The Science of Litter Management®

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The Role of House Management in Antibiotic Free Operations

Antibiotic Free (ABF) poultry production involves the rearing of poultry without any antibiotic addition whatsoever—no antibiotics in the hatchery vaccines, none in the feed and none in the drinking water if the birds should become sick. Some producers take this concept even further by completely eliminating all drugs from their programs and feeding a vegetarian diet. While ABF production is of questionable value to the birds in terms of health and welfare, and has potentially negative environmental implications due to the loss in feed efficiency, it is of increasing value to the consumer.

Consumer groups, retail food stores and restaurant chains are increasing their requirements for the meat they consume and sell to be ABF. Recently, Chick-Fil-A, the largest chicken fast food chain in the US, announced they will only purchase ABF product by 2019. The level of consumer demand shows no sign of abating and many other restaurant chains are expected to follow Chick-Fil-A's example. It seems that the US is heading down the same road as Europe where retail customers and consumers dictated the removal of antibiotics from animal production long before the regulatory agencies followed suit. For those integrators who desire to sell to this market, making the change can prove more challenging at times than the increase in price per pound they receive for their product.

When PLT® was first introduced to the poultry market, the focus was on the bacterial control properties of the product. However, our customer base was much more excited about the ammonia control properties of SBS and that quickly became the main focus of the Jones-Hamilton sales efforts. However, the shift in litter ecology from the use of SBS is a critical component to its efficacy and is critical in an ABF operation. The use of LS-PWT2®/PWT® for crop acidification enhances the effects of PLT® in the litter by adding a second front in determining the type of microflora that establishes in the birds' GI tract. PLT® is unique in that it can be added with birds in the house helping to maintain proper litter microflora at times of high risk to the bird.

Successful implementation of an ABF program requires several components that can intertwine with each other:

- Deliberate management of intestinal microflora
- Increased proficiency in house and litter management
- Decreased pathogen pressure

Management of Intestinal Microflora

The rapid establishment of healthy, normal intestinal microflora is of utmost importance in an ABF program. The sooner the normal flora can be established, the less likely the bird's gut will be colonized by unwanted bacteria such as salmonella and clostridium. Chicks are born with an essentially sterile gut. Because of this, the first seven days of the chick's life are critical for determining which bacteria will become a resident in the intestinal tract of that bird. Salmonella, for example, plays a game of musical chairs inside the chicken. It must have a receptor site or "chair" to sit on in order to infect the bird. Once those receptor sites are full with normal gut flora, food-borne pathogens such as Salmonella have a very difficult time infecting the chicken. This is the basic premise behind both competitive exclusion (CE) products administered in the hatchery and acidifying litter treatments used in the house prior to chick placement. Both types of products are used to influence which bacteria the chicks will be exposed to first. CE seeks to accomplish this by directly providing healthy bacteria into the intestinal tract of the bird. Litter treatments are used to suppress the growth of pathogens thereby shifting the dominant bacterial population in the litter to healthy flora which prefer the low pH and higher sodium growth environment. Because it takes several days for the CE products to become fully established, they should always be used in conjunction with a litter treatment and water acidification to reduce the initial Salmonella load within the chicken house and protect the bird from exposure until the CE product can replicate and fill the GI tract. Reducing the Salmonella challenge that the chick faces in the first seven days of life greatly reduces the amount of Salmonella on the carcass of that chicken at the time of processing.

The Role of Litter and Water in Establishment of Healthy Intestinal Microflora

Acidifying the litter with sodium bisulfate shifts microbial ecology of the litter to one that is more favorable to the normal flora and desirable lactic-acid producing bacteria present in the litter. Work by Pope and Cherry (2000) showed that the application of PLT® litter treatment (sodium bisulfate) to litter prior to bird placement resulted in a 2-3 log decrease in total litter bacteria and *E. coli* respectively. Sodium bisulfate (SBS) is a dry, granular acid salt that is approved by the EPA as a litter acidifier and by the FDA as an animal feed and water additive. The hydrogen ion of the SBS reduces the pH of the litter and floor pad environment providing acidic pressure on bacteria while the sodium component exerts osmotic pressure. These are the two synergistic components of SBS that account for its bactericidal activity. The safety and ease of use of dry granular acid salts allows them to be applied in the presence of animals so that the timing of each application can be customized to the specific need. In addition, the pKa of SBS is below the endpoint pH desired for water application allowing for increased palatability and consumption when delivered through the drinker system as a water acidifier.

Sodium bisulfate applied to the litter has been shown in both laboratory and field studies to reduce the Clostridial load in the litter as well. In the laboratory trials conducted by USDA-ARS and Mississippi State University (Mutalib et al. 1997), recycled litter seeded with *Clostridium perfringens* maintained a litter population of 103-105 cfu/g of litter. After treatment with sodium bisulfate (SBS) at the rate of 50lbs/1000 sqft, litter pH was reduced to 2.0 and levels of Clostridium were zero (see Table 1). In one field study (Terzich, 1997), three farms in North Carolina with a history of gangrenous dermatitis were treated with sodium bisulfate applied to the top of the litter surface at Day 1 and Day 21. The treated houses had Clostridial levels in the litter 2-3 logs lower than the control houses. In addition, mortality from GD was reduced by 75% and onset was delayed for over 2 weeks from historical average. Repeated applications for 3-4 growouts were necessary to eliminate clinical expression of disease on the farms. In a study conducted in Norway (Garrido et al, 2004), researchers showed that acidifying the litter to a 2.8 prior to bird placement resulted in lower levels of *C. perfringens* and *Enterococcus* sp. In the intestinal tracts of birds raised on the acidified litter compared to the controls.

Sample Number	Negative Control cfu/g	Positive Control cfu/g	SBS cfu/g Treated
1	0	$9x10^3$	0
2	0	$1x10^5$	0
3	0	$1x10^4$	0
4	0	$1x10^4$	0
5	0	$4x10^4$	0

Table 1. Impact of SBS treatment on litter seeded with *Clostridium perfringens*, Mutalib et al. 1997.

Research shows that acidifying drinking water allows for the crop to be acidified both before and after the normal crop flora becomes established (Byrd et al, 2001). By providing the bird with water at a pH below 4.0 for its first drink and for the next few weeks, the crop is protected while normal flora is being established and during times of great gut flora instability due to rapid growth. This assists in the establishment of normal flora, the exclusion of pathogens such as salmonella and the prevention of necrotic enteritis. The use of a mineral acid such as sodium bisulfate allows the pH of the water to be lowered to biologically significant levels without negatively impacting water consumption. Additional measures such as adding direct-fed microbials, prebiotics and acidifiers to the diet can also be effective in the establishment and maintenance of healthy normal gut flora that assist in the prevention of necrotic enteritis.

Decreased Pathogen Pressure

Decreasing environmental pathogen pressure on the bird is usually accomplished in three ways:

- Acidification of the dirt pad of the house once per year at clean-out
- Maintaining a minimum down time during which the house is empty
- Decreasing bird density from conventional placements

The microbial ecology of the house shifts over time. Because poultry houses have dirt pads rather than concrete floors, the pads will absorb ammonia from the litter. The longer birds have been raised in the house, the more ammonia is absorbed into the pad. It isn't unusual to have 60 PPM of ammonia at bird placement on new litter due to the ammonia released from the pad itself. As the ammonia content of the dirt pad goes up, so does the pH. As the pH shifts to levels above 7.5-8.0, the type of bacteria and other microbes that make up the typical flora of the dirt pad begins to shift into ones that aren't quite so good for poultry. Because these are the bacteria that birds are exposed to upon placement, decreases in performance can be seen—especially on an ABF program.

In order to get the house ecology back to one more favorable to birds, growers should shock acidify both the dirt pad and the drinker system while the house is empty. While this doesn't always work 100% of the time, the vast majority of growers who have tried this have done so with success. The average pH of the houses before treatment was 7.8 while the average pH after PLT® pad acidification treatment was 1.8. This low pH makes the dirt pad very hostile to bacterial, viral and fungal pathogens. Research completed at the University of Arkansas (Watkins, 2003) shows that treating the dirt pad with 100-lbs./1,000 sq. ft. of PLT® litter acidifier will reduce the pH of the floors to below a 3.0 and results in a 99.99% decrease in bacteria, yeasts and molds living in the dirt pad (see Figure 1). This shifts the microbial ecology of the houses back to the way they were when new in addition to neutralizing any ammonia trapped in the pad so that it won't be released upon heating.

	pH	Aerobic Bacteria	Molds	Yeasts
Pre-Treatment	7.17	6,732,500	21,750	6950
2 hours Post-PLT® Treatment at 100lbs/1,000 sq. ft.	2.61	66	7	4

Figure 1. Microbial Levels Pre and Post PLT® treatment, Watkins, 2003.

The sooner the normal flora can be established, the less likely the bird's gut will be colonized by unwanted bacteria such as salmonella and clostridium.

Downtime in an ABF programs needs to be held to a minimum of 14 days. Twenty-one days between flocks is ideal as this gives time for pathogens such as Salmonella and Clostridium in the litter to die off. Having 21 days of down time can mean a significant difference in terms of bacterial, viral and coccidial challenge on a day-old bird and can often times mean the difference between success and failure on an ABF program.

In addition to increasing downtime, decreasing density can also reduce bacterial and coccidial pressure on the birds in the house by keeping house numbers of these organisms at a lower level. Having fewer birds in a house also decreases the humidity pressure on the floor making it easier for growers to maintain litter quality and proper litter function throughout the entire flock.

Improving House & Flock Management Critical For ABF Operations

There is perhaps no other period in a chicken's life that is as critical to general health and food safety as the brooding period. This is especially true in an ABF or organic program. The environmental conditions present when the chick arrives on the farm sets the pattern for the rest of the grow-out period. The environment of the chicken house during that chick's first seven days of life determines the bird's population of intestinal flora and greatly influences the passage of maternal antibodies.

Litter Temperature and Ammonia Purge

A major goal of the layout period is to encourage ammonia and moisture release from the litter. Regardless of the amount of down-time between flocks, houses should be closed to preserve as much heat in the house as possible. Utilizing the heat in the litter from the previous flock helps to reduce the amount of ammonia that needs to be managed at the beginning of the next flock. Maintaining litter temperatures above 70°F will greatly enhance ammonia and moisture release. Closing the house soon after catch in cold weather keeps the floor 20-30˚F warmer than it would be if the houses were left open and is also recommended in warm weather though the temperature differential is not as great. This greatly decreases the amount of fuel necessary to pre-heat the house to the proper temperature and to get uniform floor temperatures quickly during the first week of brooding. However, using the free heat in the litter during the down time does not negate the need for proper pre-heating procedures in preparation for brooding. Over time litter temperatures will gradually decline and it is essential to pre-heat houses to prepare for chick placement. As the litter temperature rises during the pre-heat, there will be a second purge of ammonia. It is critical to complete this second ammonia purge before litter amendments are placed and before chicks arrive. This requires a minimum of a 48-hour pre-heat for the litter to cure properly even if floor temperatures are achieved much more quickly.

- **Deliberate management of intestinal microflora**
- **Increased proficiency in house and litter management**
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Floor Temperature

One of the most critical but often overlooked factors towards proper brooding is floor temperature. Dr. Louis Pasteur, one of the earliest poultry scientists, illustrated the importance of warm feet to the immunocompetence of chickens. Fowl cholera was sweeping through France and Dr. Pasteur was called in to determine what was causing the disease. He tried injecting a crude preparation from the sick chickens into healthy ones but he could not make them sick. The only way that he could infect the chickens in his lab was to place their feet in ice water. Once he chilled the chickens, then he could reproduce the disease. The same thing happens to chicks placed on a cold floor. They have difficulty regulating their body temperature at that age and chilling places them under a significant amount of stress. Chilled chicks also undergo vasoconstriction to retain heat. This interferes with the passage of maternal antibodies into the chick through yolk sac absorption. The stress of chilling, combined with impaired yolk sac absorption, retards the immune response of the chick. This makes a flock much more susceptible to any disease causing agents present in the house, which may influence the microbiological profile of the chickens in the processing plant.

The core temperature of the litter at placement should ideally be 90°F and the surface temperature at 94°F at the time the chicks are placed. It's important that actual litter temperature be observed and not air temperature. In houses that are not properly preheated, litter core temperature can be as much as ten degrees lower than the air temperature, which provides a perfect way for chicks to be chilled. Chicks that are placed on a cold floor spend more time trying to keep warm than eating or drinking. Numerous studies have shown that birds placed on floors even as little as five degrees cooler than optimal temperature, gain significantly less weight than chicks placed on warm floors. Litter temperature also plays a large part in bird distribution during brooding. Uneven bird distribution will cause uneven cycling and coverage of coccidial vaccines, transient areas of wet litter due to increased relative humidity and areas of increased bird density all of which can wreak havoc in an ABF program.

Relative Humidity

Controlling relative humidity throughout the brooding period is essential to prevent a bloom of Clostridium, coccidia and other unwanted organisms during the brooding period when ventilation needs are low. Houses should be ventilated for relative humidity and directional air flow maintained to keep the litter dry. Allowing the floor to get damp and tacky will causes changes in the litter microflora and thereby intestinal microflora in a way that is often difficult to recover from. Additional applications of sodium bisulfate at 14-21 days can be done if necessary to correct wet litter issues resulting in high ammonia or Clostridial challenges.

Summary

If you're considering implementing an ABF program to meet consumer demand, a smart first step is to evaluate your house and litter management practices to ensure the environment to which birds are introduced do not present unnecessary challenges that may inhibit bird intestinal health and performance. While environmental challenges always play a role in terms of production, their impact increases in an ABF operation.Effective litter acidification and water acidification programs are even more crucial to bird health and performance, and therefore profitability, in an ABF program.

References

Byrd et al. Effect of Lactic Acid Administration in the Drinking Water During Pre Slaughter Feed Withdrawal on Salmonella and Campylobacter Contamination of Broilers. Poult Sci. 2001 Mar;80(3):278-83

Jim Donald. Treating Poultry House Floors to Improve Poor Performance. The Poultry Engineering, Economics, and Management Newsletter. Auburn University. Issue 23. May 2003.

Garrido, Margarita Novoa et al. Acidified Litter Benefits the Intestinal Flora Balance of Broiler chickens. Applied and Environmental Microbiology, Sept 2004, p.5208-5213.

Mutalib et al. Effects of Sodium Bisulfate on Bacterial Microflora in Poultry Litter. Proc. 46th Western Poultry Disease Conference, page 8. 1997.

Pope MJ, Cherry TE. An evaluation of the presence of pathogens on broilers raised on Poultry Litter Treatment (PLT)-treated litter. Poult Sci. 2000 Sep;79(9):1351-5.

Terzich, M. The Effects of Sodium Bisulfate on Poultry House ammonia, litter pH, litter pathogens and insects, and performance. Proc. 46th Western Poultry Disease Conference, pp 71-3. 1997.

Watkins, SE et al. Evaluating Effectiveness of Poultry House Sanitation. Proc. 2003 Virginia Poultry Health & Management Seminar. Pp 64-67.