Review

Review of the social and environmental factors affecting the behavior and welfare of turkeys (*Meleagris gallopavo*)

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ABSTRACT In modern rearing systems, turkey producers often face economic losses due to increased aggression, feather pecking, cannibalism, leg disorders, or injuries among birds, which are also significant welfare issues. The main underlying causes appear to relate to rapid growth, flock size, density, poor environmental complexity, or lighting, which may be deficient in providing the birds with an adequate physical or social environment. To date, there is little information regarding the effect of these factors on turkey welfare. This knowledge is, however, essential to ensure the welfare of turkeys and to improve their quality of life, but may also be beneficial to industry, allowing better bird performance, improved carcass quality, and reduced mortality and condemnations. This paper reviews the available scientific literature related to the behavior of turkeys as influenced by the physical and social environment that may be relevant to advances toward turkey production systems that take welfare into consideration. We addressed the effects that factors such as density, group size, space availability, maturation, lightning, feeding, and transport may have over parameters that may be relevant to ensure welfare of turkeys. Available scientific studies were based in experimental environments and identified individual factors corresponding to particular welfare problems. Most of the studies aimed at finding optimal levels of rearing conditions that allow avoiding or decreasing most severe welfare issues. This paper discusses the importance of these factors for development of production environments that would be better suited from a welfare and economic point of view.

Key words: turkey behavior, welfare, production, social behavior, density/group size

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INTRODUCTION

Turkey production is considered small compared with broiler production; however, this industry has achieved a relevant increase since 1980, escalating from 122 million to 226 million turkeys produced in 2006 within the European Union countries (Food and Agriculture Organization, 2012), whereas the value of turkeys produced in the United States during 2010 was $4.37 billion (US Poultry and Egg Association, 2013). Despite the growing relevance of turkeys, the scientific literature regarding the welfare of intensively reared turkeys is scarce compared with other poultry species. There is a major need for more insight into the factors influencing turkey welfare, not only due to public demands to ensure a sustainable production system that foments management practices that take in consideration the welfare of turkeys, but also because this information is needed to reduce losses due to poor bird performance.

A recent study showed that 60% of female and 33.8% of male 16-wk-old turkeys in commercial German facilities showed some degree of footpad lesions (Krautwald-Junghanns et al., 2011). Lupo et al. (2010) indicated that in the French turkey industry the average condemnation rate was 1.8%, whereas condemnation rate for broilers was lower and reached 0.87% (Lupo et al., 2008). These are only some examples of relevant animal welfare issues that also have important implications for the economic return of turkey production. Knowledge of the main factors affecting the welfare of turkeys and the means to minimize this impact can not only improve their quality of life, but may also be beneficial to industry by achieving better bird performance, improving carcass quality, and reducing mortality and condemnations.

Unfortunately, there is a lack of studies conducted under commercial settings, on the effects of the social and physical environment over the behavior, welfare, and performance of commercial turkeys. Most of these

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studies have been conducted under particular experimental situations (Martrenchar, 1999); therefore, the application of results to commercial practice is difficult. In this paper, we review the available scientific literature regarding fundamental factors affecting behavior and welfare of turkeys; this literature is relevant to consider the establishment of science-based management practices and to ensure animal welfare.

MAIN FACTORS AFFECTING THE BEHAVIOR AND WELFARE OF TURKEYS

Density and Group Size

Maintenance of high bird densities per unit of space is a common practice in intensive turkey production systems. Although literature for turkeys is scarce, the abundant references on the effects of density in broilers (for a review, see Estevez, 2007) shows the important behavioral and performance changes that may occur when increasing density, especially when environmental control is not matched to maintain the demands of the increased number of animals (Dawkins et al., 2004). This situation may lead to more or less severe performance and welfare problems.

Density and group size are factors which effects are often confounded, together with space availability, because only 2 parameters can be controlled simultaneously. Therefore, individual effects of each contributing factor are difficult to differentiate. Although it is possible to minimize the confusion to a certain extent by using specific experimental designs (i.e., Leone and Estévez, 2008), it is not always a practical approach, especially in applied research, in which the size of the commercial housing is fixed. Keeping in mind those issues, in the current review we treat the effects of group size and density, as well as the space availability, as were described in the original study.

The influence of density on the behavior and health of turkey poults was investigated by Martrenchar et al. (1999), who reduced space allowance from 24 to 15 dm^2 and from 16 to 10 dm^2 for males and females, respectively, until wk 12, and from 40 to 25 dm^2 afterward in case of males. The authors observed gait deterioration at higher density, suggesting stocking density as one of the potential causal factors. They also showed that stocking density had less influence on behaviors such as standing, walking, feeding, drinking, preening, and pecking at the environment, or at another bird. However, similar to the findings for other density studies conducted in broilers (Estévez, 1994; Cornetto et al., 2002; Ventura et al., 2012), they found that increased density lead to a significant increment in the frequency of disturbances among resting poults (Martrenchar et al., 1999). This behavior is considered a factor closely linked with carcass quality in meat poultry (Cornetto et al., 2002).

Turkeys, as birds with a highly competitive social system (Buchholz, 1997), are prone to behaviors leading to the establishment of a social hierarchy. The hierarchy in groups of wild turkeys is based on close kin relationships between relatives, where external males are rejected from the group after moderately aggressive fights, and where the closed units are created for life (Balph et al., 1980; Healy, 1992). The effects of group size, group composition, and space availability on the behavior of turkeys have been mainly investigated by Buchwalder and Huber-Eicher (2003, 2004, 2005a). They indicated that insufficient space may lead to increased risk for broken wings due to hitting the pen walls or other birds during aggressive encounters caused by unfamiliarity of newly introduced group members (Buchwalder and Huber-Eicher, 2004). The incidence of this problem in commercial farms is, so far, unknown, but probably would be more likely to occur in small enclosures rather than in large commercial facilities.

Small groups of familiar toms seem to be able to distinguish nongroup members toward whom they display aggressive interactions, but the frequency of interactions appears to be modulated by enclosure size (Buchwalder and Huber-Eicher, 2004). More pecks toward newly introduce unfamiliar toms were observed in small (2 × 3 m) compared with large pens (6 × 13 m). Buchwalder and Huber-Eicher (2004) explained these results in terms of a minimum critical distance requirement between opponents, which would be essential to avoid chances of aggressive interactions. Therefore, the newly introduced bird would have been able to keep a larger distance in large pens, resulting in fewer aggressive encounters. These results differed somewhat from other scientific evidences that suggest that aggressive interactions, at least in broilers, occur at a higher frequency in open areas rather than in more crowded regions of the enclosure (Pettit-Riley and Estevez, 2001).

Nevertheless, in another study Buchwalder and Huber-Eicher (2003), found that the response toward nonfamiliar conspecifics mainly depended on the size of the group in which the foreigner was introduced. The smaller the group (minimum of 6 up to 30 birds), the more intense the aggressive reaction was, with more fights being initiated and more aggressive pecks being delivered. These results seem to be in accordance with other poultry studies, without aggression-enhancing introductions of foreign individuals to the group, where a reduction in the frequency of aggressive interactions with increased group size was also reported (Estevez et al., 1997, 2002, 2003).

Unfamiliarity between several thousand birds of a commercial flock is a common situation in modern turkey rearing systems due to the group becoming too large to allow any form of hierarchical system. In this situation, it is inefficient to even attempt to establish a hierarchy. It has been speculated that the cost in terms of energy necessary for hierarchy formation in large groups of poultry would outweigh the benefits (Estevez et al., 1997). Furthermore, the probability of finding the same individuals over time to get the advantages of dominance will be small (Pagel and Dawkins, 1997). Other social strategies, such as a tolerant social system based on scramble competition, have been proposed to explain the social dynamics in large groups of domestic fowl (Estevez et al., 1997), and they may apply also to turkeys.

Feather pecking is, together with aggressive encounters, an important welfare and management concern in large poultry flocks. They are commonly considered to be linked to large groups, as found for laying hens (Bilčík and Keeling, 2000). No study has looked over the effects of group size over feather pecking in turkeys, but in an experimental study Busayi et al. (2006) compared feather pecking rates of a commercial male line selected for growth and breast yield with a traditional Nebraska Spot turkey coming from small experimental flocks. A higher frequency of pecks and pulls occurred in males (32%) compared with females (15%) of the commercial line, but were not observed in the traditional one. However, differences in time budgets across sexes were small. Some differences were also observed with regard to age, where males showed stronger feather pecks and pulls at 3 wk of age, whereas females showed the highest frequency at 9 wk.

Space Availability and Spatial Distribution

Spatial distribution, also referred to as space use patterns, is defined as the localization of birds within the living area in relation to their group mates and resource distribution. Spatial patterns can be very important in terms of bird management as, for example, it was observed that overcrowding of broilers around the walls of the enclosure caused increased disturbances during the resting period (Cornetto et al., 2002; Ventura et al., 2012), which may increase the risk of scratches and downgrading. Although the literature on spatial distribution in turkeys is practically inexistent, one study on nocturnal turkey behavior reported that sleeping areas were mainly located around enclosure walls (Sherwin and Kelland, 1998). Therefore, it is expected that turkeys' space use would be driven by similar factors as those in broilers.

In relation to inter-individual distances, Buchwalder and Huber-Eicher (2004) observed that the distance between the birds was larger across nongroup members than within group members. However, this distance was not the maximum distance that the pen allowed, and 50 cm seemed to be sufficient space between the unfamiliar individual and the other birds of the group. This was interpreted as an attempt to integrate in the group, while keeping a safe distance to avoid aggressive reactions from encounters (Buchwalder and Huber-Eicher, 2004). Under commercial conditions, restricted space availability may inhibit birds to fully use the available space. However, detailed studies of space use in broilers demonstrated that space use related more to the size of the enclosure, utilizing a greater amount of space when available, rather than to flock size or density (Leone and Estévez, 2008). This might also be the case for turkeys.

Aging and Maturation

Changes in time budgets and behavioral repertoire are common in growing animals. Poultry is no exception. Similar to broilers (Newberry and Hall, 1990; Bizeray et al., 2000; Pettit-Riley and Estevez, 2001; Estevez et al., 2003), a general decline in activity with age has been observed in commercial turkeys (Hocking et al., 1999; Martrenchar et al., 1999; Busayi et al., 2006) together with a general reduction of oral activities such as feeding, foraging, drinking, preening, and pecking at the pen walls and fixtures (Hocking et al., 1999; Busayi et al., 2006). Parallel results were obtained by Sherwin and Kellend (1998), who found a similar decline from 4 to 22 wk of age in sleeping, environment pecking, wing flapping, and running in turkeys maintained in small groups and low density, whereas the time engaged in feeding, standing, sitting, strutting, and preening varied through the study. At 18 wk, birds spent 30% of their time strutting, which may be considered as a threatening behavior but also as courtship toward humans as found in other bird species (Bubier et al., 1998). Main differences in the behavior of turkeys compared with other poultry species were related to the absence of dust bathing or ground scratching, which are commonly observed in broilers or laying hens (Sherwin and Kelland, 1998). Running and frolicking were observed, but injurious pecking was rarely noticed and feather pecking or cannibalism were not registered at all during development, even though the animals were not beak trimmed, and the light intensities were higher than the ones of commercial facilities.

Similar results were obtained by Hughes and Grigor (1996) studying time budgets of beak-trimmed turkey poults up to 12 wk, kept in small groups of 10 to 11 birds. Percentage of sitting/sleeping behavior increased over time, whereas standing/walking behavior primarily declined, and rose at the end of the study. Beak-related behaviors (feeding, drinking, preening, environmental and bird pecking) rose to the peak of 45% in wk 2 and then declined gradually to around 28% by the end of the study. The general decline in activity with age have been found even when the effects of high stocking density and group size were minimized, and sufficient space was provided to the birds (Sherwin and Kelland, 1998). Reduction in activity also reflected on the distances covered: 27.5 m/30 min at 7 wk to 11.9 at 12 wk (Buchwalder and Huber-Eicher, 2005b).

Turkeys are known to increase the incidence of feather pecking and cannibalism with age, and this may have practical implications. In a comparative study of traditional and commercial strains of turkeys from 3 to 9 wk of age, the frequency of feather pulls was found to increase with age in both strains, and a higher occurrence of gentle pecks was found in the traditional line, but in no case had effects on mortalities (Busayi et al., 2006). However, damaging pecking in turkeys can occur as early as the first or second week of age (Moinard et al., 2001).

Photoperiod and Lighting

Lighting has profound effects on the physiology and behavior of poultry (Manser, 1996). In modern poultry production, photoperiod and light intensity are strictly controlled to promote growth and to avoid excessive feather pecking and cannibalism. Interestingly, even under artificial low light intensity, time budgets seem to follow a photoperiod rhythm, with higher proportion of resting, and low standing and walking occurring during midday (Busayi et al., 2006). At night, turkeys appear to be mostly inactive, although they may stand up 2 to 12 times during the dark period, usually turning around slowly and lying down again (Sherwin and Kelland, 1998).

Although low lighting intensity (1/10 lx) is used to reduce the risk of undesirable behaviors such as feather pecking and cannibalism, it can also inhibit walking, foraging, exploration, and social behaviors (Hughes and Grigor, 1996; Barber et al., 2004). In general, turkeys prefer bright environments, as Sherwin and Kelland (1998) demonstrated that turkeys avoided chambers with less than 1 lx light intensity compared with 5, 10, or 25 lx. But additional studies indicated that turkeys may prefer different light intensities to perform different activities. In this line Barber et al. (2004) demonstrated that in an experimental situation where birds were given continuous access to 4 rooms with different light treatments (below 1, 6, 20, and 200 lx), at wk 2 birds spent most of time in the brightest environment, whereas at 6 wk the authors observed partition of behaviors between the 2 light environments. Resting and perching were only observed in the environment below 1 lx, whereas the rest of the behaviors were performed in the 2 brightest environments. Although environmental enrichment through variation in light intensities may be interesting to improve health and welfare of turkeys, this has never been tested under commercial conditions. From a management point of view, it should be considered that a sudden and temporary increase in light intensity, for bird inspection for example, may lead to fear reaction among birds (Appleby et al., 1992).

Regarding the type of lighting, some studies have shown that the use of fluorescent, compared with incandescent, lighting reduced the incidence of injuries in tails and wings, whereas incidence of tail and wing injuries was positively correlated with the intensity (5, 10, 36, or 70 lx) of fluorescent lights (Moinard et al., 2001). Potential benefits from the use of fluorescent light are that turkeys may perceive it as lower light intensity (Lewis et al., 2000), or it may relate to the composition and proportion of red light that they contain (10% for fluorescent compared with 70% for incandescent; Moinard et al., 2001). Other types of lighting types are known to have powerful effect over the behavior of turkeys. Studies by Gill and Leighton (1984) found birds maintained in low intensity blue light were more docile and less active. Sexual behavior in these pens was at a minimum, and social interactions were rare. In contrast, birds exposed to high intensity intermittent white light were hyperactive and showed extreme flightiness during handling.

Another aspect that should be considered in turkey management is that turkeys are known for having potential for vision in the UV-A spectral range, and it is possible that plumage may contain visual information detectable only under in UV-A wave bands (Hart et al., 1999). In fact, results from Hart et al. (1999) and Moinard and Sherwin (1999) suggest that turkeys preferred a UV-A-enriched environment to one illuminated by fluorescent light alone. In modern housing, the use of fluorescent or incandescent lamps that emit low levels of the UV-A spectrum may limit the natural communication conveyed by the plumage of turkeys. In fact, Hart et al. (1999) suggested that provision of supplementary UV light may reduce the incidence of visually mediated, aberrant behaviors.

Besides light intensity and type, the lighting program has been proven to have a significant effect on the behavior of turkeys and may be used to improve bird management. For example, Classen et al. (1994) demonstrated that turkey male poults of a heavy strain reared to 188 d of age in 6L:18D at 7 d increasing to 20L:4D by 63 d, or starting with 6L:18D and increasing to 10L:14D from 84 to 112 d, showed a superior walking ability and sat less often compared with birds maintained at constant 24L:0D. Lewis et al. (1998) investigated the influence of 4 different photoperiods (8, 12, 16, or 23 h) with light intensities of 1 or 10 lx on the behavior of male turkeys. Light intensity did not influence feeding behavior, but injurious pecking took place at a higher frequency for the 12-h photoperiod, 10-lx combinations. On the other hand, Sherwin et al. (1999) carried out an experiment in which the control group was reared under conditions approximating to commercial and compared with 2 intermittent lighting patterns regimens: 12L/24 h and eight 2-h scotoperiods/24 h, finding that even though some patterns of intermittent lightning were effective in reducing the frequency of injurious pecking behavior, they compromised other welfare indicators, such as musculoskeletal function and the occurrence of blindness (Sherwin et al., 1999).

Feeding

The number of studies dedicated to the effects of diet composition, the form in which is presented, and how its availability may influence behavioral patterns and welfare in turkeys is very limited. Turkey poults at 6 to

12 wk fed with pellets spent less time feeding compared with their behavior at the younger age of 1 to 5 wk, when fed with crumbs (Hughes and Grigor, 1996). On the contrary, Hale and Schein (1962) found that 12-wk-old pellet-fed birds spent more time feeding; less time drinking, preening, and resting; and had higher engagement in other behaviors compared with mash-fed ones. The main differences between these results may relate to genetic factors due to 30-yr difference between them, the age of the birds, and how the feed was presented.

Nutritional enrichment in the form of whole wheat provided in separate feeders, replacing 10% of wheat from their regular diet, has been used with the objective of increasing the time dedicated to feeding and decreasing time availability for injurious pecking (Mirabito et al., 2003). A positive effect of the intervention was detected during the first 2 wk. However, from 9 wk onward, increased feeding frequency was only detected during the evening, and in general, the provision of whole meal had little effect on feeding behavior, and no effects on the turkeys' pecking behavior.

Feed restriction is a commonly used management practice in the breeder turkey industry to control male BW for optimal semen production and to manage risk of heat stress or musculoskeletal lesions. However, food deprivation can have a negative impact on the welfare of turkeys, which may manifest through changes in their behavior patterns. Hocking et al. (1999) compared the behavior of ad libitum and feed restricted commercial Large White turkey male line from 8 to 28 wk. Ad libitum fed birds mainly showed standing, walking, and preening behavior (44 to 77% of the time budget), whereas feed-restricted birds showed high frequencies of oral activities such as pecking on pen walls and furnishings (20 to 59% of the time budget depending on the week). It was emphasized by the authors that first signs of the increased oral activity and reduction of sitting was observed already 2 wk after restriction began.

Transport

Catching and transport of live turkeys, as for other poultry, may be one of the most stressful events in the bird's lifetime if not done properly. Pretransportation procedures such as inadequate catching and crating have a major negative impact on birds' welfare, varying from mild stress to death before arriving at the slaughterhouse. Therefore, the way in which these procedures are conducted can have a dramatic impact on carcass quality and economic profit. Most of the available studies in turkeys describe the direct effects of the procedures on animal welfare in form of deaths on arrival (**DOA**; Wichman et al., 2010). A large-scale study conducted by Petracci et al. (2006) in Italy showed an average DOA of 0.38% up to 0.52% during the summer. Causing factors are suspected to be similar to broilers: thermal stress, acceleration, vibration, motion, impacts, fasting, withdrawal of water, social disruption and noise, incorrect transport of sick or injured animals, and the human factor (Mitchell and Kettlewell, 1998; Prescott et al., 2000; Petracci et al., 2006).

For turkeys, there seem to be some benefits of automatic, compared with manual, crating in terms of reduction of body damage and heart rate (Prescott et al., 2000). Even though the birds were herded into the module using an automatic loading system, the manual handling proved to be more stressful than the automatic conveyance. The human participation during the manual crating procedure was the factor with the most influence on turkeys' stress indicators.

Recently, Wichman et al. (2010) described the effect of crate height (45, 50, or 90 cm) during 6 h confinement on the behavior of turkeys. Whereas turkeys could not stand in the lowest crates, they stood 35 and 43% of the total time in the 50- and 90-cm-height crates, respectively. More stepping, turning, and preening were performed in 50- and 90-cm crates, whereas in the 40-cm crates more rising attempts were observed. The conclusion of this study was that 40-cm crates decreased the possibility of birds moving and changing postures. However, a potential danger that should be considered is that bigger crates can lead to further carcass damages due to scratches made by the nails among crated birds.

DISCUSSION

Scientific studies on the effects of the characteristics of the physical and social environment of turkeys' behavior and their implications from a welfare standpoint are still scarce. In general, studies have demonstrated that turkeys may show large behavioral adjustments as a response to inadequate environmental conditions. For example, studies focused on the effects of density, group size, or both have shown that high densities led to gait deterioration and decreased activity, insufficient space availability related to a higher frequency of injuries, especially wing breakages, as well as increased aggression levels, whereas large group size led to feather pecking occurrences (Sherwin and Kelland, 1998; Martrenchar et al., 1999; Buchwalder and Huber-Eicher, 2003, 2004, 2005a; Busayi et al., 2006). Similar to other poultry, a general decline in activity was found with increasing age (Hughes and Grigor, 1996; Sherwin and Kelland, 1998; Hocking et al., 1999; Martrenchar et al., 1999; Busayi et al., 2006), with first signs of decreased locomotion becoming apparent generally from 4 wk of age onward (Sherwin and Kelland, 1998), whereas the injurious pecking may occur already after wk 3 of life (Busayi et al., 2006).

Feed presentation has also the potential to alter turkey activity; the provision of feed in pellets compared with crumbles has been associated with longer feeding bouts (Hughes and Grigor, 1996), which could be beneficial to divert the birds from other undesirable activities such as feather pecking. However, these results are in opposition to the increased feeding time when provided with crumble feed in turkey studies conducted

30 yr ago (Hale and Schein, 1962). Also, the addition of fodder enrichments in the form of whole wheat was found to increase eating time; however, it did not influence birds from 6 wk onward (Mirabito et al., 2003). Similar to broiler breeders, in turkeys feed restriction increased oral activity paralleled with increments in standing, walking, and preening behavior (Hocking et al., 1999), which is typically interpreted as a sign of hunger and frustration (Bokkers and Koene, 2004). However, as for broiler breeders, it is required to maintain a BW balance to avoid other health and welfare problems associated with excessive BW.

The issue that has perhaps received the most attention in turkeys is lighting. Turkeys preferred fluorescent over incandescent lighting (Lewis et al., 2000; Moinard et al., 2001), probably because is perceived by them as less intense, and they showed better walking ability when provided with dark periods (Classen et al., 1994; Lewis et al., 1998; Sherwin et al., 1999). Young birds showed clear preferences for brighter environments to perform all activities, whereas adults rested and perched preferably under dim light but conducted all active behaviors in brightness (Barber et al., 2004). Some studies have also shown that birds may benefit from UV-A light-enriched environments by reducing visually mediated aberrant behaviors (Hart et al., 1999; Moinard and Sherwin, 1999).

However, of all the factors that may influence turkey health and welfare, catching and crating (Prescott et al., 2000), as well as transportation to slaughter (Wichman et al., 2010), have been shown to be some of the most detrimental procedures for welfare, with the potential of causing not only major carcass damage and lost profitability, but also the death of the birds if procedures are conducted in an inadequate manner.

Current studies have shown that changes in activity, such as locomotion, and time budget schemes, and exhibition of aggression, feather pecking, or cannibalism are behavioral indicators that can be largely influenced by the conditions of the physical and social environment. However, it is essential to consider that the results presented in this review were mostly based on studies conducted under strict experimental conditions, and therefore, it is difficult to extrapolate the conclusions to what would happen under commercial systems in which several thousand birds are reared simultaneously. Additionally, variability between flocks, farms, and even countries caused by different management systems and environmental conditions can determine to a great extent the variability in behavioral and welfare outcomes. It is also important to remark that in some experimental studies the effects of density, group size, and pen size were often confounded because of the difficulties of separating those effects, and furthermore biological events often do not follow a linear pattern. In broilers, differences between experimental and commercial situations were found to cause uncertainty in welfare risk estimation and hazard consequences (De Jong et al., 2012). This uncertainty could be reduced by further studies, expert opinions and their judgments, and obviously by studies conducted under commercial scenarios. The use of mathematical models for complex analysis may also be relevant to find the optimal balance between flock productivity and welfare (Estevez, 2007).

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