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Strategies and facilities in order to improve animal welfare

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ABSTRACT - To keep the position in being a world-wide exporter of chicken meat, Brazil must meet international quality standards, always seeking alternative resources of improvement, without increasing production costs, including litter quality, requirements of animal welfare and environment affairs, such as the use and reuse of broiler litter. Researches are performed in the areas of animal welfare, environment, animal behavior and use of modern climatization technology improving the quality of the environment created to raise broilers, also trying to reduce the greenhouse gas emissions and global warming in the environment, becoming a sustainable production system. This paper has a bibliographic revision of the subject mentioned above, intending to show a state-of-art key factors related to a new concept of broiler environment and welfare.

Key Words: broiler, broiler litter, electrical energy, environment, gas, welfare

Estratégias e instalações para melhorar o bem-estar animal

RESUMO - Para manter a posição de maior exportador de carne de frango, o Brasil deve se adequar às exigências internacionais dos padrões de qualidade, procurando sempre recursos alternativos de melhoria, sem grande incremento no custo de produção, incluindo a qualidade da cama, requisitos de bem-estar animal e as questões ambientais, como o uso e a reutilização das camas de frango. Para isso são necessárias pesquisas nas áreas de bem-estar animal, ambiência, comportamento animal e uso de tecnologias de climatização modernas que aperfeiçoem a qualidade do ambiente gerado para criação dos frangos, visando, além deste fator, menor emissão de gases com potencial efeito estufa para o ambiente, tornando-se um sistema de produção sustentável. De acordo com o exposto, realizou-se uma ampla revisão bibliográfica deste assunto, buscando mostrar o estado da arte dos principais fatores relacionados aos novos conceitos de ambiência e bem-estar de frangos de corte.

Palavras-chave: ambiência, bem-estar, cama, energia elétrica, frango de corte, gases

Introduction

The welfare of confined animals is strongly dependent of the facilities conceptions and the equipment used. Direct and indirect mechanisms have an effect on animal healthy and performance that must be understood as facilities projects and specifications. According to Wathes (2004), future rural constructions must anticipate much more than simply providing shadow for animal confinement, because animal welfare demands related to the consumer have increased considerably, demanding new project concepts.

With the production of 10.962,000 tons of chicken meat in 2009 and adding 10.940,000 tons produced in 2008, Brazil exports around 70% of its production, taking the 1º place as chicken meat exporter (UBA, 2009). Due to this position, it's extremely important to adapt to required international quality standards, always seeking alternative resources for improvement, without increasing production costs.

Both European Union and Japan, two big poultry importers from Brazil, set requirements demanding Brazil to adapt to European quality standards, including the quality of the broiler litter, requirements for the animal welfare and environmental affairs, such as the use and reuse of broiler litter.

The ventilation system is one of the most important aspects able to create conditions for the production success, by reducing the humidity produced in the barn because of the poultry respiration, the litter humidity, renewing the air, helping to remove the heat produced in the facility and, most importantly, removing the ammoniac gas which is formed by fermentation of poorly conserved broiler litter.

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Welfare

According to Bracke et al. (2001), welfare can be considered the animal biological needs. One definition of animal welfare very popular today was set by FAWC (Farm Animal Welfare Council), in England, meeting the five liberties related to animals.

According to Manning et al. (2007), the poultry production traditional indicators of welfare, such as mortality rate, morbidity, chest lumps, locomotor problems, are not ideal to measure the welfare, because they don't work in a preventive way. The ideal is to work with indicators that prevent these situations.

Water is a vital nutrient, associated with many aspects of the metabolism (Jafari et al., 2006). According to Defra (2002), the consumption of water in a broiler house can be monitored by the calculus of 11.100 l day $^{-1}$. An increase or decrease of consumption levels can be an indication of poultry healthy problems that can be specially related to thermal environment affairs or even related to management problems.

Animal behavior

The animal has its behavior strongly influenced by its external environment, knowing how it acts over the animal by its behavior, it is possible to identify, quantify and characterize the conditions of animal thermal comfort and welfare. The behavior analysis involves factors connected to the own animal, such as the ones related to its surrounding environment.

Researching the behavior of broilers submitted to many combinations of air temperature and relative humidity in climatic chambers, Sevegnani et al. (2005) concluded that such conditions influence ration and water ingestion, this way the results indicated that higher the temperature and more advanced the age of the chicken, the ingestion of water increases while the ingestion of ration decreases.

According to Alves (2006) the observation of animal behavior may provide answers more reliable to its welfare, once the animal behavior is modified when responding to environmental difficulties, being one component of regulatory and emergency responses.

According to Cordeiro (2007), the chicken has limited flexibility, but good capacity of visual discrimination, this stimulus has an important role on the animal behaviors such as feeding, aggressiveness, territoriality, etc.

With the advancement of hardware and software, new technologies appeared and became more affordable, such as real time image analysis by video camera, image acquisition hardware, and image analysis software, this way involving the phases of acquisition, processing and classification. Studies implying this level of technology are useful in order to better understand the effects of thermal environment over the animals, which reflect their performance. However, it is used in a limited manner because of visual restrictions in commercial production conditions because of the dependence of visual classification.

To help the tests of environmental preferences, Jones et al. (1996) and Green & Xin (2008) developed environmental preferences chambers (EPC), which contained many compartments linked to each other where different environments could be created, and the variables studied were independently manipulated in an automate system. According to Green & Xin (2008), some preferences must be considered non-exclusive, which means, to have one behavior at one space and a different one at another. To confirm this report, Kristensen et al. (2000), also mentioned that a criticism to the preference tests is that the choices are non-exclusive and choices that are minority, are ignored when the results are read.

Thermal environments

Many researches about productivity versus thermal stress on animal production have been made, such as the solution for these conditions (Pereira & Nääs, 2003). The result of thermal stress comes from the interaction among air temperature, heat and wind speed (Lin et al., 2006). According to Tao & Xin, (2003), when the environment temperature is in the thermoneutral zone the internal temperature of birds is kept between 41.2 and 42.2ºC, whenever the environment temperature increases, biophysical mechanisms are activated. If these mechanisms are not enough to keep homeothermy, the internal temperature increases killing by thermal stress. In the case of adult chicken, the environment temperature must be of 21.1ºC, the humidity 50%, the air renewal must occur in less than 1.3 min and the maximum speed of the air must be between 2.29 and 2.41 m s^{-1} (Barnwell & Rossi, 2003).

Humidity also has an important role for lodged animal production, affecting the thermal physical feeling of the animals, because the heat can be tolerable with a low humidity rate, but not tolerable when it is high. In a high humidity rate, in a cold microclimate, it may occur condensation on the walls and other components of the facility, increasing the temperature of the broiler litter, diseases will eventually appear.

The recommended temperature for broilers in an initial stage in the broiler house must be between 32.0 and 35.0°C, and must decrease in 1.0°C every two days until it reaches 22.0 °C. For the third week, the temperature must be around 22.0 ± 2.0°C, according to Nicholson et al. (2004). However

Cobb (1995) estates that the environment must present temperature equals 32.2°C and for the second week must present temperature equals 29.4°C. Excessive heat or cold can damage the production, not necessarily killing the bird. Researches exposing young birds to periods of six hours with a temperature equal 43.3°C and no access to water resulted in dehydration problems and reducing the growth rate (Vest, 1997).

Ventilation

Ventilation is an effective way to reduce the temperature of a dry bulb for convective heat loss (Wathes & Charles, 1994), being also one of the key factors for the production success, promoting: humidity elimination caused by the birds breathes; environment temperature control, environment oxygen renewal and ammonia gas elimination. Being a continuous procedure, even the excess or the lack of ventilation may interfere in the broiler production process final results (Moura, 1998), being dependent of animal density, besides the broiler house orientation (Moura, 2001; Sevegnani, 2001).

A ventilation system study, natural and induced, in different seasons of the year, was performed by Lee et al. (2003), where mechanical ventilation maximum internal temperature average was 3.6ºC lower than natural ventilation, both in the summer.

Ventilation management inside the broiler house varies according to the season of the year. Summer ventilation, necessary for the broiler house, must meet both thermal and hygienical demands, influenced by the location of the building, area and side curtains (Abreu, 2003).

Aerial environment

Air quality is a key factor for poultry production. Air is the source of oxygen for the metabolism and a vehicle for exceeding heat dissipation, from steam, gases that come from the animals and dejects decomposition, from dust released by the broiler litter (Furlan, 2006). The quality must be determined through the gas levels, dust and microorganisms (Scahaw, 2000). According to Muller et al. (2007) nitrogen oxides, such as CO, SO_2, total oxidizers, total hydrocarbons and particles, are the main standards in routine measurements of air quality control. The importance of monitoring the air environment in broiler housings occurred because of animal welfare and also due to public health matters.

Ammonia is a gas produced by uric acid microbial decomposition. The recommendation inside the barns is a maximum concentration of 20 ppm (CIGR, 1994). When the amount of ammonia inhaled is superior to 60 ppm, the bird can be easily infected by breath diseases, when the ammonia concentration levels reach 100 ppm, there is a decrease in the breath volume rate, damaging physiological processes of gas exchanges, common at the beginning of the creation in barns, with the reuse of the broiler litter (Gonzáles & Saldanha, 2001).

Broiler litter pH has an important role on the volatilization of ammonia, once formed the free ammonia will be found in two ways: one as NH_3 and as ion NH_3, depending on the pH besides the ammonia concentration positive direct relationship. Besides that the concentration of ammonia tends to increase when the pH increases (Blake & Hess, 2001).

Miragliotta (2001) compared the levels of ammonia in broiler houses with different ventilation and density systems, and found that the tunnel ventilation system managed to remove the gases created inside the facilities with a density of 18 birds m^2, assuring an adequate air quality, being even more effective than the conventional ventilation system, with lower density of 13 -15 birds m^{-2}.

The limit permitted for carbon monoxide (CO) concentration change from country to country. In the United States, the regulations proposed by Niosh (2004) are 35ppm for every eight hours of work and 200ppm for 15 minutes of work being the maximum level. For Occupational Safety and Health Administration (OSHA, 1991) the permitted concentration is 50 ppm for every eight hours of work (EH-64, 1999). In Canada the limits are the same recommended by Niosh. The CIGR (1989) recommends a maximum limit of exposure of 10ppm of CO for the animals.

According to Czarick & Fairchild (2007), the increase of CO concentration is usually linked to equipment maintenance problems. The increase of the ventilation rate during a cold period will make necessary the heating system activation what may increase the production of carbon monoxide.

The increase of the temperature, known as global warming or greenhouse effect, comes from the excessive use of fossil fuels, the destruction of forests and organic substances degradation, including biological breath. Among the gases, the carbon dioxide (CO_2) is responsible for nearly 60% of these effects (Tunç et al., 2006).

Nitrous oxide is an important global warming gas, it is naturally formed in the soil, specially as a subproduct of nitrification and denitrification, fossil fuel burn and industrial operations.

Methane (CH_4) is related to agricultural processes, becoming difficult to measure. Researchers have been conducted to identify and quantify the emissions of CH_4

from individual sources. Li et al. (2005) estimated that the emissions of CH_4 in different kinds of animal production, finding out that the individual animal contribution for the emission of CH_4 in China, from 1990 to 2000, was 58% in swine dejects, 14.1% in chicken and 11.0% in cattle, the last one had a small percentage because of the extensive production system.

In relation to methane emission, which may come from manure production, or even from enteric fermentation, which according to Lucas et al. (2006), depends on the animal species, age, production level and the kind of food they are fed with.

National standards for air quality environment were established by EPA in 1997, where the six most common ways of pollution in the United States of America were considered: the CO, nitrogen dioxide (NO_2), ozone (O_3), hydrogen sulfide gas (H_2S) and particle material. These pollutants were chosen based on two criteria: public health protection, such as animal risk, crops, vegetation and facilities (Muhkhtar & Auvermann, 2006).

Broiler litter

The environment quality of the barn is highly dependent of the quality of broiler litter, which is the ideal environment for bacteria and ammonia production. The two things, which most influence the conditions of the litter are manure, and humidity. According to Lu et al. (2002) in his study of the bacterial condition of broiler litter, samples of four farms in Georgia, USA, with flocks about six weeks old. The authors found different genetic sequences associated to birds and human diseases, such as *Clostridium, Staphylococcus, e Bordetella spp*., and bacteria resistant to aminoglicosideums and cloranfenicol. Fernandes & Furnaleto (2004), tried to identify the main biological agents that can be exposed to workers in the broiler house. In the microbiology of broiler litter, 82% predominating gram-positive bacteria, specially *Lactobacillus sp and Salinococcus* sp. and some *Clostridium* sp., *Staphylococcus sp and Bordetella* sp.

Traldi et al. (2004) in a study evaluating the probiotics effect on the characteristics of a reused litter, to evaluate carcass injuries, found out that beds reused for two cycles caused more serious injuries than the new ones.

An alternative has been studied to reduce the volatilization of ammonia, consequently improving the litter quality; the addition of some substances to the litter will help, through chemical reactions, the increase of nitrogen fixation. Moore Jr. et al. (2000) when studied the effects of aluminum sulfate n the pH, verified that it reduced the pH of the litter, especially on the four first weeks of the cycle. Another additive used to treat broiler litter is the agricultural plaster ($CaSO_4$), through chemical reactions, increases the nitrogen fixation avoiding increasing the levels of ammonia concentration. Oliveira et al. (2003), in an evaluation about the dry matter, the pH and amount of volatilized ammonia of broiler litter treated with different additives and not treated, found out a lower pH (6.97) in broiler litter that used agricultural plaster.

According to Fiorentin (2006), another treatment very used in Brazil is the addition of hydrated lime in the litter, which reduces the activity of water (AW) in the litter and increases the pH at the same time.

Locomotor problems

The reducing of the walking behavior on confined chicken, related to the place where the bird is located and the selection for best feeding conversion and heaviest weight have negative consequences for these birds welfare, mainly because of the high number of abnormality in their legs.

Bristol University, in England, developed the Gait Score, which evaluates the groups of birds in industrial barns, according to the age of the birds, considering the basic locomotion reactive capacity, varying from 0 to 5 between immobility and regular mobility of the chicken in the barn. These evaluation registries are necessary to adequate to the regulations for GLOBALGAP IFA certification.

Since 1930, innumerous causes of deformities in bone tissue of birds were identified. The population density is an important aspect to be considered, an extreme increase of birds per square meter may cause a reduction in their growth rate, increase their mortality, low the litter quality and a increase the number of chicken carcass injuries besides legs problems (Oliveira, 2006).

Behavior and leg injuries studies show that an elevated bird density, above 30 kilograms per square meter, may create serious welfare problems, increasing the incidence of skeletal abnormalities and mortality rates (European Parliament, 2006).

Weeks et al. (2000) analyzed the behavior, in different degrees of lameness, in broilern raised in a system of 23 hours of light and one hour in the dark. The observations demonstrated that the abnormal walking behavior altered significantly the chicken feeding behavior and consequently their welfare.

It was also reported that the low body weight results in a better physical capacity when compared to individuals with a heavy body weight.

Corr et al. (2003) accomplished a study which the objective to analyze the chicken strength reaction when walking without any pain-killer administration. It was reported that the fast growth of the chicken with biomechanical limitations may be the key factor influencing the abnormal walking behavior of the birds and the role of the pain still needs to be determined.

Conclusions

It is important to develop new processes, in the broiler production to assure a better performance and high product quality indicators, without affecting chicken welfare. Therefore, it is necessary to better understand new technologies, including concepts of new environment and production costs optimization, defining ethical limits that will guide to better production systems.

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