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Review

Turkey farming: Welfare and husbandry issues

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A review was undertaken to obtain information on the major welfare issues associated with turkey farming. In the hatchery there are some negative effects of long term storage of turkey fertile eggs on post-hatch growth and quality of chicks. There is a view that free range turkeys housed on deep litter in naturally ventilated sheds with natural light and access to forage and shelter belts is beneficial to bird welfare. However, an increase in mortality in the last few weeks of growth can be caused by very hot or cold environmental temperatures. Turkey welfare can be compromised at high stocking density. The selection of fast growing strains of turkeys has resulted in leg and locomotory problems. Mortality rates in turkeys caused by gait problems range from 2 to 4%. However, intermittent lighting improves bird activity and a decrease in locomotory problems. Under commercial conditions, domestic turkeys are often aggressive towards other birds. Beak treatment is used to prevent injuries caused by cannibalism, bullying, and feather and vent pecking with infrared beak treatment the most common trimming method used. However birds that have been severely beak treated can develop chronic pain. The barren environment of turkey houses has been identified as a major cause of poor animal welfare and responsible for cannibalism. Use of straw bales in the shed and elevated platforms gives the bird the chance to explore the environment and reduce pecking. Foot pad dermatitis (FPD) is a common condition in turkeys and is largely caused by wet litter. Apart from bird flu, Blackhead is one of the most serious poultry diseases in turkeys. Mortality can reach 70% in some flocks. Good management is essential to maintain turkey health and welfare including taking action to minimise contact of turkeys with wild birds and other animals. Pick-up of turkeys from sheds for transport to processing plant can result in welfare concerns. Mortality has long been a concern in relation to turkey transport. During this procedure the heads or wings of the birds can be injured against the solid sides of the crates, birds are exposed to temperature extremes, sudden acceleration and braking of the vehicle, vibration, fasting, injuries, social disruption and noise.

Key words: Turkey, welfare, cannibalism, beak treatment, stocking density, cannibalism, transport.

INTRODUCTION

For turkey meat birds to meet their genetic potential in growth there is a need for farmers to use best practice husbandry and management (Case et al., 2010). Good nutrition is a key factor in achieving high growth rates and good meat yield but management factors such as shed temperature and lighting also influence growth. Turkeys are raised on the floor in modern intensive barn systems and on free range farms and at the end of the growing period are transported to an abattoir where they are stunned and slaughtered (Hartung et al., 2009).

Welfare considerations associated with turkey production are becoming increasingly important (Kijowski et al., 2005). Genetic selection for rapid growth and higher body weight has resulted in health problems. Natural mating by commercial turkeys is difficult due to their high body weight and poor ability to mate. High

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stocking density on farms causes poor air quality and contributes to cannibalism as well as difficulty in inspecting all the birds. Farm procedures like catching, transport and slaughter can cause welfare problems for turkeys. Stress associated with transport especially in inappropriate containers on long journeys results in poor carcass quality. Stunning and slaughter can also have a high impact on animal welfare. To prevent cannibalism, turkeys are raised under low light intensity or are beak treated which may also result in a welfare concern (Ostovic et al., 2009). Poor welfare of breeding birds results from restricted feeding programs, and use of forced molting to control their body weight. There has been an increasing move toward organic poultry production in free range systems to overcome the issue of raising turkeys in sheds with high stocking density.

Housing systems can have a high influence on animal welfare. Turkeys grown in a traditional farming system are preferred by consumers (Kijowski et al., 2005) and there is a strong move toward producing organic poultry and the selection of slow growing lines which have better meat quality. Slaughter of such lines is usually carried out at about 25 weeks. Organically produced turkeys are kept mainly in Germany and the UK (Zeltner and Maurer, 2009). The organic diet must be sourced from ingredients grown without fertilisers, herbicides and insecticides. In some organic diets no synthetic additives are permitted in the diet. Organic is a term defined by law and all organic meat producers are governed by a strict set of guidelines, including registration and certification, production, permitted and non-permitted ingredients, the environment and conservation, processing and packing. This paper identifies the major welfare issues in turkey industry and the extent to which welfare is compromised.

Definition of welfare

There has been considerable debate about how animal welfare should be assessed (Fraser, 2003; Sandøe et al., 2004) with many definitions provided for animal welfare. The variation in both the definition and methods of assessing welfare has resulted in considerable debate and disagreement on how welfare should be assessed and interpreted in most farmed species (Hemsworth and Coleman, 1998). In this review we use the following definition: the provision of good welfare for turkey means meeting high standards of husbandry which includes care of animals, good housing, protection from the environment, maintaining good health, preventing disease, recognising and treating disease, providing good nutrition and good stockpersonship.

Assessment of turkey welfare

The Brambell Committee (Brambell et al., 1965) recommended all animals are entitled to good welfare and defined the basic freedoms. In Europe a project (LayWel, 2006) developed a series of welfare assessment protocols for laying hens. However no such protocols have been specifically developed for assessing turkeys although all aspects of the welfare of turkeys from placement on the farm and transport to the processing plant are summarised in a report on the welfare of turkeys by the Farm Animal Welfare Council (FAWC, 1995).

The layer welfare assessment system in LayWel (2006) has an emphasis on scoring animals according to their health status, feather cover, injuries and behaviour. The welfare scores reflect how the bird is interacting with its environment. Current methods of assessing welfare in the turkey industry have concentrated on assessing the impacts of housing and husbandry on production, behaviour and physiology. To assess bird welfare it is important that observations and measurements are made on individual animals. For example the poultry welfare quality project (LayWel, 2006) used the welfare freedoms as the basis for assessing bird animal welfare and focused on 4 welfare categories. These included; 1) injury, disease and pain; 2) hunger, thirst and productivity; 3) behaviour and 4) fear, stress and discomfort. Scores were given for a range of welfare risks in the various poultry production systems. The findings suggest that birds housed in more intensive systems are at a greater welfare risk and this may also apply to turkeys. Beak treatment is a controversial husbandry practice in turkeys. Beak treatment methods used have included using a cold blade, hot blade, biobeaker and the infrared method. One approach has been to assess welfare of beak treated birds on the basis of their performance. The results from these studies showed that the husbandry practice of beak treatment has a positive impact on bird welfare by reducing injuries to other birds, but the initial impact from the treatment was to cause a reduction in growth.

Another approach that has been used to determine the welfare impact of beak trimming was to assess the potential chronic pain in the beak stump by making an anatomical assessment of the incidence of neuromas. The presence of neuromas is an indicator that the bird may be feeling chronic pain in the beak stump and is a negative emotion that birds may experience as discussed by Duncan and Fraser (1997).

The welfare state of birds has also been assessed using preference and behavioural demand tests (Dawkins, 1980). These tests determined if preferences are influenced by the animal's feelings and place a value on the bird's choice (Dawkins, 1983) particularly when an evaluation is made of how hard the animal works to obtain their preference. In the case of turkeys preference testing of beak trimmed versus control birds has not been evaluated in terms of the resources they will select and if there is a decline in the strength of their demand to access a facility or resource because they may be feeling pain from beak trimming.

A further approach that has been used to assess welfare of turkeys has been to assess the effect of various stocking densities and lighting regimes on bird behaviour. Dawkins (2003) indicated it is difficult to attribute poor welfare in birds if certain behaviours are absent. More recently there has been a greater emphasis on behavioural indicators of poor coping such as fearfulness, aggression and stereotypies.

Embryo and chick mortality

Adoption of best practice fertile egg handling, storage, incubation and hatching conditions ensures hatched chicks have optimum health and welfare. There are some negative effects of long term storage of turkey fertile eggs. Storing fertile eggs for more than 1 week increases embryonic abnormalities and chick mortality which is a welfare issue. For example when eggs are stored for 4 days there are fewer chicks that die at hatch, better hatchability is achieved and there is reduced incubation time compared with eggs that are stored for 14 days. Post-hatch growth and quality of chicks and poults from fertile eggs stored for long periods also suffers (Fasenko, 1997).

Housing system

There are 3 types of turkey production systems; conventional, barn and free-range. In conventional housing, commercial turkeys are kept in enclosed houses (some with side curtains) with environmental control of heating, ventilation and lighting. Sheds can house up to 20,000 birds and on larger farms the turkeys are usually distributed across a number of sheds. Turkeys are grown to a variety of ages from 3 to 5 months depending on the strain used. Stocking density is adjusted by moving birds to other sheds or having a pickup for early slaughter.

In the free range system turkeys are housed on deep litter in naturally ventilated sheds with natural light and have access to forage and shelter belts. Kijowski et al. (2005) indicates that the free range system is beneficial to bird welfare. However, Herendy et al. (2004) found that carcass yield decreased in male and female birds housed in the extensive system. Burs and Faruga (2006) also noted problems in the outdoor system and found an increase in mortality in the last two weeks of growth (20 to 22 weeks) due to ground frost at night. Burs et al. (2007) reported no significant changes in blood plasma biochemistry of turkey-toms kept in a shelter with access to open-air runs compared to those raised traditionally in a brooder house. Birds kept in a free range system have a lower incidence of Foot Pad Dermatitis (FPD) compared to intensive systems (Sarica and Yamak, 2009, 2010) presumably because birds have greater exposure to damp litter while indoors.

Selection for high growth rate

The merging of the genetic stocks within a small number of individual companies has increased the demands on breeders to minimise disease risk, to maintain diverse genetic pools and to have appropriate breeding goals (Wood et al., 2006). However, the selection of fast growing strains has resulted in leg and locomotory problems for turkeys (Nestor, 1984; Nestor et al., 1985), higher mortality rates particularly under intensive housing conditions (Martrenchar et al., 1999). Fast growth has been accompanied by internal organs (such as the heart and lungs) lacking the capacity to meet the demands of metabolism. Birds have greater difficulty coping with heat stress (Yahav, 2007). Injuries on the back of the female from the claws of the male during mating are another issue that has emerged as a result of genetic selection for fast growing strains (Rauw et al., 1998). As a consequence, natural mating by breeder turkeys is very difficult due to their size and weight and artificial insemination is normally practiced by breeder farms.

ENVIRONMENT

Brooding

Supplementary heat is required for five weeks when brooding turkey poults in winter. Tom turkey poults require supplementary heat also during late summer because they are not yet fully feathered and the digestive system has not yet fully developed (Gencoglan et al., 2009).

Heat stress

Heat stress is major welfare problem in the turkey industry. Huge economic losses can occur because of mortality and decreased production due to high environmental temperatures. The utilization of food additives to improve poultry welfare during the hot summer months is essential under farm production conditions. Ascorbic acid has often been provided as a supplement to minimize the impact of heat stress. However, studies on ascorbic acid supplementation in the diet during summer showed that there was no improvement in body weight, feed intake, feed conversion ratio, slaughter weight, carcass yield, composition and thigh and breast pigmentation and shank and tibia bone characteristics (Konca et al., 2008). On the other hand addition of 1% of arginine to the feed contributed to a significant improvement in turkey breeders' welfare during summer. Birds showed more frequent dust-bathing, improved egg-laying and sexual behaviour and there was less aggression among birds (Bozakova et al., 2009). The heat stress for young turkeys (assessed by body temperature and surface temperature) when exposed to environmental temperatures from 25 to 35°C can be alleviated using mechanical ventilation from 1.5 to 2.5 m/s (Yahav et al., 2008).

Air quality

Ammonia and other toxic gases need to be kept below certain levels for bird health and also to maintain good production. If excessive, they reflect inadequate ventilation or poor litter management. Ammonia levels greater than 10 ppm can reduce feed intake with effects on body weight and production. It can cause lesions of the air sacs and cause inflammation of the cornea and conjunctiva (Carlile, 1984). Also, because stock people find high ammonia concentrations aversive, they are likely to give birds only a cursory examination during routine inspections and this could delay diagnosis of health problems. While there is some argument over whether birds can smell ammonia, the evidence of adverse effects on birds exposed to ammonia would suggest they are at least as sensitive as people (Wathes, 1998).

Ammonia concentrations increase with wet litter. Corrective action needs to be taken if concentrations exceed 20 ppm at the level of the bird. Patches of wet litter need to be removed from the shed and replaced with dry litter. Humans can smell ammonia at a level of 10 to 15 ppm; it irritates eyes and nasal mucous membranes at concentrations of 25 to 35 ppm. Thus, if there is an ammonia smell there is a potential air quality problem. In free range paddocks birds may create boggy patches in water which can also result in odour problems (albeit not ammonia). Ammonia concentrations (and other gaseous odours) are considered critical to bird welfare. Hydrogen sulphide is highly toxic to humans (and animals) with adverse clinical symptoms occurring above 10 ppm. If it can be smelt there is a serious ventilation problem. Its main source is from the anaerobic decomposition of faeces/manure and this is more likely to occur if litter becomes wet and caked. CO_2 cannot be detected by smell. At normal concentrations (0.3% or 3,000 ppm) CO_2 is involved in the regulation of respiration. Thus, if CO_2 in the atmosphere increases, this results in an increased respiration rate which functions to minimize the increase in body CO_2. Another noxious gas that is also odourless and colourless is carbon monoxide; concentrations should be below 50 ppm. Carbon monoxide can bind with haemoglobin in the blood much more easily than oxygen (210 times faster) and this drastically reduces the amount of haemoglobin available to carry oxygen. Exposure to all these odours may affect the respiratory system leading to health problems for turkeys (Fallschissel et al., 2009).

In domestic poultry there is a strong relationship between production and welfare (Al Homidan et al., 1998; Feddes et al., 1995; Hayter and Besch, 1974; Kristensen et al., 2000). The immunological challenges often associated with poor air quality can lead to a reduction in feed intake and production (Kelley et al., 1987; Kemeny, 2000). Airborne particles could also increase the susceptibility of birds to diseases through irritant action or via allergic reactions (Harry, 1978). It is likely that improving air quality in turkey houses could improve production and provide a better working environment for stockpersons. Wathes (1998) indicated that the minimum ventilation rate required to provide acceptable levels of atmospheric dust should be 3.66 m^3/h/kg. High NH_3 concentrations in broiler and turkey houses can adversely affect bird performance. Acidifiers have been used in poultry houses to reduce NH_3 levels. The metabolic biostimulant, Bio-Kat reduced NH_3 concentration by 61% in the exhaust air of treated litter compared with untreated litter. The Bio-Kat treatment was most effective during the first 10 to 12 days, and its efficacy decreased over time (Shah et al., 2007). Reuse of litter also increases NH_3 emission rates by 130% compared to fresh litter while variability of NH_3 emission rates between houses can occur due to differences in the way litter is managed (Gay et al., 2006).

Air quality and environmental enrichment

There has been some work on providing an enriched environment for turkeys to reduce boredom and encourage locomotory behaviours. The behaviour of turkeys provided with elevated levels, straw bales and access to an open area were assessed in terms of air quality inside the barn as well as health and welfare of birds and humans and the resulting emissions into the environment (Hinz and Berk, 2002). Mean values of dust concentration were mostly below accepted limits (dust 3 mg/m^3, NH_3 20 ppm, CO_2 3000 ppm). The concentration of endotoxins ranged from a few hundred to 12 000 ng/m^3 with an overall average of 3000 ng/m^3. It was concluded that enriching the environment in turkey sheds by providing structures had no negative effects on animals' or farmers' health and welfare.

Lighting and turkey welfare

Photoperiod

A survey of the turkey breeder industry indicated that farmers have a good understanding of light management (Grimes and Siopes, 1999). Most farmers provide turkeys with 14 to 15 h of light daily with some farmers using day lengths of 16 to 18 h. Sodium lights were the most common light source, followed by incandescent and fluorescent light. However the EU has set new energy efficiency requirements for lamps. Incandescent light and halogen bulbs are being replaced by more energy-efficient bulbs.

There is a welfare view that there should be at least 6 h period of continuous darkness every 24 h and that intermittent lighting program should be avoided due to the increased incidence of leg abnormalities (Clarke et al., 1993). Most farmers do not use intermittent or step-down/step-up lighting programs although research indicates these programs improve gait (Classen et al., 1994) and reduce leg problems (Hester et al., 1986) due to an increase in bird activity. However, there has been some use of intermittent programs, because when the light is switched on there is an increase in bird activity which results in a higher feed intake and a decrease in locomotory problems (Hester and Kohl, 1989) and reduced pecking (Lewis et al., 1998). However a light regime of 8 periods of IL:2D reduced injuries caused by wing and tail pecking but increased injuries due to head pecking (Sherwin et al., 1999).

Light intensity

To prevent outbreaks of feather pecking, bullying and cannibalism the light intensity in sheds is usually maintained at low levels with turkeys preferring intensities of 5-25 lux (Sherwin, 1998). At low light levels turkeys find it difficult to explore the environment and they develop eye problems (Siopes et al., 1984). In addition stockpersons cannot detect birds that are being pecked, sick or need culling. No behavioral differences were observed between turkeys provided 10-80 lux (Denbow et al., 1990) although Barber et al. (2004) showed that turkeys have some preference for temporal variation in the lighting. Turkeys spent most of their time in the brightest light at 2 weeks of age, but in 20 and 200 lux at 6 weeks. At 2 weeks of age, all behaviours were observed to occur most often in 200 lux. At 6 weeks, resting and perching were observed least often in <1 lux, whereas all other activities were observed more in the two brightest light environments.

Yahav et al. (2000) observed that body weight of 18 week-old turkeys, was highest under the lowest light intensity of 10 lux and coincided with higher weight gain and lower food intake and better food conversion efficiency. Light intensity affected heart muscle weight but not the weight of breast muscle or abdominal fat. It was suggested that differences in feed conversion were related to differential investment of energy expenditure for maintenance.

Beak treatment

Under commercial rearing conditions, domestic turkeys are often aggressive towards other bird which can lead to serious injuries or even death. Aggressive encounters and injuries due to head, feather and tissue pecking seriously threaten the welfare of domestic turkeys and also result in economic losses for the turkey industry. Turkeys will exhibit an increase in aggression when unfamiliar birds are housed together but a marked drop in aggression occurs as they become familiar with each other (Buchwalder and Huber-Eicher, 2003, 2005). At present beak trimming is unavoidable if turkeys are reared in naturally ventilated sheds where light intensity cannot be controlled.

Methods of beak treatment

Following the development of the hot blade beak trimming machine in 1943 there have been refinements to the machine including some control of cutting and cauterisation and control of blade temperature. The Lyon Electric Company in San Diego, California has been manufacturing hot blade machines for beak-trimming turkeys for over 60 years. The Lyon Company (1982) suggest that precision beak-trimming of 6 to10 day-old turkey poults is one of the most accurate methods available. The machines have a timed cauterisation of 2 s and Lyon suggests that properly done, this method of beak-trimming will suffice for the productive life of the bird (Glatz, 2000).

The electric arc beak trimming machine uses a high voltage electrical current to burn a small hole in the upper beak of turkeys. In the 1980's the Bio-Beaker (Sterwin Laboratories, Millsboro, Delaware, USA) was developed which used a high voltage arc (1500 Volt AC electric current) across two electrodes to burn a small hole in the upper beak of turkeys. The primary advantage of the electric arc trimmer is that an adequate beak-trim is achieved during the first day of life, making the unit ideal for use in the hatchery. This allows treated birds to eat and drink normally for the first few days with their beaks intact. In turkeys, (Grigor et al., 1995) the beak tip fell off in 5 to 7 days and the wound healed by 3 weeks (Grigor et al., 1995; Noble and Kestor, 1997).

Since 2002, infrared beak treatment has been introduced and is by far the most popular methods used worldwide. It is an innovative procedure and uses an infrared (IR) energy source to treat the beak (Glatz, 2005). Immediately following treatment, the beak looks physically the same as it did before treatment and the bird is able to continue to use its beak normally. The IR method has proven to be safe, effective and the most welfare friendly method currently available of controlling cannibalism and feather pecking in poultry. Birds are restrained on a circular carousel using a head restraint and infrared energy is focused on the area of the beak being treated. The heat generated by an IR lamp penetrates the beak's outer layer to the epidermis. Damage to the epidermal layer, inhibits further germ layer growth. Immediately after treatment, the beak remains intact with the beak tip adjacent to the treatment line appearing lighter in colour due to reduction in blood flow to the treated area of the beak. There is no blood loss or open wound exposure. The equipment can be adjusted for various exposure times, levels of IR energy, and amount of beak treated. The beak tissues exposed to IR energy generally slough off after a few weeks giving the bird a blunted beak (Glatz, 2005).

Welfare issues associated with beak treatment

Jongman et al. (2008) indicated that the objections to the use of beak trimming in domestic poultry include the removal of sensory receptors, with a subsequent reduction in feed intake, pecking efficiency, pecking preferences, permanent loss of temperature and touch responses, behavioural evidence (hyperalgesia and guarding behaviour) for persistent pain and the potential for loss of magnetoreception (Mora et al., 2004). The adverse effects of beak trimming can be divided into; 1) acute pain while the procedure is performed (Grigor et al., 1995) until several days later (Lee and Craig, 1990), 2) sensory deprivation during a large part of the animal's life (Hughes and Michie, 1982; Gentle et al., 1997), and 3) chronic pain as a consequence of the formation of neuromas (Breward and Gentle, 1985; Gentle, 1986a; Lunam et al., 1996). Traumatic neuromas in the beak stump after trimming have been implicated as a cause of chronic pain in commercial hens (Breward and Gentle, 1985; Gentle, 1986b; Lunam et al., 1996).

In turkeys, a study on male turkey poults compared the effects of beak trimming (IR, hot blade and the electric arc methods) versus non-trimmed controls. Birds were fed either mash or crumbles. Beak trimming method did not affect time spent in feeding, foraging, drinking, preening, standing, or walking, nor did it affect body weight (Kassube et al., 2006; Noll and Xin, 2007). In the poults fed mash, feed efficiency was improved in all beak trimmed groups compared to controls. Up to 6 weeks of age, there was greater mortality in the group trimmed by the hot blade method compared to the control and the hot blade trimmed group showed the most beak re-growth (Noll and Xin, 2007). These results suggest that the amount of beak that was trimmed was insufficient to control feather pecking as indicated by the number of birds that had to be removed due to damaging pecking: 19% of controls and 21% of hot blade treated birds, compared to 7% of electric arc and 11% of infrared treated birds (Noll and Xin, 2006; Noll and Xin, 2007). This work would suggest that, in turkeys, infrared and electric arc beak trimming were preferable to either hot blade or no beak treatment although this depends on the amount of beak that is removed using the hot blade or treated using the IR and arc method. A study of the histology and pathology of infrared treated beaks showed that both upper and lower mandibles were damaged by IR indicating the method was no better for bird welfare than the electric methods (Fiedler and Konig, 2006). However, as suggested by Gentle and McKeegan (2007), the IR process is automatic and standardized and can be performed with a greater degree of control than mechanical methods. Ruszler et al. (2004) also noted that because the process is performed at the hatchery, birds undergo less handling and have a reduced risk of injury.

A recent study indicates that IR beak treatment does not result in chronic pain or other adverse consequences for sensory function (McKeegan and Philbe, 2012). By looking at the long term effects of IR beak treatment on birds up to the age of 50 weeks they found that re-innervation and scarring was visible, but no neuromas or abnormal proliferations of nerve fibres were observed at any age. However, Glatz and Hinch (2008) reported the presence of persistent traumatic neuromas in birds that had been IR beak treated. This was unexpected leading to the conclusion that the application of excess heat or excess tissue removal was responsible for neuroma formation which may not be typical of routine IR beak treatment (McKeegan and Philbe, 2012). The poultry companies that are using the IR technology are putting emphasis on optimizing the beak treatment process and retaining the maximum amount of upper and lower beak tissue that is adequate to control feather pecking and cannibalistic behaviours (pers. comm. Andrew Gomer, Novatech).

Alternatives to beak treatment

Beak-trimming has been used for many years as a standard method to prevent cannibalism (Glatz and Bourke, 2006) but the technique is coming under increasing scrutiny. Currently a number of European countries are working towards the EU Welfare Directive by legislating for a ban on beak trimming. The EU had earlier indicated this must be achieved by January 1, 2011 but a number of countries have delayed implementation. The aim was to eliminate welfare effects of beak trimming on birds namely; reduction in feed intake, pecking efficiency, and pecking preferences, loss of temperature and touch responses and magneto-reception and overcoming persistent pain. The costs associated with cannibalism are significant. Mortality from cannibalism can be greater than 20% depending on the production system and management strategies (Glatz, 2005). Alternative methods have not been fully evaluated but what is known is discussed.

Lighting

As reported above low light intensity can be used to prevent feather pecking and cannibalism in turkeys.

However, the poultry house must be light proof to use the low light intensity strategy. In some turkey houses natural daylight can pass into the shed through fan cowlings and stimulate pecking in birds. It has been shown that, in small groups of intact male domestic turkeys, supplementary ultraviolet radiation, visual barriers, and added straw (environmental enrichment) minimize the incidence of injurious pecking for birds housed under incandescent light at an intensity of 5 lux.

Groups of non beak-trimmed birds up to 5 weeks of age were assessed at higher light intensities when provided fluorescent light and incandescent light (Moinard et al., 2001). Fluorescent light significantly reduced the incidence of tail injuries, and tended to reduce injuries to the wings, compared with incandescent light. No difference was observed between 5 and 10 lux for either tail or wing injuries. The incidence of tail and wing injuries was significantly and positively correlated with light intensity. Injuries to the head were minimal in all treatments. These results suggest that turkey poults may be kept with minimal injurious pecking, under fluorescent light at an intensity of 10 lux, with appropriate environmental enrichment.

Environmental enrichment

A study investigated how intensively housed turkey hens used different elements of environmental enrichment (elevated plateaus with ramp, straw bales, racks with perches and batches of pallets) under practical rearing conditions on a farm. The animals preferred the enrichment structures early in their life but as they aged, the use of the environmental elements was reduced. The elevated plateau was significantly preferred to straw bales, batches of pallets and racks with perches. Environmental enrichment using elevated resting places such as plateaus and straw bales were preferred by turkeys and seem to have a potential to improve their welfare (Spindler and Hartung, 2009).

Two open-sided houses with male turkeys were enriched with raised platforms, round and square bales of straw and wire baskets filled with hay. One separate turkey house was left unenriched as the control. The enrichment structures influenced the resting behaviour. In both enriched houses, the total time of locomotor activity was significantly lower on square bales of straw and on raised platforms as compared to the non enriched groups (Letzgub and Bessei, 2009). In both enriched houses, animals showed more locomotion in the unenriched area compared to the raised platforms and square bales. In enriched houses even less locomotor activity was observed than in the free space, because the turkeys preferred the raised platforms and square bales of straw for resting.

Additionally, Berk et al. (2002) found that the activity of turkeys was related to the spatial distribution of their faeces. Accumulation of faeces was highest in the veranda section of the poultry house adjacent the range. Enrichment of the range with bushes or trees is required to encourage activities in the range to improve animal health and welfare and achieve an even distribution of faeces. It is suggested that free range areas be provided forage, shade and protection to the hens. In commercial poultry, claims are made that the provision of string enrichment devices will eradicate the propensity to feather peck and thereby eliminate the need for beak trimming (Jones and Ruschak, 2002). Likewise Renz and Walkden-Brown (2007) found that a string enrichment device reduced pecking in chicks. This form of enrichment is likely to sustain the birds' interest, to promote desirable 'natural behaviours' like exploration and foraging, to potentially reduce boredom, and to significantly reduce the expression of feather pecking as well as the amount of pecking-related feather damage. String has the added advantages of low cost, durability and ready availability. Its beneficial effects are considered unlikely to be constrained by genotype or housing system. String enrichment devices have been on a number of layer farms in Europe (Jones, 2005).

Surveys in Europe have shown that increases in pecking is related to poor litter condition. A number of authors have suggested that feather pecking and cannibalism in domestic poultry may be considered as redirected ground pecking, based on strong similarities in the performance of both behaviours. Blokhuis and Wiepkema (1998) report the main strategy to prevent feather pecking is to provide an adequate substrate. Substrate conditions during the rearing period affect the development of feather pecking and the use of scratch grain is recommended. During the rearing period Gleaves (1999) recommended the location of semi sold milk or whey blocks around the house, hanging green leafy vegetables and spreading grass clippings to prevent feather pecking. An alternative approach is to use scratching trays in the shed and provide high fibre grain to encourage more forage related activities in birds.

There is potential to improve the ranging ability of laying birds in free-range systems and get the birds out of the shed (where they tend to feather peck) by using shelterbelts, crop rotations (Miao et al., 2006), shade and sand baths. Improving the attractiveness of the range for birds is therefore an important aspect to investigate. Currently many range areas are just fenced open fields with hardly any cover. This does not allow birds the opportunity to seek shelter from weather or predators, or make the free range area stimulating for the birds to use (Hegelund et al., 2002).

Studies have shown that there is a positive relationship between the availability of cover and the percentage of laying birds in the range (Zeltner and Hirt, 2003; Hegelund et al., 2002; Nicol et al., 2003; Bestman and Wagenaar, 2003). Enrichment with shade and shelter and providing a variety of these facilities enables birds to meet their behavioral needs. Trees provide an area where birds can dust bathe (Dawkins, 2003), and seek shade and protection from predators. More birds use the range area when cloud cover is prevalent (Hegelund et al., 2002) and when man made shade areas are provided. The use of the range decreases as the flock size increases. A greater percentage of the birds use the range in small flocks compared to larger flocks (Hegelund et al., 2002; Hirt et al., 2000). Hens in the range usually remain close to the poultry house (Furmetz et al., 2005) and leave the area denuded of forage. However, when trees or shrubs or shaded areas are provided about 75% of hens in larger flocks will use the range (Bestman and Wagenaar, 2003). Nevertheless poor use of the range by hens remains a major issue in all free range systems. Birds are unable to hide from predators if there is no overhead protection provided by trees or other shaded areas. Even though feather pecking is reduced when the hens use the free range frequently, feather pecking remains a serious problem on free range farms (Bestman and Wagenaar, 2003, 2006). Reduced feather pecking occurs when birds are reared in the same facility, stocking density is low, high quality litter is used and perches are provided (Bestman and Wagenaar, 2003, 2006; Knierim et al., 2008). Further work on the use of the above facilities on free range turkey farms is required.

Nutrition

In laying hens an adequate amount of insoluble fibre in the diet appears to be important for minimising the outbreak of cannibalism in laying hens and may have relevance to turkeys. Millrun, oat hulls, rice hulls and lucerne meal are effective sources of fibre. It has been suggested that the physical properties of the fibre, modulate the function of the gizzard, giving the birds a calm feeling. In addition it has been suggested that the increased rate of digesta passage, increases hunger and results in laying birds spending more time eating and less time pecking (Choct and Hartini, 2005).

Genetics

Aviagen Turkeys is the premier supplier of turkey breeding stock worldwide, supporting the brands of B.U.T. and Nicholas. Aviagen Turkeys has pedigree breeding programs in the USA and Europe. In domestic poultry, Kjaer (2005, 2009) reported on the considerable interest in the genetics of feather pecking and cannibalism. It was considered that a genetic solution might be more sustainable, efficacious and cost effective than beak-trimming. Differences in the rate of feather pecking, quality of plumage and mortality from cannibalism between populations of domestic fowl are well documented. The nature of the genetic background of these differences is less well known.

Selection lines differing in the propensity to perform feather pecking or cannibalistic pecking have been developed. Realised heritability of 0.1 to 0.7 has been reported.

Stocking density

Stocking density is an important issue in turkey welfare with high stocking density being a major animal welfare concern. Currently there are a wide range of recommendations for stocking densities for growing turkeys. Gunthner and Bessei (2006) showed that the behavioural effects of stocking density are only observed for sitting/lying, preening and feather pecking, with more sitting/lying, preening and feather pecking at the lower stocking densities.

The behavioural responses to the different stocking densities were generally small in magnitude. Bessei and Gunthner (2006) determined the water consumption of male and female turkeys under different stocking densities throughout the growing period and the influence of disease, vaccination and medical treatment on water intake. There was no significant effect of stocking density on water and feed intake and water: feed ratio. Abdel-Rahman (2005) observed that turkey welfare was poorer at higher stocking densities with impacts on behaviour, higher blood corticosterone levels, reduced body weight and poorer health.

Majumdar et al. (2003) indicated that poults reared in floor spaces of <0.30 m^2 /bird had lower feed intake and better feed conversion ratio (FCR) during the prestarter period compared with poults reared in a larger floor area of 0.46 m^2/bird. However, during the starter period, poults reared in a smaller floor area consumed less feed but there was no significant difference in the FCR. Buchwalder and Huber-Eicher (2004) found that in small groups of turkeys, an increase in floor space reduces the number of aggressive pecks and threats aimed at introduced unfamiliar birds. Additionally, they found evidence that there might be a critical distance below which retreating from an opponent is not successful in avoiding aggressive encounters.

Martrenchar et al. (1999) compared different animal welfare traits at three different stocking densities of 8, 6.5 and 5 birds/m^2. No decrease in locomotory activity was observed at the highest density, contrary to results reported for broiler chickens (Blokhuis and van der Haar, 1990; Lewis and Hurnik, 1990; Martrenchar et al., 1997). However, resting birds were more distracted by other birds as the stocking density increased. The birds' gait appeared to be worst at the highest density. Birds reared at a density of 8 birds/m^2 showed a higher incidence of hip lesions (scabs and scratches) and of FPD than those reared at 6.5 or 5 birds/m^2 indicating that bird welfare is compromised at the highest density.

Group size

Few authors have studied the influence of group size on welfare. In laying hens the incidence of cannibalism increases with groups less than 12 birds (Hughes and Wood-Gush, 1977). Conversely, in large groups (more than 100 birds) the difficulty of establishing a stable social hierarchy makes feather pecking behaviour independent of group size (Hughes et al., 1997). It has been demonstrated that it is possible to keep male turkey broilers at a high light intensity (60 lux) without the occurrence of severe feather pecking if group size and stocking density are low (animals housed in pairs at a density of 0.2 birds/m^2) (Sherwin and Kelland, 1998). Further studies to determine the optimal group size in turkeys are required.

Litter

Foot pad dermatitis (FPD)

FPD is a common condition amongst commercially grown turkey poults and is largely caused by litter quality. In turkeys 48% of female and 46% of male flocks have noticeable signs of FPD (Martrenchar et al., 2001). The skin of the footpad becomes hard and scaly, often developing horn-like pegs of abnormal keratin. The footpad can become swollen and frequently splits. In the centre of the lesion the epidermis separates, and is often totally necrotic. The cause of FPD is complex, but many contributing factors have been suggested, such as diet (Clark et al., 2002), skin structure, bird weight and sex, litter moisture, litter type (Mayne, 2005) and ventilation (Martrenchar et al., 2001). It may not be possible under high commercial stocking densities to have flocks with a low prevalence of FPD (Martrenchar et al., 2001).

Litter type

The litter types used are mainly straw and wood shavings. Litter quality is affected by factors such as stocking density, air temperature and moisture, season, consistency and amount of faeces and drinker design. Wet litter is one of the key factors affecting FPD, followed by biotin deficiency. Turkey poults reared on wet litter have an increased incidence and severity of FPD lesions, but the problem is alleviated by replacing the wet litter with dry litter. Recent research has demonstrated the association between biotin levels and FPD. There are some indications that increased stocking density is associated with an increase in FPD. Supplementation of the diet with biotin has been shown to reduce the severity and incidence of lesions if birds are reared on dry litter, but if on wet litter, lesions may still occur (Mayne, 2005).

Due to differences in water adsorption capacity and the rate of its further release, litter moisture in turkey sheds can be significantly affected by the type of material used. Turkeys are housed for longer periods than broilers and the impact of litter quality on FPD is greater. Kuczynski and Sobodzian-Ksenicz (2002) compared; 1) long rye straw and softwood shavings in a summer-autumn flock, 2) long rye straw and chopped rye straw in an autumn-winter flock and 3) softwood shavings and chopped straw in a spring-summer flock. The amount of litter caking was increased on long straw and the resulting incidence and severity of FPD caused birds to suffer poor health, welfare and production. Youssef et al. (2009) housed birds on dry, clean wood shavings and replaced it daily with fresh, clean and dry litter. There was no effect of uric acid or NH_4Cl in the litter, but the FPD severity was increased markedly by litter with higher water content. Dairy compost was evaluated as a possible bedding substrate for turkeys compared to shavings. There were no significant differences in livability, but body weight was lower for birds housed on the dairy compost and there was a greater incidence of FPD (Frame et al., 2004).

Sobodzian-Ksenicz et al. (2008) investigated the effect of applying two different additives (brown fine coal and microbe vaccine solution) to the straw litter on the physical and chemical characteristics of bedding and on turkey performance. Both additives led to a significant rise in litter temperature, which positively affected its physical parameters and contributed to the improvement of the birds' welfare and performance (lower mortality, higher final weight). Pintaric and Dobeic (2000) showed that the addition of a bioenzymatic additive resulted in a 12% drop in ammonia release from the litter. By adding the bioenzymatic additive to bedding more frequently, it was possible to achieve a larger drop in ammonia and unpleasant odour emissions.

Productivity

The productivity of turkeys raised on deep litter was compared to those raised on a slatted floor (Oblakova et al., 2004). Significantly higher live weight and better FCR was found for birds raised on a grid floor compared to birds on deep litter. However, Wojcik et al. (2004) found that turkey cocks kept on a slatted floor made of metal mesh had lower final body weight and higher body weight losses during transportation and a higher number of birds with damaged carcasses in comparison with the turkey cocks kept on a litter floor.

Disease

The introduction of Codes of Practice for Poultry in a number of countries (eg. Standing Committee on Agriculture and Resource Management, 2003) has meant that persons who are responsible for turkeys must ensure that the bird's health and welfare are maintained. The basic requirements of the Codes of Practice that relate to health include provision of sufficient food and water to sustain health, protection from disease (including those diseases that are caused by poor management) and avoidance of pain, distress, suffering and injury in birds.

Good management is essential to maintain turkey welfare including taking action to minimize contact of turkeys with wild birds and other animals. Appropriate hygiene, proper housing, and brooding and appropriate stocking density are essential when welfare of turkeys is being judged. The housing facilities and equipment used in turkey farming need to be cleaned and disinfected as much as is practicable before restocking to prevent the carry-over of disease-causing organisms to incoming birds. Free range turkeys should not be kept on land which has become contaminated with organisms which cause or carry disease to an extent which could seriously prejudice the health of turkeys (Standing Committee on Agriculture and Resource Management, 2003). Preventative health programs and performance targeting can greatly contribute to the efficiency and ultimate viability of turkey farms. Good management requires that sick and injured turkeys are treated without delay and isolated if necessary. Records of sick animals, deaths, treatment given and response to treatment need to be kept to assist disease investigations. Each turkey shed should include, whenever necessary, a hospital pen where sick birds should be placed (European Council, 1998). Turkeys which have an incurable disease, irreparable injury or painful deformity that create unacceptable levels of suffering should be humanely euthanased. The euthanasia of animals raises welfare problems. Regulation proposals state that the method used should not cause pain or distress. Drowning or suffocating by methods such as putting live birds into tied-up bags is forbidden (European Council, 1998). In practice, farmers use cervical dislocation.

Biosecurity

A survey was conducted to determine the potential disease/pathogen risk pathways on commercial turkey farms. A questionnaire was sent to the farms which related to domestic and wild birds on the farm, proximity to waterfowl habitats, water sources and treatment, biosecurity practices, personnel, vehicles and equipment movement and disposal methods for dead birds, litter and manure. It was shown that drinking water, movement of personnel between farms and contact with wild birds were the main potential pathways for pathogen transfer to domestic birds (Rawdon et al., 2008).

Salmonella and Campylobacter

The bacteria Salmonella and Campylobacter are bacteria which cause the industry significant concern particular with food safety. A study to estimate prevalence and risk factors for *Salmonella* spp. and *Campylobacter* spp. caecal colonization (Arsenault et al., 2007) found that in turkeys the odds of *Salmonella* colonization were 5-8 times greater for flocks which allowed visitors to enter the premises especially staff who came from the hatchery. The prevalence of *Campylobacter*-positive flocks was 46% for turkeys. For turkeys the odds of *Campylobacter* flock colonization were 3 times greater in flocks having a manure heap 200 m from poultry house and 4 times greater in flocks drinking un-chlorinated water. Uncertainty exists concerning the key factors contributing to *Campylobacter* colonization of poultry, especially the possible role of vertical transmission from breeder hens to young birds. A longitudinal study of *Campylobacter* colonization was performed in turkey flocks (Smith et al., 2004). Management practices such as proper litter maintenance, control of people movement between the farm and other turkey flocks, were likely responsible for the absence of *Campylobacter* in the flocks before processing.

Food borne salmonella outbreaks in humans have been associated with consumption of foods of animal origin, including turkey meat from processing plants. Trampel et al. (2000) found that to reduce *Salmonella* on turkey carcasses may require removal of litter and faeces from feathers before turkeys enter a processing plant. Preslaughter practices of feed withdrawal, catching, loading, transport, and holding do not significantly alter the prevalence of *Salmonella* in market-age turkeys. It may be possible to monitor the *Salmonella* status of turkey farms based on samples collected at the abattoir (Rostagno et al., 2006). The ability of 2 probiotic cultures (P1 and P2) to reduce environmental *Salmonella* in commercial turkey flocks 2 weeks prior to processing with or without the use of a commercial organic acid was evaluated (Vicente et al., 2007). The administration of selected probiotic candidate bacteria in combination with organic acids can reduce environmental *Salmonella* in turkey houses prior to transport, and that this practice could help to reduce the risk of *Salmonella* cross-contamination in the processing plant. Intestinal tracts of turkeys from 10 conventional turkey farms, where antimicrobials were routinely used, and 5 organic turkey farms, where antimicrobials had never been used, were collected and cultured for *Campylobacter* species (Luangtongkum et al., 2006). None of the *Campylobacter* isolates obtained were resistant to gentamicin, while a large number of the isolates from both conventional and organic poultry operations were resistant to tetracycline. Multidrug resistance was observed mainly among *Campylobacter* strains isolated from the conventional turkey operation (81%).

Shed disinfection

Mueller-Doblies et al. (2010) showed that disinfectants containing a mixture of formaldehyde, glutaraldehyde and quaternary ammonium compounds perform better under field conditions than oxidising products and should therefore be the first choice for disinfection of turkey premises to eliminate *Salmonella* contamination.

Field study

A field study was conducted to estimate the sanitary condemnation proportion in male turkey broiler flocks, to describe the reasons for condemnation and the related macroscopic lesions, and to investigate whether primary production information would predict the risk of condemnation (Lupo et al., 2010). Emaciation, arthritis were the main reasons for condemnation, representing 76% of the condemned carcasses. Three variables were significantly associated with increased risk of condemnation: locomotor disorders on the farm, high cumulative mortality 2 weeks before slaughter, and clinical signs observed during the *ante mortem* inspection at the slaughterhouse.

Role of probiotics

The effects of selected probiotic bacteria or antibiotics on performance of poults suffering mild idiopathic diarrhoea and stunting (Higgins et al., 2005) were compared. Poults receiving antibiotics followed by a probiotic culture had significantly higher weight gain than non treated or probiotic-treated poults.

Control of meal worms

To control the lesser mealworm, *Alphitobius diaperinus* (Panzer), in turkey houses (Salin et al., 2003) a combined treatment included an adulticidal compound (pyrethroid: cyfluthrin) and a larvicidal compound (insect growth regulator (IGR): triflumuron). The combined insecticide treatment greatly reduced the adult and larval stocks throughout the different growing periods, and control of *A. diaperinus* populations was achieved by the end of the second treatment.

Blackhead

Blackhead may be the most serious poultry disease in turkeys (Beyer and Moritz, 2000). Mortality has been reported to reach up to 70% in some flocks. Early signs of this disease include drowsiness, drooping of the head and wings, walking with an unusual gait, soiled vent feathers due to diarrhoea and bright yellow faeces resulting from the infection of the liver. The bird also may become anorexic leading to a considerable loss of weight and a depressed, weak appearance. Sometimes, the head of the bird appears to be cyanotic, which is a bluish or black discoloration of the skin due to deficient oxygenation of the blood-hence the name, Blackhead. Once infected, it often is difficult to eliminate Blackhead from a flock. Therefore, prevention is the best strategy. One medication that can be used as a preventative is Nitarsone, which also is known as Histostat-50 (Alpharma, Fort Lee, New Jersey). Histostat-50 is a premix that can be added to the feed on a continuous basis up to 5 days prior to processing or marketing.

Turkey pick up and transport

Pick-up of turkeys from farms and transport can result in welfare concerns. Catchers are often required to carry birds upside down through a shed to a truck outside especially when the containers are not able to be taken inside the shed. Birds are usually caught by one or both legs and then placed into the crate. During this procedure the heads or wings of the birds can be injured against the solid sides of the crates. These methods are criticized by the European Council (1998). It has been shown in broiler chickens that, although corticosterone levels were higher in birds handled in an inverted position than in those handled in an upright position, stress due to the crating was greater than stress due to handling before crating (Kannan and Mench, 1996).

Surveys on meat chicken have identified a high prevalence of heart failure and dislocation of the femur at the hip, probably due to the stress of catching, loading and transporting and to catching and carrying birds by one leg, respectively (Gregory and Austin, 1992). Wing injuries may occur when the wings protrude out of the crates and become trapped between containers during loading and unloading.

Four designs of a modular turkey transport systems were compared for carcass damage and heart rate of turkeys during loading. Three systems required turkeys to be manually loaded. Another system was loaded by herding turkeys into it (Prescott et al., 2000). Birds in the manually loaded systems had similar levels of fractures and bruising. Birds which were herded into the module had less damage and heart rate was lower for birds.

Wichman et al. (2009) investigated how different crate heights affected the turkey’s ability to alter their body position while being transported and what effects this might have on their welfare using behavioural observations. The main findings from the study were that the degree of physical confinement in the cages influenced the bird’s behaviour and low height crates decreased the bird’s ability to move and change their position.

Transport

Mortality has long been a concern in relation to poultry transport (Bayliss and Hinton, 1990). When birds are being transported they are exposed to a number of stressors including temperature extremes, sudden acceleration and braking of the vehicle, vibration, abrasion on the crates, fasting, withdrawal of water, social disruption, noise and high temperature. Kowalski et al. (2001) showed that transport of turkeys caused a considerable increase in the levels of creatine kinase, triglycerides, corticosterone, adrenaline and noradrenaline, as well as a decrease in the total lipid content. Crowding and overheating resulted in a significant decrease in the level of glucose, values of humoral and cellular immunity indices, as well as an increase in the concentration of triglycerides (overheating) and corticosterone (crowding). Activation of the sympathetic system via increased plasma levels of adrenaline and noradrenaline were observed. The transport of live animals has important economic and welfare implications. A commercially-available organic acid product (Optimizer™) was added to the drinking water of commercial turkeys during preslaughter feed withdrawal (Pixley et al., 2010). A significant reduction in rate of weight loss during holding at the processing plant was observed in the treated turkeys.

Young poult transport

A study done on turkey flocks identified hatchery- and transportation-associated risk factors for poult mortality in the first 14 d after placement (Carver et al., 2002). Hatchery and transportation-related risk factors for flock mortality included desnooding, truck, truck temperature, shipping time, and weather conditions at placement.

Carcass lesions

The duration of transport between farm and slaughterhouse has been positively correlated with the prevalence of some carcass lesions (McEwen and Barbut, 1992).

Stunning

Sometimes, the birds are not sacrificed properly, which makes manual sacrifice necessary (Mota-Rojas et al., 2008). The main point of concern regarding the slaughtering procedure itself is the intensity of the stunning current in water bath stunners. In the EU the recommended minimum current for a turkey is 150 mA per bird applied for a minimum of four seconds when delivered as 50 Hz sinusoidal alternating current. These parameters have been shown to induce cardiac arrest in >90% of turkeys and so eliminate chances of recovery (Gregory and Wilkins, 1989). The effect of stunning method (gas *vs.* electrical) on some turkey breast meat quality traits was evaluated. Turkey breast meat from gas stunned birds seems to have more favourable quality characteristics in comparison to breast meat of electrical stunned birds.

A new humane slaughter method for broilers using low atmospheric pressure was aimed at developing an alternative method of slaughtering broilers adapted to existing plant equipment. This method could be adopted in turkeys. Insensibility via electroencephalogram (EEG) and electrocardiogram (ECG) and loss of posture was recorded in birds. A 90% reduction in the EEG and ECG signal occurred within 32 s after a pressure of 21.4 kPa was reached; within 35 seconds the chickens' heart exhibited complete fibrillation of both the atria and ventricles. Finally, at 37 seconds after attaining the desired pressure, loss of posture was recorded indicating death (Thaxton et al., 2009).

CONCLUSION

The welfare of turkeys can be affected during most processes from the hatchery, rearing on the farm, transport and processing. Genetic selection, housing conditions, transport and slaughter can all be causes of poor welfare. The major issues are concerns associated with disease, poor locomotion due to high growth rate, chronic pain from beak treatment, behavioral problems caused by high stocking density, lack of enrichment in the turkey house and in the free range and poor air quality in turkey sheds. Depopulation of sheds and transport and slaughter can also result in poor welfare for birds. Changes in the current practices may lead to higher costs which cannot be sustained by producers.

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