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EFFECT OF DIFFERENT HOUSING SYSTEMS ON PRODUCTIVITY AND WELFARE OF LAYING HENS*

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Abstract

Under the EU regulations, all cages designed for commercial laying hens should meet the specifications of enriched cages. In addition, the European Union allows and even promotes the housing of layers in barn and free-range systems. However, not every breed and commercial line is suitable for each of these systems in terms of productivity and quality of eggs. These factors have an effect on the profitability of poultry production, which is the main criterion determining the choice of a system by the producer. The current state of the art is insufficient to determine which system has the most favourable effects on performance of laying hens and quality of their eggs, because research results are inconclusive. Therefore, further studies and observations are needed to show differences in the adaptability of different hen breeds to different production systems. This will make it possible to optimize housing conditions in accordance with the principles of welfare and proper choice of layer breeds and commercial lines so as to maximize production and economic results while making the hens resistant to production stress.

Key words: laying hens, housing system, behaviour, production results, egg quality, welfare

Current intensive poultry production systems that aim to maximize profit offer increasingly new technological solutions which facilitate labour and increase productivity. However, these systems do not always meet the natural needs of birds. Ignoring welfare of animals is not only an ethical issue but also a practical issue because well-being and housing comfort translate into better weight gains, health and productivity of the birds.

In the European Union and in the world, eggs are currently produced under the intensive system (mainly in conventional and furnished cages or in the barn) and in extensive systems. Each layer housing system and technological solution is associated with certain problems such as social stress, influence of adverse thermal

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and humidity conditions, inability to express natural behaviours, threat of zoonoses, and layers' pathological behavioural reactions, which determine productivity and welfare.

Large-scale commercial poultry farms whose aim is to intensify production are characterized by high stocking density, cage housing, lack of outdoor areas, restricted movement, considerable mechanization of handling, etc. In large commercial farms, a single bird lives with hundreds or thousands of other birds but is only able to recognize about 90 birds (Hughes et al., 1997). However, such groups exhibit less aggressive behaviour because the cost of energy needed to form dominance hierarchies exceeds the benefits (Estevez et al., 2002). Because the intensive system may cause stress and behavioural and physiological abnormalities, which adversely affects productivity and health (Hall, 2001; McLean et al., 2002; Bessei, 2005), this type of technology is often abandoned or at least attempts are made to improve bird welfare levels.

The objective of this paper is to review the literature concerning the effect of different layer housing systems on flock productivity and health, physiological parameters and quality characteristics of eggs, and avian behaviour and welfare.

Performance and health status

Numerous studies have shown that existing production systems and their possible modifications influence the well-being and behaviour of birds, which has an effect on their productivity. It is also known that genetic origin affects production results, determining feed utilization and egg production depending on the housing system (Reiter and Kutritz, 2001).

Hetland et al. (2004) reported that hens kept in groups of 8 or 16 in enriched cages consume more feed compared to hens reared in groups of 3 in conventional cages. Meanwhile, Elson and Croxall (2006) demonstrated lower feed intake by hens maintained in enriched compared to conventional cages. However, Valkonen et al. (2008) did not find any effect of rearing Lohmann Selected Leghorn layers in furnished cages on productivity and feed conversion. A study by Van Horne and Van Niekerk (1998) showed less efficient feed conversion in the aviary and free-range systems compared to conventional (farm) systems. Under the alternative production systems, laying hens must spend extra energy on heat production and moving, which is often due to low stocking density and low temperature (Preisinger, 2000).

Pohle and Cheng (2009 a) reported that White Leghorn W-36 layers raised from 19 weeks in batteries of conventional and furnished cages differed significantly in body weight between 30 and 60 weeks of rearing.

According to Weitzenbürger et al. (2005), because poultry mortality depends on many factors it cannot be the only main criterion to evaluate housing systems.

Hegelund et al. (2005) hold that in practice, the organic production system may be a potential cause of health problems, especially when the outdoor areas are not properly used. Mortality is as high as 11–18% in organically raised large flocks of poultry but it can decrease to 7–9% in smaller organic flocks (Berg, 2001; Fiks-van Niekerk et al., 2003). When mortality exceeds 20% under the organic production system, it is very often due to cannibalism. Considering the threats associated with

organic production, it is recommended that flocks containing less than 1700 birds are kept in this system (Bestman, 2004).

A frequent problem associated with organic poultry production is salmonellosis. Comparison of the battery and organic production systems shows that free-range layers are characterized by much higher mortality and are more threatened with zoonoses (salmonellosis) (Fiks-van Niekerk et al., 2003). However, Van Overbeke et al. (2006) maintains that organic poultry production is threatened with salmonellosis as much as the other production systems.

The literature reveals that egg production from conventional cage layers is higher than in alternative systems such as aviary, floor management or free-range system (Tauson et al., 1999; Leyendecker et al., 2001a). Other studies conducted in several European countries indicate that egg production in furnished cages is comparable to that in conventional cages (Abrahamsson and Tauson, 1997). Meanwhile, Pohle and Cheng (2009 a) reported that layers maintained in furnished cages laid more eggs at 40 weeks compared to conventionally caged birds ($P \leq 0.05$) because of considerable improvements in welfare levels.

The literature quoted above shows that the effects of housing system on layer productivity and health are inconclusive.

Physiological parameters

Housing system may significantly affect the physiological status of birds, including the haematological indices and biochemical parameters of their blood.

Catecholamines, adrenaline and noradrenaline take part in many metabolic processes; among other things they regulate emotions and provide motivation for action (Elenkov and Chrousos, 2006). However, Pohle and Cheng (2009 a) showed that housing system has no effect on adrenaline and noradrenaline levels, but found a significantly higher level of dopamine in 50-week-old laying hens kept in a battery of cages compared to hens from enriches cages. A positive correlation between corticosterone secretion and social stress was reported by many authors (de Kloct et al., 2008; Roelofs et al., 2009). The results of these studies suggest that hens raised in battery cages are more stressed than those from furnished cages. A study by Pohle and Cheng (2009 a) with White Leghorn W-36 layers raised from 19 weeks of age in batteries of conventional and furnished cages showed a decrease in the level of serotonine and increased corticosterone in hens from conventional cages between 50 and 60 weeks of age.

Resistance to environmental factors and susceptibility to stress are genetically determined (Zulkifli et al., 2004; Al-Murrani et al., 2006). Mahboub et al. (2004) reported differences in the morphological blood picture of laying hens from two commercial lines and found that they may result from differences in birds' susceptibility to stress-causing agents, with poultry (especially free-range poultry) being often exposed to adverse thermal and humidity conditions, diseases and parasites, which are also stressors and may cause changes to the blood picture (Campo et al., 2005; Özkan et al., 2005; Akşit et al., 2006). Brodacki et al. (2006) showed a highly significant increase in haematological indices in birds kept under the environment-friendly system compared to the intensively reared group.

The literature cited above indicates that housing system has an effect on the physiological parameters of hens. The cage production system appears to induce greater stress in birds compared to furnished cages.

Egg quality

Layer production system has a considerable effect on the quality of eggs, including their physicochemical properties, which has been documented by many studies (Gianneanas et al., 2009; Matt et al., 2009; Trziszka et al., 2004).

Another issue is the severity of eggshell dirt and the microbiological condition of the shell. For example, proportionately more dirty eggs were found in alternative production systems compared to conventional cage systems (Leyendecker et al., 2001 a), which may be due to the soiling of nests or egg-laying on litter. Comparison of conventional and furnished cages shows that dirty eggs are less frequent in the latter system (Abrahamsson and Tauson, 1997). However, De Reu et al. (2009) observed no statistically significant differences in percentage of dirty eggs between furnished cages and the non-cage system. Tauson et al. (1999), who compared 3 production systems (conventional cages, aviary and floor housing) and 2 bird genotypes (Lohmann Selected Leghorn and Lohmann Brown), found no differences in dirty eggs from different housing systems and from Lohmann Brown hens, but eggs produced by LSL hens under the floor system were less dirty than those from LSL hens raised in the cage and aviary systems.

Protais et al. (2003) and De Reu et al. (2005) showed that eggshells from the aviary system are more contaminated with aerobic bacteria compared to those from the cage system (furnished and conventional cages). De Reu et al. (2009) also found significantly lower bacteria counts on eggshells from furnished cages compared to those from the alternative system (4.75 vs. 4.98 log cfu/shell). However, the same authors found no statistically significant differences in percentage of enterobacteria on eggshells between the cage and alternative systems. Wall et al. (2008), who compared conventional and furnished cages, found statistically significant differences in enterobacteria count on eggshells (12.3% in furnished cages vs. 5.8% in conventional cages). Schwarz et al. (1999) reported that free-range eggs were characterized by a higher contamination with aerobic bacteria (by about 1 log) compared to eggs from conventional cages. However, De Reu et al. (2005) did not find any differences in gram-negative bacteria counts on eggshells between conventional cages, furnished cages and aviaries. De Reu et al. (2009) reported that bacterial contamination of eggs is determined by the production system but farm organization and management also play important roles.

Wall et al. (2002) and Guesdon and Faure (2004) found that the number of cracked eggs was greater in furnished cages than in traditional cages. The nest area in furnished cages is small and eggs may bump into each other. Meanwhile, Leyendecker (2003) showed a lower proportion of cracked eggs in furnished compared to conventional cages. In addition, different slopes of the cage floor may influence the number of cracked eggs (Valkonen et al., 2008). Similarly, De Reu et al. (2009) found a greater percentage of cracked eggs ($P \leq 0.01$) in furnished cages (7.8%) compared to an alternative production system (4.1%). Guesdon et al. (2006) showed

that the proportion of hair-cracked and broken eggs was higher in furnished cages (15.4–19.6%) compared to standard cages (8.1–12.2%). Hidalgo et al. (2008) did not find any significant differences in eggshell damage between the cage, free-range and organic systems.

According to Pohle and Cheng (2009 a), the housing system of White Leghorn W-36 layers reared in batteries of conventional and furnished cages from 19 weeks of age had no effect on shell thickness.

The evidence cited above shows that housing system has no conclusive effect on the number of dirty and cracked eggs, whereas greater bacterial contamination of the shells is characteristic of alternative systems.

Behaviour

Factors that influence avian behaviour include housing system (Oden et al., 2002; Anderson et al., 2004; Whay et al., 2007), flock size and stocking rate (Albentosa et al., 2007), and microclimate conditions (Stub and Vestergaard, 2001; Herbut et al., 2002; Prescott and Wathes, 2002).

According to Weeks and Nicol (2006), the welfare of layers kept in conventional cages is compromised by the lack of nests. On the other hand, enriched cages have nests and sandbaths, which enables birds to express natural behaviours such as nesting and bathing (Tauson, 2002). Yue and Duncan (2003) observed frustration and stereotypies in birds unable to use nests. Cooper and Appleby (2003) reported that birds have a strong instinct to find a nest for egg laying.

Pohle and Cheng (2009 b) observed that 25 to 41% of the analysed birds used perches during the day. Appleby (1998) reported that about 80% of birds used perches at night. Likewise, Duncan et al. (1992) reported that about 99% of layers used perches during the night.

Pohle and Cheng (2009 b) and Appleby et al. (2002) also found that birds prefer litter pecking, resting and preening to sandbathing. However, a sandbathing box may positively affect other forms of behaviour such as pecking, preening and resting.

The activity of birds increases with the growing number of birds per group, when total cage size increases (Carey et al., 1995). However, cages with perches make the birds less active (Matsui et al., 2004). Johnson et al. (1998) reported that caged birds spent more time eating compared to aviary birds.

Poultry production systems with outdoor areas are currently becoming increasingly popular. This housing system has a potentially favourable effect on avian welfare because it allows them to perform natural patterns of behaviour such as moving, scratching, pecking, foraging and feeding (Mahboub et al., 2004; Tuyttens et al., 2005). Mahboub et al. (2004) concluded, however, that layers vary in free-range use and frequency of use according to breed. Freire et al. (2003) found that in hens raised in large flocks, outdoor access may have a positive effect on their welfare by reducing the number of aggressive behaviours. However, according to Hegelund et al. (2005), in practice this production system may cause health problems, especially when the free range is not used properly. Green et al. (2000) reported increased incidence of feather eating in free-range birds on warm and sunny days. Also Weitzenbürger et al. (2005) reported that feather picking and cannibalism

are a major problem in both conventional and alternative production systems. They also pointed out that the protection of outdoor areas against predators is inadequate, which often causes strong stress reactions and makes birds less eager to use them. Shimmura et al. (2008) did not observe any increases in feather eating and cannibalism in free-range birds. On the contrary, they believe this type of behaviour increases in confined birds which are unable to express their natural behaviours. The literature also suggests that feather eating increases with increasing stocking rates per m^2 area (Bilçik and Keeling, 1999; Nicol et al., 1999; Zimmerman et al., 2005), which is a fairly common phenomenon in large commercial farms. Mahboub et al. (2004) and Bilçik and Keeling (2000) reported that an increase in the number of birds per flock makes them more aggressive.

The number of birds using free range depends on flock size. In flocks with more than 500 hens, only a small percentage of poultry use outdoor areas (Zeltner and Hirt, 2003).

Väisänen et al. (2005) state that current breeding lines of hens have poorer social learning capacity and show a weaker ability to cope with group disruptions compared to their ancestors. Meanwhile, Anderson et al. (2007) believe that long-term genetic selection by egg-type breeding firms to enhance production parameters has no impact on behaviour patterns in the next production cycles.

Important factors that affect the behaviour of birds are their genetic origin (Nielsen et al., 2003; Mahboub et al., 2004) and flock size (Reiter and Bessei, 2000; Zeltner and Hirt, 2003). Mahboub et al. (2004) showed differences in the behaviour of birds representing two different commercial lines. LSL layers were characterized by more movement on grassland but spent less time there compared to Lohmann Traditional layers. According to Nielsen et al. (2003), hens of conservation or general-purpose breeds use outdoor area more frequently and show much greater movement compared to commercial lines that spend more time lying and feeding.

Leyendecker et al. (2005) reported that free-range poultry show higher motor activity and have a greater scope for showing natural behaviour such as flying and wing flapping. However, Knierim (2000) failed to observe any differences in the number of sitting birds at 5 weeks of rearing between free-range and confined birds.

Dawkins et al. (2003) found that birds were stimulated to get to free range by the presence of grass, high outdoor temperature, and absence of harsh sunlight, which means that birds most often stayed on free range on warm summer days at dusk or at dawn. Another factor that improved bird welfare on free range was the presence of trees which provided a shade and protection against predators.

The proportion of free-ranging birds is 50% according to Green et al. (2001) and as much as 67% according to Bestman and Wagenaar (2003). Dawkins et al. (2003) demonstrated that not more than 15% of birds use free range, but this finding concerned broiler chickens.

In summary, avian behaviour is largely dependent on the housing system. Keeping hens in enriched cages and with outdoor access makes it easier for the layers to express their natural behaviour, which has a favourable effect on their welfare. The way birds behave is also determined by their genetic origin.

Welfare

According to Appleby et al. (2004), conventional cages do not give birds the possibility to experience all five freedoms, which are the basis of animal welfare, and their main disadvantage is that they prevent birds from performing their natural behaviour.

The literature reports that furnished cages improve hen welfare by reducing stress, aggression and feather eating, and by improving bone mineralization (Kopka et al., 2003; Leyendecker et al., 2005; Vits et al., 2005). However, Guesdon et al. (2004) did not show a beneficial effect of furnished cages on welfare compared to traditional cages. When comparing conventional and enriched cages, Barnett et al. (2009) found that group size and living space have little effect on layer welfare, whereas cage equipment (perch, sandbath, nest) has no influence on bird welfare as measured by physiological parameters, although it has a positive effect on bone strength. The presence of leg deformations in layers kept in furnished cages is probably due to excessive perch use, which may pose a problem in this type of cages (Vits et al., 2005).

Provision of outdoor areas to birds has a favourable effect on their welfare as it allows them to express their natural behaviours such as moving, scratching, pecking, foraging and eating (Mahboub et al., 2004; Tuyttens et al., 2005). The use of free range by birds not only boosts their immunity but helps to reduce stress experienced during rearing (Bestman and Wagenaar, 2003; Nicol et al., 2003).

Production system also has an effect on leg diseases. The fracture resistance of bones is lower in conventional cages than under alternative production systems (Leyendecker et al., 2001b). When comparing conventional cages with furnished cages and aviaries, Leyendecker (2003) showed humerus strength to be significantly higher in furnished compared to conventional cages, but it was not greater than in aviaries.

In furnished cages, increasing the number of birds reared in one cage may negatively affect feathering (Appleby et al., 2002; Hetland et al., 2003; Weitzenbürger et al., 2005). Other research provides evidence that equipping cages with a perch and bedding material improves feathering in laying hens (Abrahamsson and Tauson, 1997).

Claw length is also dependent on production system. In alternative production systems, birds have an opportunity to trim their claws when moving and litter scratching, unlike in conventional cages where long claws increase the risk of injuries (Vits et al., 2005) and impair movement. This problem has been partly solved in furnished cages, although views on this matter are divided.

Production system has a considerable effect on bird welfare. It appears that free-range systems are best in providing layers with high welfare levels because they reduce rearing stress while enabling birds to perform their natural behaviour.

The present review of the literature indicates the need for further research and observations to show differences in the adaptability of different hen breeds to different production systems. This will make it possible to optimize housing conditions in accordance with the principles of welfare and proper choice of layer breeds and commercial lines so as to maximize production and economic results while making the hens resistant to production stress.

The organic poultry production system is another issue and its principles are prescribed by separate regulations.

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EWA SOSNÓWKA-CZAJKA, EUGENIUSZ HERBUT, IWONA SKOMORUCHA

Wpływ różnych systemów utrzymania na produkcyjność i dobrostan kur nieśnych

STRESZCZENIE

Zgodnie z przepisami unijnymi wszystkie klatki przeznaczone do utrzymania kur nieśnych towarowych muszą spełniać parametry tzw. klatek wzbogaconych. Ponadto Unia Europejska dopuszcza, a wręcz propaguje, utrzymanie niosek w systemie ściołowym zamkniętym lub z możliwością wybiegów. Jednak nie każda rasa, jak i zestaw towarowy kur nieśnych nadają się do utrzymania w każdym z tych systemów. Chodzi tu przede wszystkim o wyniki produkcyjne, jak i jakość uzyskanego produktu, czyli jaj. Wpływa to na opłacalność produkcji drobiarskiej, a to jest głównym czynnikiem decydującym o wyborze danego systemu przez producenta.

Na podstawie dotychczasowego stanu wiedzy nie można jednak stwierdzić, który z istniejących systemów wpływa najkorzystniej na wyniki produkcyjne niosek i jakość uzyskanych jaj, gdyż wyniki badań nie są jednoznaczne. Dlatego też istnieje potrzeba dalszych badań i obserwacji w celu wykazania różnic w adaptacji kur różnych ras w różnorakich systemach chowu, co w konsekwencji pozwoli na optymalizację warunków utrzymania zgodnego z zasadami dobrostanu zwierząt i właściwego doboru ras oraz zestawów towarowych kur nieśnych do określonych systemów chowu, tak aby uzyskać jak najlepsze wyniki produkcyjno-ekonomiczne przy jak najwyższej odporności danych kur na stres produkcyjny.