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The Welfare of Animals in the Egg Industry

An HSUS Report: The Welfare of Animals in the Egg Industry

Abstract

Hundreds of millions of chickens in the egg industry suffer from poor welfare throughout their lives. Male chicks, considered a byproduct of commercial hatcheries, are killed soon after they hatch. The females are typically beak-trimmed, usually with a hot blade, to prevent them from developing the abnormal pecking behaviors that manifest in substandard environments. The overwhelming majority of hens are then confined in barren battery cages, enclosures so small that the birds are unable even to spread their wings without touching the cage sides or other hens. Battery cages prevent nearly all normal behavior, including nesting, perching, and dustbathing, all of which are critically important to the hen, as well as deny the birds normal movement to such an extent that the hens may suffer from physical ailments, including osteoporosis and reproductive and liver problems. Once their productivity wanes, typically after 1-2 years, the hens are "depopulated," and many experience broken bones as they are removed from the cages. The birds are either killed by gassing on the farm or after long-distance transport to a slaughter plant, where they experience further stress and trauma associated with shackling, electrical water-bath stunning, and throat-cutting. Throughout the commercial egg industry, the welfare of birds is severely impaired.

Introduction

In the United States in 2007, more than 77.3 billion table eggs were produced by approximately 280 million hens, each laying an annual average of 263 eggs.[1] Most egg-laying hens (95%)[2] are confined in small, barren battery cages. The most commonly used cages hold 5-10 birds.[3] A typical U.S. egg farm contains thousands of cages, lined in multiple rows, stacked 3-5 tiers high. Industry guidelines stipulate that each caged hen may be afforded 432.3 cm^2 (67 in^2) per bird,[2,4] an amount of floor space equivalent to less than a single sheet of letter-sized paper.

Hatching

Chickens destined for the egg industry are artificially incubated and hatched by the thousands at commercial hatcheries. Male chicks will not mature to lay eggs and since they are not selectively bred for rapid growth and increased breast muscle (meat) as those in the broiler chicken meat industry, there is no market demand for them. As such, male chicks are considered a byproduct of egg production and are customarily killed upon hatching. In the United States, 260 million chicks are killed by the commercial egg industry annually.[5] Methods of chick disposal include maceration (wherein live, fully conscious, and unanesthetized chicks are inserted into high-speed grinders); exposure to carbon dioxide, argon, or a mixture of the two gases;, or by use of a high-speed vacuum system that sucks chicks through a series of pipes to an electrified "kill plate."[4-6] Although there is little published research establishing that the vacuum system is effective and it is highly likely that the chicks experience considerable distress before they are killed, the majority of male chicks die by this method.[5]

Beak-Trimming

Most laying hens in North America are beak-trimmed as young chicks[7] in order to prevent potential outbreaks of injurious feather-pecking and cannibalistic behavior that can result from such intensive confinement in barren conditions, as well as to reduce feed wastage of adult birds. Beak-trimming generally involves removing 1/3-1/2 of the beak tip,[4,8] but in some cases, up to 2/3[9] may be cut off. The most common commercial method uses a heated blade both to cut and cauterize the beak tissue,[8,10] but newer technologies include infrared energy and laser procedures.[7,11,12] Beak-trimming using a hot blade causes tissue damage and nerve injury, including open wounds and bleeding, which results in inflammation, and acute and possibly chronic pain.[7,8,13-16] Beak amputation can also result in the formation of a painful neuroma, a tangled nerve mass, in the healed stump of the beak,[8,16,17] particularly if the procedure is delayed until the birds are older than five weeks of age or if a large, critical amount (2/3) of the beak is removed.[8,11,15]

The beak is a highly innervated, complex organ containing free nerve endings that serve as nociceptors (receptors for painful or injurious stimuli) and sensory receptors that are concentrated in the area around the tip of the beak, innervated by branches from the trigeminal nerve.[8,18] Hence, beak-trimming removes many of the receptors important for touch, taste, pain, and temperature perception.

Chickens use their beaks to explore their surroundings. The beak is their primary means of touching and feeling, as well as picking up and manipulating objects, and chickens use their beaks in much the same way that we use our hands.[19] Studies have shown that because birds need to adapt to a new beak form after this amputation procedure, their ability to consume feed is impaired following beak-trimming.[20] Beak-trimmed chicks also exhibit difficulty in grasping and swallowing feed.[13]

Ian Duncan, Emeritus Chair in Animal Welfare at the University of Guelph, has asserted that “it is possible to keep hens without de-beaking them,”[21] and animal scientists David Fraser, Joy Mench, and Suzanne Millman have referred to practices such as beak-trimming as “stop-gap measures masking basic inadequacies in environment or management.”[4] Many factors present in today’s commercial egg production industry heighten the risk of injurious pecking behavior, but important among these is the lack of environmental stimulation in monotonous, barren environments that restrict or severely limit important behavior, such as natural foraging (ground-pecking) activities.[22-25] Beak-trimming has been banned or is being phased out in some European countries including England, Norway, Finland, and Sweden,[26,27] due to the pain the mutilation causes and because adjustments to the environment and management practices can be used to mitigate the risks of injurious pecking and cannibalism outbreaks.

Behavioral Restriction*

Hens in battery cages cannot perform many of their important, natural behavior, including nesting, dustbathing, perching, and foraging. They are also so severely restricted in the movements they are able to perform that they suffer from physical abnormalities due to lack of exercise.

Nesting

Nesting behavior is so important to the laying hen that it is often used as a prime example of a behavioral need.[28] Under natural conditions, approximately 90 minutes before oviposition (egg laying), a hen locates a remote, private place in which she carefully scrapes out a shallow hollow in the ground and builds a nest.[29] Very similar behavior can be seen in non-cage husbandry systems for hens.[30,31] Nesting behavior is triggered internally with a sudden rise in progesterone against a background of fairly high estrogen levels. This hormonal fluctuation, associated with ovulation, then results in nesting behavior approximately 24 hours later.[32,33] The internal, biological signals to perform nest-site selection and nesting behavior occur no matter what the external environment.[34] Studies have shown that hens are highly motivated to gain access to a nest site when they are about to lay an egg.[35,36] Caged hens prior to oviposition are restless, show stereotypic pacing and escape behavior, or perform “vacuum” nesting activity, the expression of the motions of building a nest in the absence

* This section is drawn from “An HSUS Report: A Comparison of the Welfare of Hens in Battery Cages and Alternative Systems,” prepared by Sara Shields, Ph.D., and Ian J.H. Duncan, Ph.D. For more information, see the full report online at www.hsus.org/web-files/PDF/farm/hsus-a-comparison-of-the-welfare-of-hens-in-battery-cages-and-alternative-systems.pdf.

of appropriate nesting materials. Decades of scientific evidence suggest that hens are frustrated and distressed, and that they suffer in battery cages because there is no outlet for nesting behavior.[37-43]

Dustbathing

The absence of loose litter in a battery-cage environment is also behaviorally restrictive as hens are prevented from performing normal dustbathing behavior. Dustbathing keeps chickens' feathers and skin in healthy condition. Given access to dry, friable substrate, such as dirt, wood shavings, or peat, hens would normally dustbathe approximately once every other day. During a dust-bath, the hen crouches, lies in, and rubs dust through her feathers before standing and shaking off the loose particles. The best experimental evidence suggests that the function of dustbathing is to balance lipid levels in the feathers.[44-46] However, dustbathing is caused by a variety of factors, some of which are external[47] and others internal.[48,49] Light and heat trigger dustbathing, as does the presence of a friable, dusty substrate, but even when deprived of these normal eliciting stimuli, hens in battery cages will still try to dustbathe on the wire floor. Peripheral factors, emanating from the feathers (including ectoparasites), seem to be unimportant since even featherless chickens will dustbathe.[50] Although there has been a report of dustbathing deprivation leading to stress,[51] others have suggested that dustbathing is not driven by a need, but is a pleasurable activity.[52] This does not lessen its importance, since good welfare is dependent on both an absence of suffering and a presence of pleasure.[53]

Perching and Roosting

Barren with wire mesh flooring, conventional battery cages also prevent hens from perching and roosting. Perching is another natural behavior of the hen. When given the opportunity, hens will normally roost high in the trees at night. The scientific literature suggests that the foot of a hen is "anatomically adapted to close around a perch"[41,54]—that is, their feet evolved to clutch onto branches. Perch use is important for maintaining bone volume and bone strength.[55-57] Perches can also serve as refuges for hens to avoid injury from more aggressive hens[58] and will reduce agonistic interactions.[59]

In a naturalistic setting, roosting behavior is thought to function in protecting chickens from predation at night, but evolutionary history continues to drive the hen's need to perform the behavior, even in the industrialized production environment. When perches are provided in cages, hens may spend 25-41% of day time on them,[60-62] though this may be the birds' method of utilizing the extra space.[63] Hens immediately begin to use perches when the lights go off at night, and in one study, within 10 minutes, more than 90% of all hens were found on perches.[64] When perch space is limited, hens will crowd together for roosting space at night.[65] In motivational analysis experiments, hens show behavior indicative of frustration when thwarted from accessing a perch.[64] They are also willing to push through an increasingly heavily weighted door for perch access.[66] Thus, many studies conclude that hens are highly motivated to perch.[41,64,66]

Scratching and Foraging

The wire floor of a battery cage also deprives hens of the opportunity to express normal foraging and scratching behavior. Hens are behaviorally adapted to engage in these activities, which would normally take place in loose, varied ground cover. The birds scratch the earth in search of food and as a means of exploring the environment, and studies have reported that domestic fowl spend more than 50% of their active time foraging.[67,68] Battery-caged hens are fed a concentrated diet, yet, like other animals in captivity,[69] their natural urge to forage remains strong, despite the presence of a complete diet fed *ad libitum*. Studies have shown that hens will choose to forage for feed on the ground in loose substrate rather than eat identical food freely available in a feeder.[68,70] The lack of appropriate foraging substrate may lead to redirected pecking and to the development of abnormal feather-pecking behavior.[24]

Exercising

Hens in cages are so intensively confined that they have no opportunity to exercise and are not exposed to the normal range of physical forces that structure their bones. The scientific literature provides ample evidence that restriction of normal movement patterns to the extent found in cages causes physical harm in the form of bone weakness. Dynamic loading is a process that occurs during normal movements and causes stresses and strains to bone and muscle that keep the skeletal system healthy. The lack of exercise in cages leads to bone fragility and impaired bone strength.[39,71-73] While all hens selectively bred for egg production are prone to skeletal weakness due to osteoporosis (see below), caged hens are more prone to the disease due to lack of exercise. Several studies have compared the bone strength of caged hens to those in perchery and deep-litter systems. Findings conclude a very significant reduction in bone strength in the birds in cages.[74-76] This problem is so severe that in one study, 24% of birds removed from their cages at the end of the laying period suffered from broken bones.[77]

Preference testing has demonstrated that hens do prefer more space than is typically allotted to them in a conventional battery cage and that when given the opportunity to choose between enclosures that differ in size, they will generally choose the larger enclosure.[78-82] Preference tests have also demonstrated that space *per se* may not be as important as access to other resources, such as outdoor access or a littered or grass floor.[79,81,83] Additionally, small spaces may temporarily be preferred for particular activities, such as nesting.[80]

Engaging in Comfort Behavior

Many studies have shown that comfort behavior, such as stretching, wing-flapping, body-shaking, and preening, are reduced or adversely affected in some way by the battery-cage environment.[84-87] These types of behavior are important for body maintenance and care of the feathers. The social spacing in a typical battery cage is restrictive to the point that hens may perceive their environment as being too small to engage in comfort behavior. Therefore, even if it is physically possible to perform these simple movements, they may not.

Exploring

Hens are naturally inquisitive, curious animals. Scientists have argued that exploratory behavior is important to animals on several grounds: Exploration satisfies the motivation to acquire information about the surrounding environment, creates agency and competency, and is also an end in itself.[88-90] Some have further argued that situations that deny environmental challenge (because they are barren and devoid of natural stimuli) deprive animals of "the very core on which their physical existence is based, namely the ability to act."[89] Exploratory behavior may be independent of goal-directed behavior (e.g., searching for a suitable nest site or foraging for food), as chickens continue to display exploratory behavior even when the functional consequences of these behaviors (e.g., nest sites and nutritious food) are present.[90] Exploratory behavior is likely a behavioral need.[89]

The barren, restrictive environments of battery cages are detrimental to the psychological well-being of an animal. When environments are predictable, monotonous, and unchanging, they do not offer the degree of stimulation or opportunity for choice that would be found in natural environments.[91] Scientists have suggested that environmental challenge is an integral part of animal well-being and that barren environments lacking challenge and stifling exploration engender apathy, frustration, and boredom.[89,90]

Disease

Today's laying hen, selectively bred for high egg production, will produce more than 250 eggs annually,[1] compared to 100 eggs per year a century ago.[92] This unnaturally high rate of lay, sustained for a year or more, takes a toll on the health of the hen and can lead to abnormalities of the reproductive tract and metabolic disorders such as osteoporosis and accompanying bone weakness. As caged hens are unable to exercise, problems with skeletal fragility are exacerbated, and the birds may also suffer from cage layer fatigue and liver problems.

Reproductive Problems

Consumer demand is greatest for the extra-large and large egg sizes.[93] The production of these eggs by small birds is one factor that can lead to cloacal prolapse, a condition in which the outer end of the reproductive tract fails to retract following oviposition.[94,95] Normally, the shell gland (the lower part of the hen's reproductive tract, the oviduct) is momentarily everted. However, sometimes the oviduct does not retract immediately after the egg has been laid, leaving a small portion to rest outside of the cloacal opening. The prolapsed part of the oviduct can become pecked at by cage-mates, leading to hemorrhages, infection, cannibalism, and possibly even death.[9,95] The provision of a nest box, as is practiced in non-cage housing systems, minimizes visibility of the cloaca during oviposition, reducing the likelihood that laying hens become victims of cloacal cannibalism.[9]

Tumors of the oviduct can also be a problem for laying hens selectively bred for high egg production. Adenomas (benign glandular tumors) and adenocarcinomas (malignant glandular tumors) are commonly found in commercial laying hens, possibly due to prolonged exposure of the oviduct to steroid sex hormones controlling egg production.[96]

Osteoporosis

Bone is the metabolic reservoir for calcium used in egg shell production.[97] The calcium requirement for hens' extremely high rate of lay is immense, and moving calcium from bone to egg shell leaves the birds prone to osteoporosis, subsequent bone fragility, and bone fractures. Osteoporosis due to bone mineral depletion is exacerbated by the inability to exercise in a cage. One study comparing different housing systems found that, on average, caged hens made stepping motions 72 times each hour, compared to 208 times for uncaged birds in a perchery system. Similarly, wing movements were almost non-existent in birds confined in cages compared to those reared in the perchery.[74] Studies have demonstrated that restriction of movement, especially the thwarting of normal behavior such as stepping and wing-flapping, is the primary cause of bone fragility for laying hens[74,98] and that exercise improves bone strength.[73] Many studies have found that alternative, cage-free housing systems lead to improved bone strength.[75,97,99-102]

Osteoporosis leaves the laying hen's fragile skeletal system prone to bone fractures. The Scientific Panel on Animal Health and Animal Welfare,[†] an independent body that provided scientific advice to the European Commission, noted that the prevalence of bone fractures that hens sustain during the laying period appears to be increasing.[99] Studies conducted during the 1990s estimated that the incidence of bone fractures for caged laying hens was 0-15%,[103-105] while more recent studies report 11-26%.[106,107] In a study published in 2003, bone fractures were the main cause of mortality in caged hens.[108] Hens are also more prone to bone breakage during depopulation, when they are removed from their cages at the end of their productive life. A 2005 study reported that nearly 25% of caged hens suffered broken bones during removal from cages.[107] Early studies from 1989 and 1990 report similar to slightly lower rates of newly broken bones in hens depopulated at the end of the laying period, with estimates of 16-24%.[77,103] If hens are transported, unloaded, and shackled for slaughter, the proportion of birds with broken bones increases, and studies have reported that approximately 30% of hens have new bone fractures following this process.[77,104]

Fatty Liver Hemorrhagic Syndrome (FLHS)

FHLS is characterized by excessive deposits of fat in the hen's liver and abdomen. The liver softens and becomes more easily damaged; if the fat oxidizes, blood vessels in the liver may rupture, resulting in massive bleeding and death.[109,110] Caged laying hens on high-energy diets are the most frequently affected by FLHS,[111,112] which is a major cause of mortality in commercial flocks.[110] Numerous sources suggest that

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[†] "In May 2003, the five Scientific Committees providing the [European] Commission with scientific advice on food safety were transferred to the European Food Safety Authority (EFSA)…These Committees [including the Scientific Committee on Animal Health and Animal Welfare], composed of independent scientists, were established in November 1997 by Commission Decision 97/579/EC." See: http://ec.europa.eu/food/committees/scientific/index_en.htm.

restriction of movement and lack of exercise, inherent in battery-cage systems, are factors that predispose the birds to this disease.[113-116]

Cage Layer Fatigue

Cage layer fatigue is "virtually unheard of" in laying hens who are not raised in cages. First identified when flocks were moved into cages during the advent of intensive egg farming in the 1950s, the disease continues to be a "major issue"[110] within the industry. Cage layer fatigue is related to osteoporosis in that it is a consequence of skeletal depletion due to high, sustained egg output.[97] The skeletal system of hens suffering from the disease can become so weak that the birds become paralyzed. Affected hens may have fractured thoracic vertebrae associated with compression and degeneration of the spinal cord.[117] However, if they are removed from their cages and allowed to walk normally on the floor (i.e., if they are allowed to exercise) and are given feed and water, some may recover spontaneously.[97,113,118] Unattended birds will die from dehydration and starvation in their cages.[117,118]

Injurious Pecking

Feather pecking is an abnormal behavior that is a continuing welfare problem in poultry production,[119] because it causes pain from having feathers pulled,[120] results in body heat loss,[121,122] and can expose bare skin to injury. Severe feather-pecking can lead to cannibalism and high mortality. Feather-pecking is influenced by many aspects of the environment and the genetic background of the hen, and is notoriously unpredictable.[9] However, crowding, barren environments, and lack of loose litter or other foraging materials are important contributing factors to injurious pecking.[12,24,123-126] Some hen strains are more likely to develop the behavior than others, in particular, the medium-heavy brown hybrid birds.[127] Most egg producers beak-trim birds, as discussed above, to help reduce injury and mortality, but the mutilation impairs welfare, presenting a challenge best articulated by Duncan:

> [N]eural and behavioral evidence suggests that beak trimming reduces welfare through causing both acute and chronic pain. The problem is that beak trimming is carried out for the very good reason of preventing or controlling feather pecking and cannibalism, which can themselves cause great suffering. Faced with this dilemma, what are producers to do? If they do not trim beaks, then feather pecking and cannibalism may cause enormous suffering. If they do trim beaks by conventional methods, the birds will suffer from acute and chronic pain…It is known that feather pecking has hereditary characteristics…and that its incidence may have been increased by unintentional genetic selection….It therefore seems likely that the long-term solution to this problem will be a genetic one…Chopping off parts of young animals in order to prevent future welfare problems is a very crude solution.[128]

Forced Molting

Chickens molt their feathers annually in a process of feather loss and re-growth that can take several months. During the natural molting process, hens may go out of lay completely or lay only very few eggs. Thus, depending on economic factors affecting the marketplace, such as egg price, hens used for commercial egg production are either depopulated and replaced with younger pullets after a year, or they may be kept for a second egg-laying cycle following a forced molt. Force-molting speeds up the natural molt process and causes a temporary regression of the reproductive tract and cessation of egg-laying.

Until recently, most force-molting regimes involved complete feed withdrawal (i.e., starvation). While more than 80% of all U.S. eggs are now produced under the United Egg Producers (UEP) industry program,[129] which no longer permits forced molting by starvation,[2] producers who choose not to adopt the UEP voluntary guidelines may still use feed withdrawal to induce a molt. In starvation molt regimes, feed is withheld for up to 14 days[130] and may be combined with 1-2 days of water deprivation,[131,132] along with a decrease in daylight hours. Hens are then fed a diet formulated to control body weight until new feathering and reproductive function recommences.[13] During forced molting through feed withdrawal, hens exhibit a classical physiological stress response, as well as signs of "extreme distress such as increased aggression and the formation of stereotyped pacing."[7,13] Duncan considers the practice "barbaric," as it can double the mortality of the flock, and leads to "great suffering."[21]

Presently, most hens in the United States are force-molted using a low-nutrient diet made largely from insoluble plant fibers[133] or from bulking agents such as corn, wheat middlings, or alfalfa[134-136] until they lose 10-35% of their body weight.[4,137] Although these feed molts provide at least some nutritional substrate, their welfare advantages over complete feed withdrawal (starvation) molts are not well-established in the scientific literature.

Catching and Transport

Although bred for high egg output, laying hens cannot sustain metabolically taxing levels of egg production indefinitely. Chickens have a natural lifespan of 5-8 years and can live up to 30 years.[138] However, after 1-2 years of intense egg production, so-called "spent" hens are killed on-site or transported to slaughter plants. For flocks to be transported to slaughter, teams of catchers manually remove the birds from cages, typically grabbing hens by one or both legs, pulling them from cages, and carrying 2-4 birds upside-down per hand. Birds may be inadvertently hit against the cage opening, feed trough, or other objects as they are removed. On average, hens removed from battery cages are passed from handlers 3-5 times before they are crated and loaded onto trucks.[139-142]

This process is known to be stressful for chickens, as there is a rise in corticosterone levels when birds are handled, crated, and transported.[13,140,143] The battery cage is poorly designed for removal of hens, and limbs and appendages may be torn when the birds are taken out of the enclosure. Duncan states that "the combination of these three factors—fragile skeleton, poorly designed cage, and low value—results in an unacceptably high injury level" during removal from the cage for transport.[7] Bones weakened by osteoporosis and inactivity are prone to painful bone fractures and skeletal trauma.[7,74,144-147] Freshly broken bones occur often, mainly as a consequence of human handling.[141] In one study, 29% of spent hens had broken bones after transport and shackling for slaughter.[77]

Only a few slaughter plants in the United States accept spent hens. As a result, the birds often endure long journeys during which they may be in pain for significant periods.[7,144,145] Transport is associated with a number of stressors, including noise, vibration, motion, overcrowding, social disruption, and temperature extremes. Hens are also deprived of feed and water prior to, during, and after the journey, as they await slaughter upon arrival at the processing plant.[142,145] Birds are commonly exposed to heat and cold stress during transport, as wind speeds rapidly cool chickens during motion and stationary vehicles can quickly become overheated. Thermal comfort for hens in transit is rarely achieved.[148] Thermal stresses are especially problematic for spent laying hens, as they tend to be poorly feathered, have depressed metabolism due to lack of feed and water, and may be physiologically fatigued. Because spent laying hens have little economic value, there is no incentive for careful handling and transport.[145] During transport, some hens die due to physical damage, disease, and temperature and humidity extremes.[141] Dead on arrival reports vary between approximately 0.1-0.5% for spent hens, with atypical cases of up to 26%.[140,141]

As the market for spent hens has declined,[144,149,150] producers often choose to kill hens on-farm rather than transport them for slaughter. Again, hens must be removed from their cages, enduring the accompanying probability of broken bones, before they are killed, typically gassed with carbon dioxide (CO_2).[151] CO_2 is distressing for chickens to inhale, as it is an acidic, pungent gas at high concentration.[152,153] Some "spent" hens are reportedly conveyed and dropped into massive dumpsters in which they are gassed. In these containers, the gas can stratify,[154] making it difficult to ensure that each hen gets enough CO_2 to kill her. In some cases, not all hens die as a result of gassing and may regain consciousness. There have been reports of surviving hens found at landfills[151] and crawling out of composting piles of dead chickens.[149] Modified Atmosphere Killing (MAK) carts are used by some producers. Although these carts also use CO_2, they are built exclusively for gassing hens on-farm and may involve less suffering for the hens[144,150,155] due to two primary reasons: MAK carts are rolled through shed aisles, meaning the birds are handled for less time before being killed, and may better prevent the gas from becoming stratified.

Slaughter

In the United Kingdom, legal requirements stipulate that birds must be stunned to induce immediate and irreversible loss of consciousness prior to slaughter.[156] However, in the United States, the U.S. Department of Agriculture does not interpret the federal Humane Methods of Slaughter Act as providing protections for birds reared for meat or eggs. As such, no federal law requires that spent laying hens be rendered insensible to pain before they are shackled and killed.[7] Upon arrival at the slaughter plant, hens are hung upside-down in metal shackles and conveyed through an electrical water-bath stunner. They are then killed by automated knife cut to the throat and by subsequent exsanguination. Following the process of "bleed-out," birds are then passed through a scald tank, in preparation for the next step, mechanical plucking of feathers. When birds are conveyed through the electrified water bath, current flows from their head to their feet towards the shackle line. When correctly applied, electrical stunning sends a current through the brain of sufficient magnitude to induce generalized epilepsy and is thought to be accompanied by unconsciousness and insensibility. However, there are numerous concerns over bird welfare when slaughtered using conventional water-bath stunning methods, including the stress[143,157-159] and pain[160] associated with shackling (which is likely worse for spent hens with broken bones),[152,161] pre-stun electric shocks,[162-164] and ineffective stunning.[165]

Some birds are conveyed through the stunner without making contact with the electrified water bath. This can happen if birds are too short to reach the water bath, if the height of the stunner is not correctly adjusted, or if they struggle and lift their heads.[152,166-168] This problem is even worse for spent laying hens. Bruce Webster, a poultry scientist at the University of Georgia, explains:

> Spent hens…differ from broilers [chicken raised specifically for meat production] in that they are much more active, agile and reactive to disturbance.…They are more likely to struggle in the shackle and lift their bodies away from the stunner bath, reducing the probability of making good electrical contact with the stunner. They also can flex their necks so that the head is not the first part of the body to contact the stunner, and the bird gets a pre-stun shock. Birds start back from such a shock and can receive more than one pre-stun shock before being captured by the stunner. Since the head is not part of the electrical contact, these shocks do not stun the bird. Pre-stun shocks tend to make hens even more mobile in the shackles, enabling some to miss the stunner altogether by riding up on the bodies of adjacent birds.[169]

Birds who miss the stunner are fully conscious when their throats are cut. Occasionally, live birds who were not adequately stunned and/or who missed the killing machine are conscious when entering the scald tank.[7,152,170,171] When the birds are submerged in the hot water, they drown.[172]

A more humane alternative to electrified water-bath stunning slaughter is Controlled Atmosphere Killing (CAK).[‡] Using CAK, animals are not handled while they are still conscious, avoiding the problems associated with dumping, handling, and shackling live birds, and there is no risk of pre-stun shocks to conscious birds and/or ineffective stunning. In CAK systems, birds are conveyed through a tunnel filled with carbon dioxide, inert gases (argon or nitrogen), or a mixture of these gases. With CAK, birds are exposed to lethal concentrations of gases and hanging operators do not shackle the birds until after they exit the gas stunning system. The animals do not endure the pain, fear, and stress associated with the live hang step of the electrical water-bath procedure. However, no U.S. spent hen slaughtering plants currently use CAK technology.

[‡] Some gas systems are designed in such a way that birds must still be dumped from their transport crates prior to entering the gas-filled chamber on a conveyer belt. While still retaining many of the welfare advantages of CAK systems, those that move birds through the gaseous atmosphere, preferably with inert gases, while they are still in their transport crates are considered optimal.

Conclusion

The situation for the vast majority of hens in the commercial egg industry is dire. Alternative, cage-free housing, such as aviaries and percheries, have greater potential to provide higher welfare of hens, and the egg industry is increasingly employing these production systems. The scientific basis for moving away from barren battery cages customary in U.S. egg production is extensive. In 2006, a comprehensive analysis of hen welfare in various housing systems was published by the LayWel research project, funded by the European Commission and several member countries of the European Union. This project was a collaborative effort among working groups in seven different European countries that examined data collected from 230 different laying hen flocks.[173] The review noted that "[c]onventional cages do not allow hens to fulfil behaviour priorities, preferences and needs for nesting, perching, foraging and dustbathing in particular. The severe spatial restriction also leads to disuse osteoporosis" and determined that "[w]ith the exception of conventional cages, we conclude that all systems have the potential to provide satisfactory welfare for laying hens."[174]

Indeed, restrictively confined in barren, crowded battery cages, laying hens suffer from behavioral deprivation, metabolic and reproductive disorders, and broken bones. They also experience painful beak-trimming, careless handling, and inhumane slaughter. Innovative technology and systems for housing,[175,176] transporting,[177] and slaughtering chickens exists that could greatly improve the welfare of laying hens if more widely adopted within the industry. Further, selective breeding for skeletal strength[101,178] and reduced propensity to feather peck[179] would further improve the welfare of hens in commercial egg production. Scientific inquiry has clearly shown that battery cages are inappropriate environments for egg-laying hens and that additional improvements are needed to ensure the welfare of hens in the egg industry.

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