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Welfare at Slaughter of Broiler Chickens: A Review

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Abstract: Currently, poultry plants are sacrificing between 140 to 180 broilers per minute; sometimes animals are not sacrificed properly, which makes manual sacrifice necessary. In the present study a review is provided on the most relevant aspects regarding different methods used for chicken sacrifice, these methods are analyzed and a comparison with Mexican regulations is given regarding the humanitarian sacrifice of domestic birds for human consumption. We conclude that the main objective of broiler sacrifice should be the well-being of the animal, it must also be economic, practical and safe for workers. In Mexico, research must be developed to justify adequate use of sacrificial methods and its effect on the quality of poultry meat such as ostrich, turkey and quail.

Key words: Poultry, electrical stunning, carbon dioxide, decapitation, sacrifice, animal welfare

Introduction

Different sacrificial methods can be used on birds: chemical products, mechanical or electrical stunning; whatever sacrificial method is used, it must desensitize the animals throughout the slaughter procedure (Contreras, 2001; González *et al*., 2007). According to Mexican sacrificial regulations (NOM-033-ZOO, 1995) the sacrificial procedure or desensitizing, referred to is the action through which an animal is quickly induced to a state of unconscious. The main objective for the methods used on broilers is to immobilize the chicken for a considerable amount of time, this way allow for handling, reducing carcass damage caused by wing flapping and violent muscular contractions during bleeding (McNeal and Fletcher, 2003; McNeal *et al*., 2003). Concussion is induced by rapid acceleration of the head, causing movement of the brain relative to the cranium (*commatio cerebri*). If the acceleration is sufficiently severe, extensive tissue damage will occur and brain function will be irreversibly impaired (Göksoy *et al*., 1999).

After sacrificing the birds, the most appropriate is to cut the jugular vein and carotid artery, this allows for quick bleeding before scalding (McNeal *et al*., 2003; González *et al*., 2007). It is important to emphasize that the main relevance in sacrifice and bleeding is to decrease the number of live animals that reach the scalding process. a significant number of broiler chickens are not properly stunned, the overwhelming majority of broilers do not have their necks cut efficiently, as a consequence, many birds may recover consciousness as they bleed to death which will result in their suffering considerable distress. Some may be alive when entering the scalding tank (Stevenson, 1993). Thus, the objective of the present review was to analyze the most relevant aspects regarding different methods used for chicken sacrifice, these methods are analyzed and a comparison with Mexican regulations is given regarding the humanitarian sacrifice of domestic birds for human consumption.

Desensitization methods: Today poultry plants are sacrificing between 140 to 180 broilers per minute, sometimes birds are not adequately desensitized due to lack of chicken uniformity or because equipment is poorly adjusted, which occasionally makes it necessary to manually sacrifice (McNeal and Fletcher, 2003; McNeal *et al*., 2003). In particular, they said that they were not confident that electrical stunning of poultry is as reliable as it is claimed to be. They also stressed that when the neck is not properly cut some birds will enter the scalding tank before they are dead and some may display obvious signs of consciousness (Stevenson, 1993). As only a certain proportion of broilers are killed in the stunner, it is vital that neck cutting should be efficient so that the other birds die as quickly as possible, thereby minimizing the risk of their regaining consciousness during bleeding out. As will be seen, however, neck cutting is nearly always not efficient and

some broilers do indeed regain consciousness during bleeding out. A cardiac arrest should be induced at stunning to avoid the problems associated with inefficient neck cutting, which are only too common in poultry processing plants (Gregory and Wilkins, 1990).

In order to evaluate the effectiveness of a certain desensitization method, the following aspects must be taken into consideration in order to assure high-quality sacrifice for the chicken: a) the technique must produce quick desensitizing with minimum pain, b) It must be secure for the worker and c) must be economical. Different methods of desensitizing most commonly used on broilers are described.

Manual neck breaking: This dislocation technique consists in breaking the atlanto-occipital of the bird and has two variants: the first one consists of breaking the neck while holding the wings. The bird must be held by the left hand so that the head looks towards the worker, then the wings must be taken from the base and folded towards the front; then the neck of the bird is taken between the middle and index fingers of the right hand, leaving the palm of the hand over the head of the bird; then the index and ring fingers are placed under head and must be bent backwards, in such a way that the articulation is dislocated and the spinal cord breaks in one quick movement. The second variant is decapitation while holding the legs. First the torso of the bird is held along the tip of the wings with the left hand, in such a way that the bird's position is vertical, then the head of the bird should be taken with the right hand with the palm over the skull and surrounding the neck with the thumb and index finger. Then the head should be bent down pressing the middle and ring fingers under the beak; once the head is in this position movement is carried out with both hands, with the subsequent disarticulation (Libby, 1975; Craig *et al.*, 1999; Quintana, 1999).

Manual neck breaking is used most frequently on chicken older than 10 weeks, its use on reproductive birds such as roosters and turkeys is not frequent, since it is hard to apply (Quintana, 1999). According to Mexican regulations manual neck breaking is only recommended for rabbits or rodents and is not recommended for poultry.

Decapitation: Decapitation is most convenient when it is necessary to obtain blood samples from animals that will be sacrificed; there is an advantage to said procedure that does not affect the brain when used for histopathological studies. The decapitation technique with scissors is carried out by cutting the neck of the bird rapidly to avoid animal suffering. The blades of the scissors must be of adequate length, well adjusted and sharp (Libby, 1975).

According to the American Association of Veterinary Medicine the poultry decapitation method is considered acceptable, but it is considered unacceptable from the animal welfare point of view. This technique consists basically on cutting the carotid artery and the jugular vein along the neck (unilateral cut) (Craig *et al.*, 1999). According to Mexican regulation (NOM-033-ZOO, 1995), decapitation refers to the separation of the head from the body with a sharp object, using one firm and straight cut and should be used as an individual emergency sacrifice on birds, depending on their size and the species, according to the above mentioned, this can also apply to cervical dislocation or gunshot (under the left wing).

Electrical stunning: Electrical stunning is the most common method used prior to slaughter in commercial poultry plants. Although five types of electrical stunning systems are available, the most common system is electrical water bath stunning (Göksoy *et al.*, 1999). Electric stunning is normally performed by immersing the animal in water using 50 V of altering and sinusoidal current at a frequency of 50Hz for 46 sec/chicken. The current flows from the head to the holding hooks, provoking an epileptic attack that leads to desensitizing and direct stimulation of the muscular mass. The electrical flux received by each bird under this condition should be between 40-45 mA. But in practice the electrical flux can vary and depends on the size of the bird, the conditions of the feathers (usually the feathers are wet and the current circulates over the surface of the feathers-and desensitizing is not adequate) and possibly body composition as well (the fat works as an insulator). Frequently equipment malfunctions and often do not have enough mechanical control making operation difficult. Birds can also receive a discharge before entering the bath caused by defects in the machinery or because of prolonged submersion, water inhalation and electric discharge to wings or breasts; in some cases the speed which they pass through the bath can affect them as well exciting the birds while hanging. All the before mentioned as well as other factors not yet known could provoke variations in the resistance of the chicken and electric current (as a matter of fact some resistance is induced when connecting birds in parallel). This procedure is criticized since a mere 60 to 90% of the birds are desensitized effectively.

A high-quality electric stunning is produced when the electric current is sufficient and passes through the Central Nervous System (CNS) of the chicken. McNeal *et al.* (2003), pointed out that when using high voltage (105 mA to 110 mA), the bird can reach 90% heart fibrillation and lowers the chance for the chicken recovery during sacrifice. They observed severely affected CNS caused

by high voltage frequencies (500 Hz) (McNeal *et al.*, 2003). According to Gregory and Austin (1992), the purpose of desensitizing with high voltage is to induce epilepsy in the chicken's brain; this was observed in a encephalogram, nevertheless elevated current increased the incidence of broken wings and bones, dislocations, deep breast muscle hemorrhages as well as congestion in wings veins. The incidence of shoulder hemorrhages and red wing tips was highest between 111 and 150 mA and breast muscle hemorrhages increased after 130 mA.

The increasing effect of higher electrical currents on the incidence of broken bones was observed by Gregory and Wilkins (1990). During conventional water bath stunning, electrical current passes through the whole body, causing muscle contraction, broken bones and breast muscle hemorrhages (Hillebrand *et al.*, 1996). The use of electrical stunning with higher stunning frequencies, e.g. 1,500 Hz, to prevent chicken from ventricular fibrillation and downgrading results in fewer broken bones than stunning with 50 Hz (Gregory *et al.*, 1990). Concussion-stunned birds had less broken or dislocated bones than the electrically stunned birds, which was associated with fewer hemorrhages. Hence, this method could reduce downgrading problems. A further advantage would appear to be an earlier onset of rigor and tenderization of the meat, which would allow earlier deboning, saving on chiller space (Göksoy *et al.*, 1999).

Gregory and Austin (1992) used elevated amperage in a study using 60 to 110 mA, the incidence of ventricular fibrillation increased from 20 to 99%, which did not allow the chicken to recover after the electrical process (that means that chicken died due to electrically inducted fibrillation and subsequent neck cutting and bleeding). It is well known that higher amperage causes increased deterioration of breast muscle, hemorrhages and an increment of broken bones (Craig and Fletcher, 1997). On the other hand Craig *et al.* (1999) determined that high amperage slows the development of *rigor mortis* approximately 6 h (50 mA *vs*. 125 mA). The desensitizing results showed that in this case it slowed the development of *rigor mortis*, while an electric *post mortem* stimulus accelerates *rigor mortis*.

The effects of the electric desensitizing on *rigor mortis* can be observed on the metabolic index *post mortem* of birds (eg. glycolysis, lactic acid accumulation, ATP depletion, change in length of sarcomere) and changes in breast pH, as well as negative impact on early blood loss and deterioration of meat quality (Sams, 1999). There is evidence that the electric stimulation rapidly slows pH which accelerates the development of *rigor mortis* (Sams, 1991; McNeal *et al.*, 2003).

Due to the importance of humanitarian chicken sacrifice and the quality of meat, several authors have published reviews on the subject (Gregory and Austin, 1992). Humanitarian poultry sacrifice using electrical stunning (desensitizing) when not carried out properly can lead to the chicken recovering consciousness (Mountney and Parkhurst, 1995). Stevenson (1993), stressed that the problem of broilers regaining consciousness before death could be eliminated by: using a current of at least 120mA for stunning and cutting both carotid arteries. The Mexican official regulation (NOM-033-ZOO, 1995), defines humanitarian sacrificing of birds as: bleeding by cutting the carotid artery through the mouth hole immediately after desensitizing, pointing out that birds should be bleed and dead before introduced to the scalding tank; desensitizing must be carried out by immersion of the head in electrified water or electrical arcs and the length of time applied, voltage and amperage will depend on the type of equipment used and manufacturers recommendations.

The minimum current used will vary from 80 to 120 mA per bird and must be carried out for a minimum of 4 seconds. Nevertheless in most slaughter plants the use an alternative current of 5 to 6 mA per bird is applied for 10 seconds, which occasionally provokes insufficient bleeding and an increase in the incidence of low quality poultry carcasses (Richardsond and Mead, 2001). The essence of the problem is that the time taken by a chicken to die varies enormously, depending on which blood vessels in the neck are cut. Neck cutting methods in use include cutting one carotid artery and one jugular vein; cutting the spinal cord; cutting both jugular veins; and cutting just one jugular vein. Most automatic neck cutters in current use sever the back or side of the neck and very rarely cut the carotid arteries. As a consequence, unless the bird was killed at stunning (and many are not killed then), there is a real chance that consciousness can return before it dies (Stevenson, 1993).

Carbon dioxide: Carbon dioxide inhalation induces breathing and metabolic acidosis, therefore it reduces the pH of the cerebrospinal fluid (CSF) which in turn causes the loss of consciousness and death after prolonged exposure (Buhr *et al.*, 1997; Kang and Sams, 1999).

In order for this practice to be effective, containers or appliances that allow for the required concentration of gas can be precisely measured. The equipment used must be designed, built and maintained in such a way that the animals can be observed and are not hurt. To induce gas on broiler containers must be hermetically sealed before liberating CO_2 in order to control the gas. The container must be filled with CO_2 progressively so that all birds can be exposed to a concentration of >40% until they expire; in some circumstances a vaporizer is needed to stop the gas from freezing. Equipment that precisely measures gas concentration must be used for the animals (Buhr *et al.*, 1997).

Carbon dioxide can be mixed in different proportions with nitrogen or inert gas such as argon. Inhalation of such mixtures induces hypoxia-hypercapnia and later death when the concentration of oxygen per volume is ≤2%. These mixtures do not induce immediate loss of consciousness and from this point of view, animal welfare must be taken in to account. Unnecessary suffering is caused by diverse gas mixtures containing high concentrations of CO_2 and insufficient breathing is experienced in the induction phase (Poole and Fletcher, 1995).

The advantages of desensitizing birds with gas have a favorable affect on meat quality since fewer broken bones and muscle hemorrhages occur on carcasses. Nevertheless, during gas desensitizing, the amount of CO_2 is normally increased and oxygen levels in the blood are decreased, which could possibly provoke physiological effects that may influence bleeding by reducing the vein return due to a peripheral vasodilatation. Hypoxemia can also cause blood retention in muscles due to arteries associated with hypotension. As a result, it would be expected that physiological effects would produce reduced bleeding for chickens desensitized with gas, which would increase incidence of side effects on carcasses (Raj and Gregory, 1991).

Raj and Gregory (1991), carried out experiments where the efficiency of bleeding was evaluated after being desensitized with: 1) 45% carbon dioxide in the air for two minutes, 2) 2% oxygen (mixed with argon) for 2 min and 3) electric current (77 and 104 mA a 50 Hz for 4 seg). The authors did not observe any significant difference between the various treatments regarding blood loss after decapitation. On the other hand Kang and Sams (1999), used 40 to 60% CO_2 concentrations in a tunnel for 25 seconds to desensitize farm chickens. The CO_2 gas caused asphyxia in an atmosphere with <2% oxygen (air was displaced by CO_2) for 2.5 min with acceptable results. Desensitizing with CO_2 is an interesting alternative to electrical desensitizing, since it reduces damage to the carcasses and accelerates the development of *rigor mortis* (Kang and Sams, 1999).

Conclusions: We conclude that desensitizing methods used for sacrificing broilers must maintain animal welfare in the highest consideration, regardless of the method used, it must be economic, practical and safe for the worker, too. Further research must be developed in Mexico justifying adequate use of these methods and the consequences on ostrich, turkey and quail meat.

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