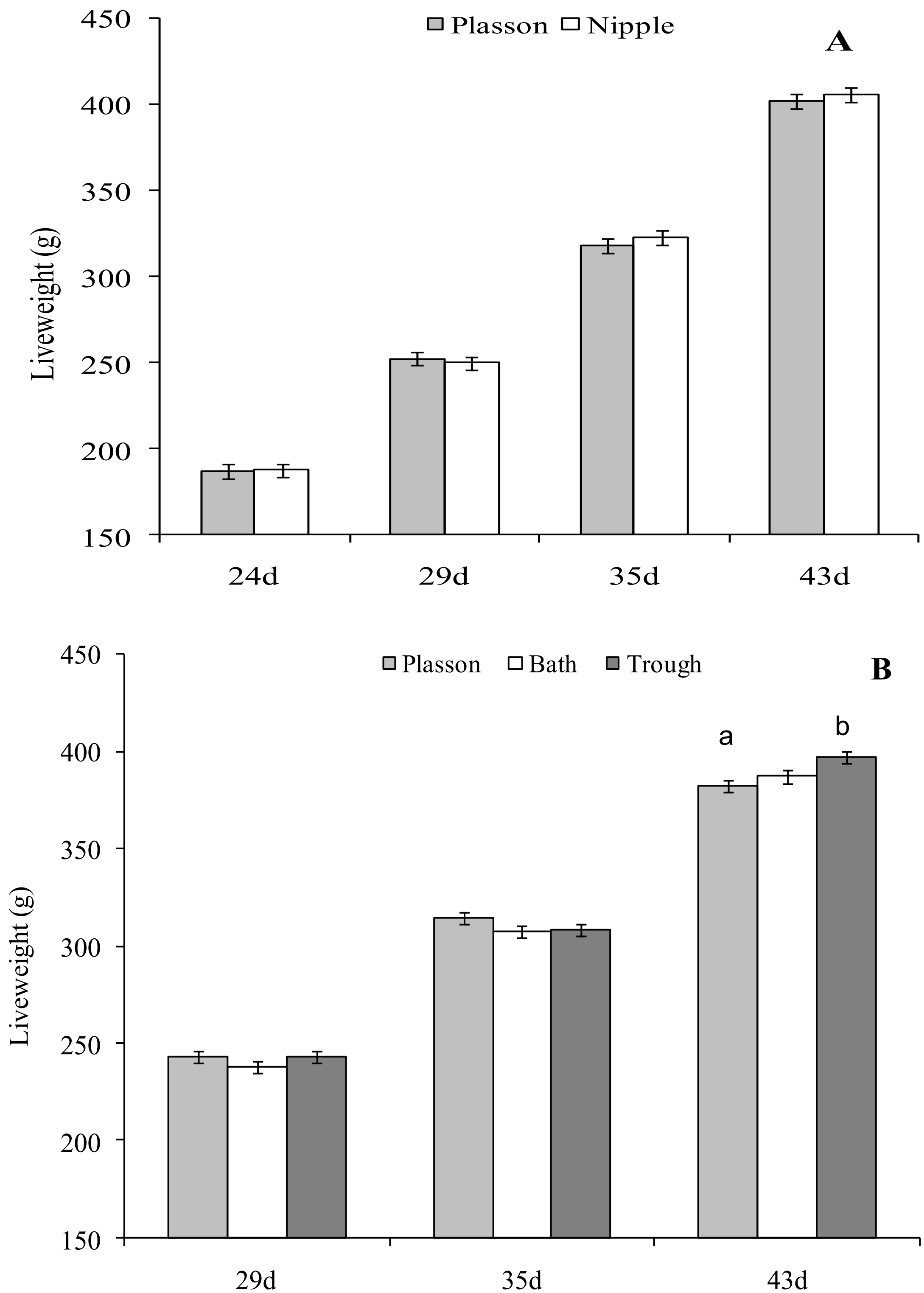

Figure 2. Liveweight of birds in study 1 (A) and study 2 (B)

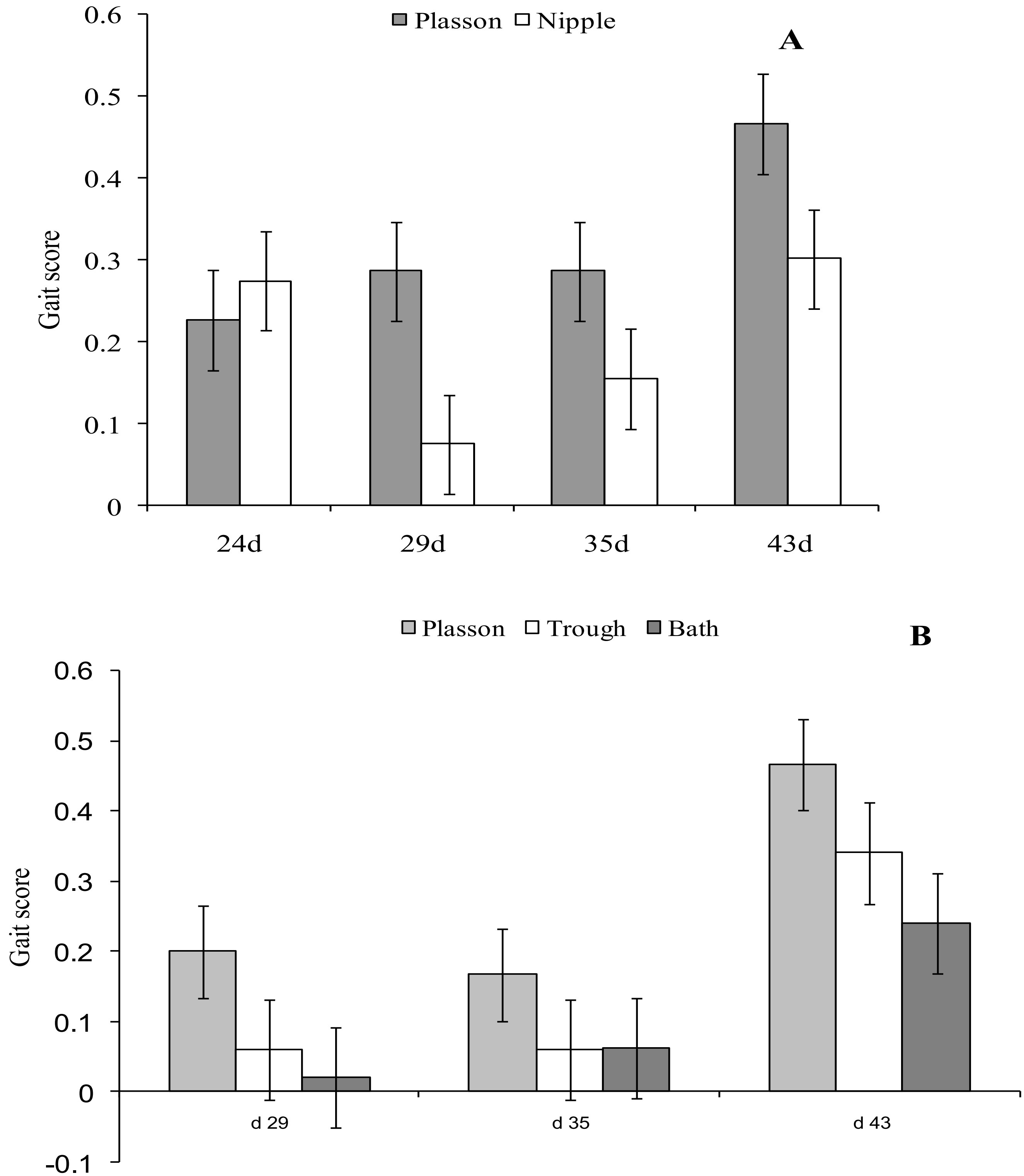

Figure 3. Gait scores of birds in study 1 (A) and study 2 (B)

Table 1. Scoring systems used for recording of bird health parameters.

Measure	Score	Definition
Feather hygiene	0	Minor soiling on less than 10% of feathers, or one small patch of heavy soiling
	1	10%- 40% of feathers affected, soiling minor to moderate/ up to 25% affected with heavy soiling
	2	40% to 75% of feathers affected, soiling minor to moderate/ 25% to 60% affected with heavy soiling
	3	Over 75% of area affected, soiling minor to moderate/ over 60% of area affected with heavy soiling
Gait scores	0	Perfect gait
	1	Detectable but unidentified abnormality e.g. uneven gait
	2	Identifiable abnormality but little effect on overall function e.g. lame in one leg or crossed legs, but 'normal' speed
	3	Identifiable abnormality and impaired function. Obvious gait defect, and bird has difficulty moving
	4	Severely impaired gait. Extreme gait defect, movement is extremely slow, and only after much encouragement, bird sits at first opportunity
	5	Completely lame, mobility severely affected. Bird cannot walk, and only mobile by shuffling on hocks or wings
Foot pad dermatitis	0	Skin intact with no lesions/ slight roughness but no evident inflammation or discoloration

	1	Minor lesions: Some small areas (< 1 cm in diameter) of discoloration or redness.
	2	Moderate lesions: Obvious swelling and much discoloration, roughness, lesions > 1 cm diameter.
	3	Severe lesions: Severe swelling, scabbing and ulcers.
Eye score	0	Eye clean, normal colour, no inflammation
	1	Eye red rimmed/ weeping slightly/ slight crustiness
	2	Severely red around rim/ much weeping/ very crusty
	3	Eye not able to open fully/ eye closes
Nostril	0	Clean and clear
	1	Some blockage visible when viewed from side
	2	Nostrils entirely blocked on at least 1 side

Table 2. Temperature and RH recordings for Studies 1 and 2

	Datalogger location				
	1	2	3	4	P-value
Study 1					
Temperature (ºC)	8.8 ± 0.2	9.0 ± 0.2	9.5 ± 0.2	8.0 ± 0.2	0.001
RH (%)	89.9 ± 0.4	87.5 ± 0.4[c,f]	89.3 ± 0.4	92.2 ± 0.4	0.001
Study 2					
Temperature (ºC)	8.7 ± 0.2	8.0 ± 0.2	8.2 ± 0.2	8.6 ± 0.2	0.06
RH (%)	89.9 ± 0.4	93.0 ± 0.4	92.1 ± 0.4	93.0 ± 0.4	0.001

Table 3. Percentage of ducks in each treatment in study 1 that had dirty and blocked nostrils at each examination. D = dirty nostrils (including blocked nostrils); B = blocked nostrils

	16		24		29		35		43	
Treatment	D %	B %	D %	B %	D %	B %	D %	B %	D %	B %
Nipple	74	38	72	38	70	34	66	28	68	38
Plasson	70	22	60	40	46	24	24	12	56	34

Table 4. Percentage of ducks in each treatment in study 2 that had dirty and blocked nostrils at each examination. D = dirty nostrils (including blocked nostrils); B = blocked nostrils

	21		29		35		43	
Treatment	D %	B %	D %	B %	D %	B %	D %	B %
Plasson	38	8	48	17	48	20	35	15
Trough	44	10	26	2	22	8	8	0
Bath	30	4	8	2	28	4	10	8