AVIAGEN BRIEF

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Addressing Carcass Quality Issues at the Processing Plant

Dr. Sarge Bilgili, Professor Emeritus, Auburn University

INTRODUCTION

Poultry is the fastest growing sector in the animal protein (meat) industry and one of the most widely consumed meats in the world. The increase in demand, along with population growth, increasing disposable income and consumer choices, has made it more important than ever for producers to take a closer look at any issues that may arise in the processing plant.

According to the Food and Agriculture Organization of the United Nations (FAO), chicken meat represents approximately 88% of worldwide poultry meat output and in 2014, accounted for approximately 96 million tons of meat (FAO, 2014). It is also estimated that since the year 2000, the global average for eviscerated carcass weight had increased from 1.44 kg (3.17 lbs) to 1.55 kg (3.42 lbs). Looking at this from an economic standpoint, the processing plant is truly the only profit center in an integrated poultry company.

The purpose of this article is to emphasize the importance of correctly addressing issues within the processing plant. After the producer has worked hard to get the correct number of birds for processing, reducing issues at the processing plant helps guarantee the most profitability for the producer. Key areas of focus will be:

- Processing overview
- Transport/Receiving
- Live-Hang
- Stunning
- Bleeding out/Scalding
- Defeathering
- Evisceration
- Chilling

BIRD HANDLING

It is important that all birds are handled in a calm and correct way at all times. All people handling birds (for catching, weighing, physical assessment, crop fill assessment, or vaccination) should be experienced and appropriately trained so that they can handle the birds with the care that is appropriate for the purpose, age, and sex of the bird.

PROCESSING OVERVIEW

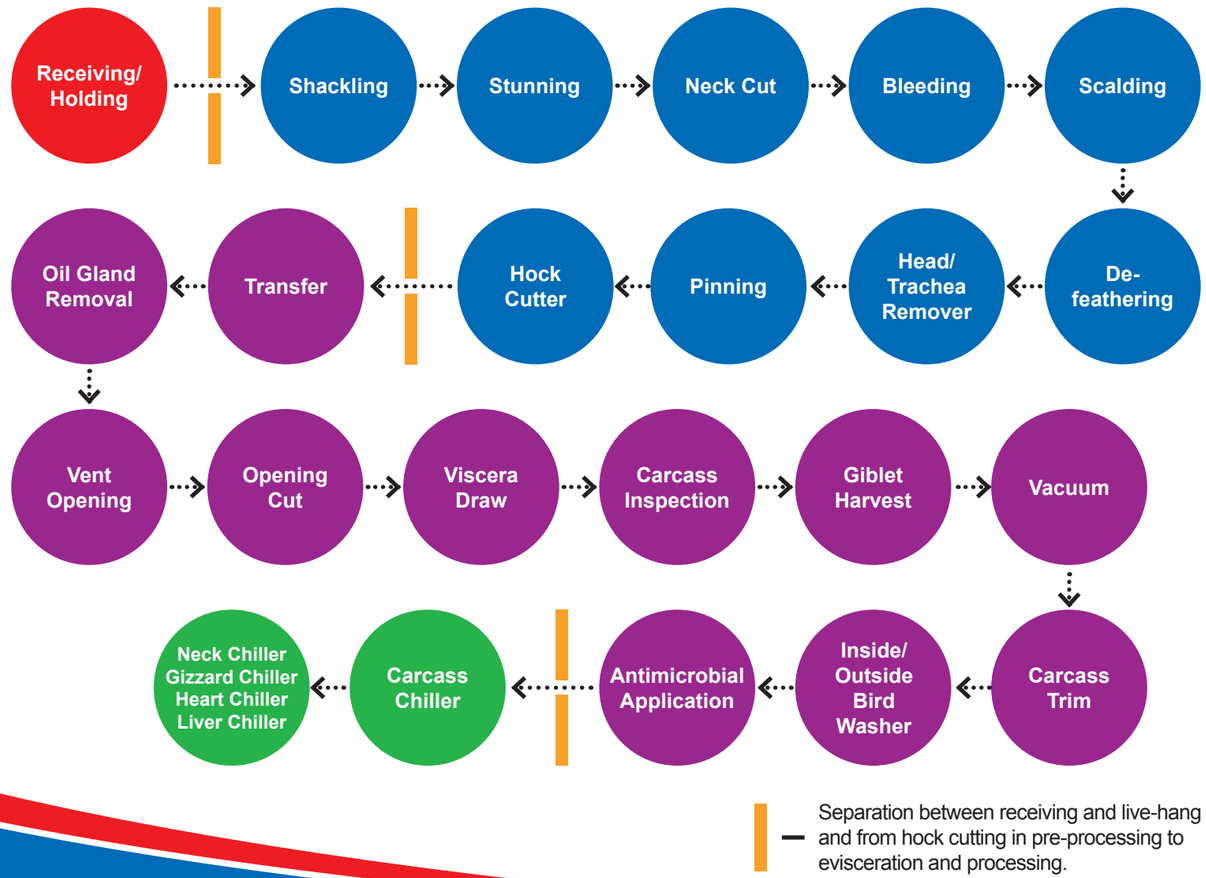
HIGH-SPEED PROCESSING

One of the key aspects of mechanized processing is high input-high output. It also includes characteristics such as:

- High speed slaughter/processing lines.
- Sanitation and hygiene procedures.
- Veterinary and government oversight (inspection).
- Sizing, portioning and forming.
- Ready-to-cook and ready-to-eat production.
- Fresh and frozen storage.
- Distribution infrastructure.
- By-product and waste processing.
- Water treatment.

Figure 1 describes the flow of the broilers from receiving into the processing plant to being shipped as a product.

Figure 1: Processing plant flow chart (red circle indicates receiving and holding, blue circles indicate slaughter and pre-processing, purple circles indicate evisceration and processing and green circles represent organ and carcass chillers).



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The processing plant is the midway point in the farm-to-fork food chain. Parameters such as bird live weight, FCR, welfare, livability and cost are monitored during production; whereas factors such as safety, quality and yield are emphasized during processing. The formula is simple – healthy birds, combined with sanitary processing and inspection produces safe and wholesome poultry meat.

TRANSPORT/RECEIVING

TRANSPORT TO THE PROCESSING PLANT

Transport of broilers from the farm to the processing plant is one of the most important steps in producing a quality meat product. Catching, crating, loading and transporting must be performed carefully so as not to cause bruising, broken bones, stress or mortality. These factors will lead to downgrades or condemnations in the plant resulting in loss of product and profit. Incorrect transport practices do not only affect the live bird, but may affect meat quality as well. By its nature, transport alters both the metabolism and physiological state of the bird, which may produce undesirable changes in meat quality (Zhang, et. al, 2009). Controlling the micro-climate (i.e. temperature and humidity birds are exposed to within the containers) is extremely important in reducing the level of thermal stress. This is accomplished by either facilitating better airflow among the birds (warm climates) and/or controlling the wind-chill by the use of covers (cold climates (**Figure 2**)).

Figure 2: Shielding birds from the cold during transport.

Transport time to the plant plays a key role in the end quality of poultry meat products. Scheduling should be done so that broilers arrive at the processing plant between 8-12 hours after the removal of feed. This allows sufficient time for birds to empty their gut, creating fewer problems with fecal material contaminating the carcasses. If held longer than 12 hours, the bird's intestinal lining will begin to break down, increasing contamination rates and reducing carcass yield.
A good method to use for calculating total feed withdrawal time can be found in the following formula:

Feed Withdrawal Period = Time in House Without Feed + Catching Time + Transport Time + Holding Time (Lairage)

It has also been noted that the longer the journey from the farm to the plant, the higher the incidence of breast bruising (**Figure 3**). This may be caused because the birds are confined to crates for longer periods of time, resulting in the breast muscle having contact with the rigid floor of the crate. Bruising incidence is worsened if the transportation route from the farm to the plant includes roads with uneven surfaces. Although it is not uncommon for transport time to take between 1-7 total hours, the less time the bird can spend in transport, the better for the live bird and meat quality.

Figure 3: Example of breast bruising.

RECEIVING BROILERS AT THE PROCESSING PLANT

Once birds have arrived at the plant there will most likely be a certain amount of time that they will have to wait before being unloaded onto the receiving dock. Depending on the season of the year and the amount of time traveled, this can pose potential problems for the birds. The longer birds are held, the greater the risk for skin scratches and lesions which may cause downgrading at processing.

Although it is recommended that broilers only have to spend a short time being held on the truck once they arrive at the plant (2 hours or less is preferred), some processing plants are equipped with environmentally controlled holding areas with fans and foggers that allow cool air to circulate around the crates, cooling the birds (**Figure 4**). This is especially helpful during the summer months when temperatures are the hottest. During the colder months, it is recommended to use a covering (tarpaulin) to help shield the birds from the cold but still allow air to flow between the crates.

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Figure 4: Examples of bird-holding areas.

SHACKLING

The live-hang area of the processing plant is one of the busiest areas of the process in terms of labor use. Because of the high volume of birds that come into a plant on a daily basis and manual shackling procedures, employees must work quickly to ensure that all birds are not only shackled and enter the processing line in a timely manner, but also in optimal quality with minimal handling damage. Extreme care and a high regard for bird welfare should be observed during this process as there is still a chance of injury to the live bird. If done incorrectly, shackling can cause bruising, broken wings, red wing tips and broken legs.

It is highly recommended that low light levels in this area be used to help calm the birds (**Figure 5**). Under low light intensities, birds are less likely to become excited and accidentally injure themselves. In some locations, blue light is also used for the same purpose. Broilers should always be handled with care by individuals who have been trained in the correct shackling techniques.

Figure 5: Example of a correctly shackled bird under low lighting conditions.

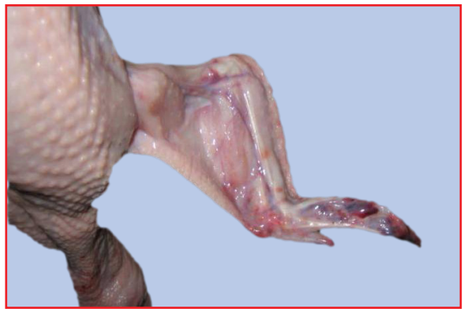
STUNNING

Stunning is a process that is used to render a bird unconscious prior to killing and to facilitate bleeding. The two most common methods are water bath electrical stunning systems and gas stunning systems, which are viewed positively from an animal welfare standpoint.

Electrical stunning is typically performed in the range of 12-150 mA (milliamps) of electrical current per bird for a duration of 2-11 seconds. Stunning is an extremely important step because if done incorrectly, it can affect carcass quality, blood loss, and meat quality (**Figure 6**). The effects of electrical stunning on final meat quality are dependent on the voltage, frequency and duration used (Huang, et.al, 2014). It is important to note that the time of unconsciousness increases with an increase in the voltage; however, carcass damage may also be increased. If the stunning voltage is too high, wing and muscle hemorrhages may occur. If the voltage is too low, birds may only be partially unconscious and can become excited, causing muscle tension and insufficient bleed out. The three most common methods of electrical stunning are high-voltage/low frequency (HS), middle voltage/low frequency (MS) and low voltage/high frequency (LS), with the HS method being most commonly used in Europe, the MS method in Asia and the LS method in the US. The main concern for electrical stunning is to correctly and humanely prepare broilers for bleeding and to limit the suffering associated with humane killing.

Gas stunning is different from electrical stunning in that it is not instantaneous. However, because birds do not have receptors for nitrogen and argon (two of the most common gasses used in gas stunning), they do not feel any distress in the minutes leading up to unconsciousness. The most crucial part of a gas stunning system is to take into account advice from qualified experts who can determine the correct flow rate in which the gas is delivered and the correct gas to use.

Figure 6: Red wing tips caused by improper stunning setting.



BLEEDING/SCALDING

BLEED-OUT

During the bleeding process, about 40% of the total blood volume drains from the broiler carcass, 3 to 5% stays in the muscles, and the rest remains in the viscera (Plumber, et.al, 2012). If the bird has been correctly stunned, the heart will continue to beat during the allotted bleed-out time, helping to pump blood out of the carcass. Worldwide, it is common to use a bleed-out time of between 90 to 150 sec. Poorly bled carcasses exhibit dispersed redness on the carcass, which can lead to downgrading (**Figure 7**) or condemnation of the whole carcass. Proper bleeding also permits maximum collection of blood as a by-product (blood meal) and significantly decreases the amount of blood in the scalder and floor drains, decreasing the organic content (Biological Oxygen Demand) of the waste-water (Kuenzel and Ingling, 1977).

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Figure 7: An example of poorly bled-out carcass.

SCALDING

Scalding is a process by which the birds are immersed into hot water in single or multi-stage tanks to help loosen the feathers prior to defeathering. Most processing plants use scald times of 1 to 3.5 minutes, depending on the type of scalding required. Most commonly, soft (52-54°C, 125-130°F) and medium (55-57°C, 131-135°F) scalding temperatures are recommended for yellow (skin cuticle intact) and white (skin cuticle removed) skin color. Intact cuticle is preferred in whole or cut-up broilers marketed as fresh. Under hard-scalding (54-60°C, 130-140°F), birds typically remain in the scalder for 45-90 seconds. Soft-scalding, however, requires a longer time of 120-210 seconds to facilitate proper feather removal. In both cases, proper agitation of the scald water is essential for effective wetting of the feathers. If the scalding temperature is too high, carcass color may appear uneven and the fillets can have an almost “cooked” appearance from heat induced denaturation (**Figure 8**). If the temperature is too low, it may cause “barking” or un-even removal of the skin cuticle (**Figure 9**).

Figure 8: Over-scalded breast.

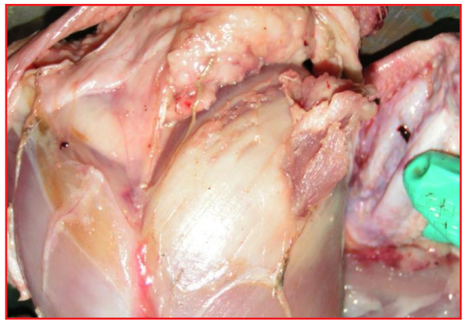
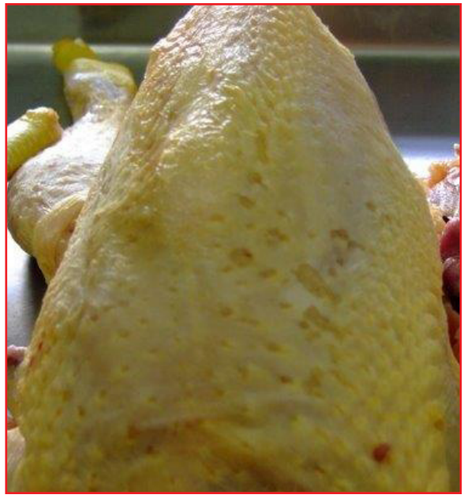


Figure 9: Skin barking.



DEFEATHERING

After the birds have been sufficiently scalded, they enter a series of defeathering machines in which rotating disks with these rubber fingers help remove the feathers from the bird without damaging the carcass. However, if placed incorrectly in the machine, these rubber fingers can also cause improper feather removal, broken wings, skin and muscle tears and carcass bruising (**Figure 10**). Both scalding and defeathering processes are considered important sites of cross-contamination, increasing the risk of spreading bacteria from the skin of a contaminated bird to ones that are not contaminated.

In the scalder, it is essential that the water move against the birds in a counter-current direction. This helps to remove feces from the carcass and ensure that as the birds move along the scalder line, they are moving through the cleanest water before entering the defeathering machine. The rate of water flow should also be high, making sure to dilute and properly remove any feces from the carcasses. If regular checks to the scalder are not made, any fecal contamination left on the carcass can transfer to the defeathering machine. This, in turn, can act as a source of cross-contamination by spreading bacteria from one carcass to another through the rubber fingers on the defeathering equipment.

Any damaged, worn, broken and missing rubber fingers in defeathering machines should be replaced daily to assure proper “break-in” period and to make sure that carcass damage is not occurring (**Figure 11**).

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Figure 10: Examples of poor defeathering, broken wing and bruising associated with defeathering.

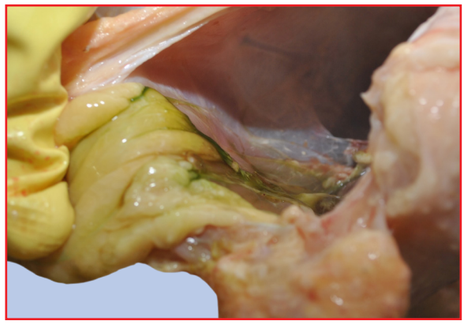
Figure 11: Carcass that has become damaged in the defeathering machine.

EVISCERATION

Evisceration is one of the most critical points for carcass contamination along the route to the finished product. If the broilers have not had long enough to empty their intestinal tract before killing and if there is viscera damage during evisceration, then carcasses can easily become contaminated with the contents of the digestive tract. As a general rule, a maximum of 8-12 hours without feed is needed to ensure that the gastro-intestinal tract is empty without reducing bodyweight before beginning processing. However, if the birds have gone too long without feed (13+ hours) the intestinal linings may break during evisceration, causing bile and other fluids to leak onto the carcass. If contamination occurs, the carcass must be washed, trimmed or reprocessed, which is both expensive and time consuming (Bilgili, 2010). **Figure 12** shows an example of uncontaminated birds with their viscera, while **Figure 13** illustrates an example of a contaminated carcass that will have to be reprocessed.

Figure 12: Clean, uncontaminated birds and their viscera.

Figure 13: Example of a carcass contaminated with bile that must be reprocessed.



CARCASS CHILLING

The two most common methods of carcass chilling during processing are water immersion and air chilling (**Figure 14**). Immersion chilling involves placing carcasses into a counter flow water system at 0-1°C (32-34°F) for 1.5 to 3 hours depending on carcass weight. The aim is to reduce deep muscle temperature to <4°C (40°F) to inhibit the growth of microorganisms. One of the key issues in water immersion chilling is to maintain a free chlorine level of about 5 ppm to reduce the likelihood of cross-contamination. This can be difficult since large numbers of birds entering the chiller introduce organic material that decreases the levels of free chlorine in the chiller.

Air chilling systems are growing in popularity, partly due to the fact that there is less water uptake of the carcass than with immersion chilling. Air chilling systems are characterized by chilling carcasses in environmentally controlled rooms with forced air. Because the rate of heat transfer is much slower with air than in water, it takes much longer to air chill. However, carcasses must reach 4°C (40°F) or less within 16 hours.

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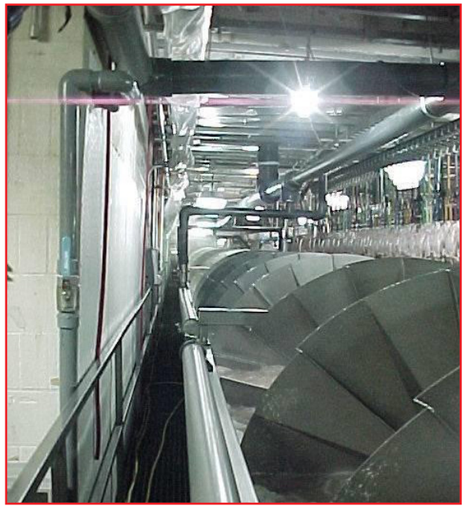
Figure 14: Examples of water immersion and air chilling systems.



KEY POINTS

- Catching, crating, loading and transporting must be performed carefully so as not to cause bruising, broken bones, stress or mortality.
- Broiler feed withdrawal time should be between 8-12 hours before processing and birds should have to wait no longer than 2 hours to be unloaded off the truck.
- Extreme care and a high regard for bird welfare should be observed during shackling as there is significant chance of injury to the live bird (bruises, broken bones and red wing tips).
- It is recommended to use low light levels or blue light in the receiving and shackling areas to help to calm the birds.
- Electrical stunning is typically performed in the range of 12-150 mA (milliamps) of electrical current per bird for a duration of 2-11 seconds.
- Gas stunning system should take into account advice from qualified experts who can determine the correct flow rate in which the gas is delivered and the correct gas to use.
- It is recommended that a bleed-out time of between 90 to 150 seconds be used.
- Most processing plants use scald times of 1 to 3.5 minutes, depending on the type of scalding required.
- Most commonly, soft (52-54°C, 125-130°F) and medium (55-57°C, 131-135°F) scalding temperatures are recommended for yellow (skin cuticle intact) and white (skin cuticle removed) skin color.
- Any damaged, worn, broken and missing rubber fingers in defeathering machines should be replaced daily.
- Every effort should be made to maintain sanitary evisceration conditions and if contamination occurs, the carcass must be washed, trimmed or reprocessed.
- Chilling of carcasses through water and/or air chilling is critical to reducing microbial growth and extending shelf-life. For either system, carcasses must be chilled to 4°C (40°F).

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1 Receiving and Holding

Adequate ventilation to minimize mortality and live shrink.

Process birds in a timely manner so that intestinal integrity is maintained and breakage during evisceration is minimal.

2 Unloading & Shackling

Carcass bruises.
Red wing tips/Broken wings.
Broken legs.

Check:

- Catching and unloading procedures;
- Shackling procedures;
- Light intensity during shackling;
- Bird movement prior to unloading, during and after shackling.

Carcass Bruising

Red Wing Tips

Broken Wing

Broken Leg

3 Stunning

Wing hemorrhages.
Red skin condition.

Check:

- Stunner settings are correct.

Wing Hemorrhages

Red Skin Condition

4 Neck Cutting

Take care that the toe and head guide bars are positioned correctly as to not sever the trachea and esophagus during neck cutting. Doing so can lead to difficulty when removing the head and lungs.

5 Bleeding

Poor Bleeding.

Check:

- Chilled birds;
- Stunner settings;
- Type and effeciency of neck cut;
- Bleeding time.

Poor Bleeding

Poor Bleeding

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6 Scalding

Carcass/meat discoloration.
Skin tears/barking.

Check:

- Scalding time, temperature and agitation.

Meat Discolouration

Skin Tears

Skin Barking

7 Defeathering

Poor defeathering.
Broken legs.
Wing damage.
Carcass bruising.

Check:

- Defeathering settings,
- Defeathering machine finger replacement;
- Adjustment of fingers.

Carcass Brusing

Broken Wing

Broken Leg

Poor Defeathering

8 Vent Opening

Carcass fecal contamination.

Check:

- Equipment settings, adjustment or replacement,
- Carcass washers.

Carcass Fecal Contamination

9 Crop Removal/ Opening Cut

Machine damage to carcass.
Viscera and carcass contamination-bile/feces.
Ingesta contamination.

Check:

- Uniformity of opening cuts, evisceration equipment;
- Crop removal equipment.

Machine Damage

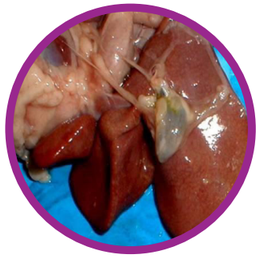
Bile Contamination

Fecal Contamination

Ingesta Contamination

Viscera/Giblet Contamination

Giblet Abnormalities



10 Viscera Draw/ Giblet Removal

Viscera/giblet contamination.
Giblet abnormalities.

Check:

- Evisceration equipment;
- Giblet removal equipment;
- Nutrition on farm;
- Health issues.

11 Chilling

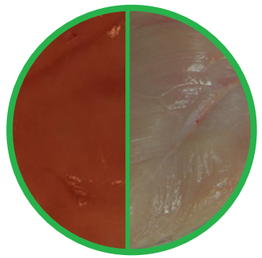
Dehydration.
Excessive moisture pick-up.

Check:

- Air chilling time, temperature, and air flow;
- Water chilling time, temperature, and agitation;
- Excessive skin openings;
- Drip time.

Dehydrated Carcass

Difference Between Normal fillet (left) Excessive Moisture (right) Pick-up



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