

REVIEW OF THE PHYSIOLOGICAL AND PATHOLOGICAL WELFARE INDICATORS APPLIED IN TURKEYS (*MELEAGRIS GALLOPAVO*)

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Communication

Abstract: Concern on animal welfare has become an important issue in Europe for a decade now. In commercial poultry husbandry, there are many trials to standardize the production in order to reduce the economic loss caused by poor welfare at marketing age. As it known, factors such as density, group size, space availability, maturation, lighting, feeding, and transportation can have effects on welfare of turkeys. However, to ensure a better quality of live for the birds as well as the industry as good performance, reducing the mortality and condemnations it is important to have another point of view as different kind of indicators. This paper reviews the available scientific literature related to the turkeys' welfare according to the main relevant physiopathology indicators by taking into a count whether they are feasible or not for being used. We addressed foot pad dermatitis and breast skin lesions as being the most relevant indicators so far. They may be relevant to improve the welfare assessment indicators of turkeys. However, measurements of corticosterone, enzyme activities, cytokines, and hematological profile seemed to be flourishing indicators to be applied more often. In this way associating the indicators that were previously studied to these new ones, it is assumed that animal, producer, industry and consumer may have a suitable bond between them (poultry chain) according to their different interests.

Keywords: welfare, pathological and physiological indicator, turkey

Introduction

For many years, commercial turkey husbandry has been practiced in many countries. In order to increase its profitability, and meet the consumers' demands, research is conducted and regulations are put in place. In poultry chain production, welfare concerns were already pointed out (*Voris et al., 1998; Bessei, 2006; Department for Environment Food and Rural Affairs, 2009; Welfare Quality®*,

2009; *Beaumont et al., 2010*); nonetheless, causes of downgrades and condemnations are still the industries' main worry (*Petracci et al., 2006; Shepherd and Fairchild, 2010*).

Studies have been developed regarding better management factors influencing domestic turkey flocks, such as diet (*Hocking et al., 1999; Mirabito et al., 2003*), light (*Hart et al., 1999; Sherwin et al., 1999a; Moinard et al., 2001*), animal stocking density and group size (*Martrenchar et al., 1999; Buchwalder and Huber-Eicher, 2004, 2005a*), environmental enrichment (*Sherwin et al., 1999b; Martrenchar et al., 2001*), and transportation (*Wichman et al., 2010*). Thus, turkey behavior could be modified by variations in such factors (*Hughes and Grigor, 1996; Sherwin and Kelland, 1998; Buchwalder and Huber-Eicher, 2003*) while welfare issues could be accomplished (*Martrenchar, 1999*). The effect of social and rearing conditions on the behavior of turkeys has recently been reviewed by *Marchewka et al. (2013)*.

The solution to what is still being considered as a problematic welfare issue will be found by dual-way cooperation between consumers, farms and the complex animal production-slaughterhouse industries (*Waiblinger et al., 2006; Humane Farm Animal Care, 2008*).

In broiler chickens, among the welfare issues, high susceptibility to metabolic disorders and low locomotor activity were considered the most important (*Bessei, 2006*). It is inferred that similar issues are seen in turkeys.

Using well-defined indicators to assess welfare is extremely important in order to enhance their welfare evaluation. In this case, changes in behavior, haematological profile, plasma hormones concentration, immune measures and enzymatic activities could be mentioned (*Duncan, 1981; Hocking et al., 1999*).

The purpose of this review was to analyze, based on the existing literature, the physiological and pathological indicators that could be associated with welfare in turkey production. Therefore, improvement of the birds' health status, carcass quality, management, economic issues, and providing satisfactory welfare, would lead to better conditions for turkey production.

Pathological Indicators

Foot pad Dermatitis

Foot pad dermatitis (FPD) is defined as a necrotic lesion and inflammation of the foot pad. The main concern is that it could be the route of entry for other microorganisms potentially leading to the appearance of new diseases (*Shepherd and Fairchild, 2010*).

Lesions related to FPD are important not only for food safety and product downgrading, but also for animal welfare; therefore, decreasing them has been considered one of the main goal for the poultry industries (*Shepherd and Fairchild,*

2010). In addition, FPD was classified as the key welfare indicator in the United Kingdom in turkey production (Clark *et al.*, 2002), when considering the criteria of welfare assessments in Europe and the United States (National Chicken Council, 2010; Shepherd and Fairchild, 2010).

Severe FPD in commercial turkey flocks are common lesions, whereas, they are unlikely in broilers (Clark *et al.*, 2002). In addition, poor litter moisture seemed to be a good example of management deficiencies and the most likely cause of the FPD in turkeys; consequently, decreasing animal welfare (Mayne *et al.*, 2004; Shepherd and Fairchild, 2010).

These kinds of lesions in female turkeys were more severe than males during the fattening period according to Krautwald-Junghanns *et al.* (2011), even though Clark *et al.* (2002) reported higher frequency in males. It could be associated with the differences in animal density in different countries, (e.g. in Germany, the turkey's density for males is approximately 2.8 birds/m², while for females is approximately 5.1 birds/m²). Nevertheless, the severity of these pathological lesions is associated with other flock management factors such as litter moisture. Moreover, Grosse Liesner (2007) stated that genetic predisposition is also an important element of FPD.

Mayne *et al.* (2007b) demonstrated that FPD could be most likely associated with a rapid inflammatory response, rather than an allergic response to an environmental stimulus in the litter.

Wu and Hocking (2011) conducted an experiment with female growing turkeys in order to observe the effects of litter and animal age on FPD. The most important conclusion was that high moisture litter is the main cause of FPD, which affected the severity and the prevalence of these lesions (Mayne *et al.*, 2007a; Youssef *et al.*, 2011). Accordingly, short exposure to wet litter (4h/day; Abd El-Wahab *et al.*, 2012; 8h/day; Youssef *et al.*, 2010) could be enough for the development and marked increase in severity of FPD.

Thus, to reduce FPD in the flock, good litter management is essential to maintain the level of moisture under the 30% (Wu and Hocking, 2011); this result may be reached by using floor heating, or even providing soft litter such as lignocelluloses rather than wood shavings (Abd El-Wahab *et al.*, 2011). Furthermore, there is no significant difference in litter pH between different bird groups, suggesting no relation between organic material and FPD, such as bird's droppings and bedding material (Wu and Hocking, 2011). On the other hand, according to Abd El-Wahab *et al.* (2013), when the electrolyte in the diet changes, mainly the sodium/ potassium rate, indirectly interferes with the litter quality due to the increase of water intake and the increases of the excreta moisture, causing the occurrence of the 'wet litter conditions'.

Breast Skin Lesions

Breast skin lesions such as breast buttons, blisters, and purulent bursitis observed in conventional intensive turkey farming are still considered as the most frequent problems and as a result, they are one of the main reason of economic loss (Krautwald-Junghanns et al., 2009).

Mitterer-Istyagin et al. (2011) found the prevalence of these alterations in turkey tom than in turkey hen flocks. Although the origin is not clear and probably multifactorial, it was possible to infer that the differences between fattening period regarding body weight and the laying time may be the cause. They also conclude that sex-related influences and age status were important reasons for these results, but could also be determinate by breeding, litter moisture, and management quality.

Muscular and Skeletal Lesions

As occurs in broilers, turkeys also have skeletal abnormalities associated with higher body weight (Wyers et al., 1991). In this case, tibial dyschondroplasia (TD) has been described as the cause of enormous economic losses and also an animal welfare problem (Pines et al., 2005; Tatara et al., 2006). According to Hocking et al. (2002), there is no predisposition for this disease related to diet with higher or lower calcium: phosphorus ratios. Furthermore, the turkeys affected by TD have not been observed to have any locomotion problems as occurs in broilers (Simsa et al., 2007). Therefore, the welfare issue of TD could in this case be primarily related to location on the body where osteomyelitis may develop (Wyers et al., 1991). Additionally, Tatara et al. (2006) discovered the beneficial effects of orally administrating ornithine alpha-ketoglutarate in turkeys with skeletal disorders, which resulted in increased amino acid synthesis. It was shown that the quality of the bone is improved by higher bone mineral density of trabecular and cortical bone as well as the maximum elastic and ultimate strengths were increased.

Hocking et al. (2005) evaluated the efficacy and optimum doses of non-steroidal anti-inflammatory drugs in domestic fowl suffering from articular pain. This model could be useful when applied to different avian species such as turkeys, due to the lack of studies presently available.

In order to demonstrate the efficiency of treatments using analgesics such as synthetic opioids (butorphanol) and anti-inflammatory steroids (betamethasone) in adult turkeys with degenerative joint disorders, studies were carried out with regarding locomotion, spontaneous and sexual activities (Duncan et al., 1991; Buchwalder and Huber-Eicher, 2005b). It was demonstrated that in all the treatment groups, an increase in the natural function activities was observed.

Physiological Indicators

Corticosteroid Evaluation

It is known that stress events which could be defined as a trigger or stressor that causes a stress response, such as catching and transport of live turkeys (Marchewka *et al.*, 2013), may affect animal behavior, decrease the immune system when fighting disease and change population performance (Korte, 2001; Shini *et al.*, 2010).

Glucocorticoid hormones are synthesized and released through activation of the hypothalamic-pituitary-adrenal axis complex. Conventionally, it is possible to evaluate glucocorticoid levels in the blood; however the components only remain in circulation for a short period of time (minutes). Nonetheless, another way of measuring them is by analyzing animal feathers, which has been used in order to determine more chronic stress experience indicators (activity durations of the hormone is days-to-weeks) (Bortolotti *et al.*, 2009). In addition, corticosterone (CORT) is the main avian glucocorticoid that could be quantified by feather analysis (Bortolotti *et al.*, 2008).

According to Bortolotti *et al.* (2009), CORT is a stable hormone in feathers that could be used individually or in the flock, which gives the information about the time when the stress event happened and how the bird responded. It is a non-invasive and feasible method (Bortolotti *et al.*, 2008). Furthermore, this analysis used samples that were collected over many years and stored by taping the calamus to a sheet of paper in a binder kept at room temperature. Therefore, it is a good way to track stress, which is one of the most important factors that influences animal welfare. However, Lattin *et al.* (2011) reported that caution is necessary in the interpretation of CORT results extracted from feathers, due to the effect of the sample and effectiveness of the antibodies used in the feather assay.

Hocking *et al.* (1999) demonstrated that food restriction in commercially turkeys' production causes increase of plasma CORT during the rearing period, even if the traditional birds at 4 and 8 weeks of age have a relative high levels of this hormone.

Corticosterone metabolites' levels in faeces-urine also could be evaluated, however, many limitations have been discussed, for instance, artifacts caused by sample age, storage and transportation, diet, captivity and biological status (Millspaugh and Washburn, 2004; Tempel and Gutiérrez, 2004; Möstl *et al.*, 2005; Cabezas *et al.*, 2007; Hayward *et al.*, 2010).

Stoyanchev *et al.* (2007) gathered accurate data about natural humoral immunity in turkeys, which had muscular dystrophy, reared under conditions of poor welfare and stress. In general, lysozyme concentrations (LC) were higher in sick animals than in healthier ones due to the body attempt to go through the

disease. Nevertheless, under stress challenging the blood serum LC were decreased due to the presence of cortisol.

Furthermore, *Franciosini et al.*, (2011) showed LC was lower in broiler turkeys reared in the backyard group (pen measuring 6 m long X 4 m wide that were subdivided into 2 connected spaces, one of which opened) when compared with industrial (13,500 birds with natural light and ventilation) and experimental flocks (optimized light, ventilation, temperature and density according to *Anonymous*, 2000). These results suggest that stress situations possibly caused by predators could be a reason for those findings as well as weather conditions for instance. Moreover, there are difference between different rearing systems and natural immune parameters.

Cytokines belong in many ways of the immune response path and are important in leucocytes development, and their roles. Interleukins (IL) are a type of cytokines that are produced by leucocytes and influence other leucocytes (Snyder, 2007).

Shini et al. (2010) carried out an experimental study in chickens regarding the effects on the expressions of the proinflammatory cytokines (e.g. IL-1 β , IL-6) and chemokines (CC) (e.g. CCLi1, CCLi2) of leucocytes and heterophils under CORT oral administration. During a chronic treatment of CORT (1 week), there were a down regulation of cytokines and CC which suggest that there was suppression in the immune response. However, exposing birds to acute stress (until 24h) can cause the increase of immune system. They cited as well that IL and CC could be important markers in order to assess the influence of stress factors in their immune system.

Wu et al. (2007, 2008) reported that IL-1 β and IL-8 proteins in chicken, duck, goose, turkey and pigeon have significantly structural and functional homology, which could be used as adjuvant in vaccine for all these species. It is considered as an important tool regarding to modulating the immune system.

Hematological Profile

According to *Maxwell* (1993), the increase of heterophil to lymphocytes ratio (HLR) and basophils are well-known variables indicating stress, such as heat and incorrect transportation. However, there was no evidence of the HLR changes by food restriction in turkeys (*Hocking et al.*, 1999), neither with the crate height during short-term confinement (*Wichman et al.*, 2010).

HLR has been used for many years as the method to evaluate the stress, such as, in birds. When the immune system releases CORT, which elevates its blood concentration, afterwards, there is an increase of nonlymphocytes leukocytes (heterophil) and decrease of lymphoid leucocytes (lymphocytes), thus the HLR changing occurs (*Shini et al.*, 2010). However, understanding of these mechanisms according to the molecular point of view should be more detailed. It was observed

that during an exogenous application of CORT in 7-wk-old chicken experiment, the HLR markedly increased during 1h, 3h, and 24h post administration, which can help the innate immune response (Shini *et al.*, 2010).

Huff *et al.* (2005) compared the effects of 2 different stressors (such as transport and dexamethasone treatments) on the measure of HLR and resistance to *Escherichia coli*, from 3 different turkeys' genetic lines, (according to their rate of growth). Their data supported the concept of lighter and slower growing line birds are more resistance to stress. In addition, HLR were increased in both stressors that were used.

Proportion of basophiles seemed to have no changes into its values during food-restrict event (Hocking *et al.*, 1999).

Activities of Plasma Enzymes

Creatine kinase (CK), aspartate aminotransferase (ASAT), alkaline phosphatase (APL) and lactate are some examples for physiological measures of animal welfare which could be considered as turkey welfare indicators.

Wichman *et al.* (2010) showed that there was no difference between the size of crate and the activity of CK or ASAT; however, frequently changes in turkey behavior were noticed. Moreover, lactate levels were significant lower with male birds in the 55cm crates than in 40cm.

Hocking *et al.* (1999) observed that the activity of lactate dehydrogenase (LDH) in turkeys from 12 to 24 weeks of age was higher in male turkeys that were fed *ad libitum*. In addition, the performance of ASAT was similar to one found in LDH. However, APL was inversely of the LDH.

Conclusion

In summary, it may be concluded from this review that foot pad dermatitis (FPD), breast skin alterations, corticosterone measure analyses, immune measures (e.g. cytokines and chemokines), hematological profile, and enzyme activities (e.g. creatine kinase, aspartate aminotransferase, alkaline phosphatase and lactate) are suitable indicators of the welfare in the turkey rearing methods and in agreement with the bird protection; hence, the fittest welfare protocol using these indicator should be built and applied. On the contrary, it is important to notice the real feasibility of those indicators. The aims should be well-understanding of their usability in order to select the proper indicators for the assessment of the turkey welfare.

The proper welfare assessment cannot be done considering solely each factor as singular; it should be evaluated based on the factors that are also involved, such as the rearing methods for turkeys, management, and breeding.

The FPD and breast blisters are for now considered the most practical welfare indicators in turkeys regarding the feasibility for collecting this data scoring. Furthermore, it has a great importance if consider how practical, no time consuming and reliable welfare indicator(s) could be applied on the complex farm-slaughterhouse. Therefore, the real welfare picture could be defined.

Further studies are needed in order to obtain the useful tools in order to figure out which is the best way to deal with these challenges: intensive animal production chain versus poultry protections concerns. Perhaps, the main scope is the equilibrium between the research, farms, industries and consumers.

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Pregled fizioloških i patološkim indikatora dobrobiti ćurki (*Meleagris gallopavo*)

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Rezime

Pitanje dobrobiti životinja je preko jedne decenije jedno od važnijih pitanja u Evropi. U komercijalnom živinarstvu, bilo je mnogo pokušaja da se standardizuje proizvodnja u cilju smanjenja ekonomskih gubitaka izazvanih lošom dobrobiti u uzrastu kada se živina plasira na tržište. Kao što je poznato, faktori kao što su gustina naseljenosti, veličina grupe, dostupnost prostora, sazrevanje, osvetljenje, ishrana i prevoz, mogu imati uticaj na dobrobit ćurki. Međutim, da bi se obezbedio bolji kvalitet života za ptice, kao i za industriju dobre performanse, smanjenje smrtnosti i gubitaka, važno je imati još jednu tačku gledišta kao različite vrste indikatora. Ovaj rad razmatra raspoloživu naučnu literaturu koja se odnosi na dobrobit ćurki "u skladu sa glavnim relevantnim fizičko-patološkim pokazateljima uzimajući u obzir da li su oni izvodljivi ili ne. U radu je pažnja usmerena na dermatitis nogu i lezije kože grudi kao najrelevantnije indikatori do sada. Oni mogu biti od značaja za poboljšanje indikatora ocenjivanja dobrobiti ćurki. Međutim, merenja kortikosterona, aktivnosti enzima, citokina i hematološki profil su indikatori za koje se čini da će se u budućnosti češće primenjivati. Na ovaj način, povezivanjem indikatora koji su ranije ispitivani sa novim, pretpostavlja se da će postojati odgovarajuću vezu između životinja, odgajivača, industrije i potrošača (lanac proizvodnje živine) u skladu sa njihovim različitim interesima.

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