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No Antibiotic Ever (NAE) Versus Conventional Broiler Production: It's Complicated

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Introduction

Broiler production has evolved significantly over the years to meet a constant growing demand for animal protein. Rooted on major advances in genetics, facilities and environmental conditions, management, and specially, in nutrition and health, the U.S. broiler industry improved tremendously in productivity and efficiency, clearly demonstrated by a marked reduction of the average market age (i.e., days to market), while significantly increasing average market weight, breast meat yield and feed efficiency (National Chicken Council, 2023). For decades, conventional broiler production was dominant, with extensive use of antibiotics to promote growth and manage disease challenges (prevention and control). However, concerns over the excessive use of antibiotics in conventional broiler production raised questions about its impact on public health, regarding the increasing occurrence of antimicrobial resistance. Increasing consumer pressure combined with different marketing strategies adopted by key players in the U.S. poultry industry to differentiate and capture higher value promoted the rapid emergence of different production approaches, resulting in a variety of “negative labels” for their final products reaching consumers, such as: Grown without antibiotics, raised without antibiotics, humanely raised without antibiotics, no antibiotics, no added antibiotics, raised without added antibiotics, no antibiotics important for human medicine, no medically important antibiotics, no human antibiotics, no antibiotics ever, and others. However, what started as a marketing differentiation strategy quickly became widespread and common in the industry. Consequently, the economic viability of broiler production without the use of antibiotics has become a subject of ongoing debate and analysis within the poultry industry, with some producers switching back to the practice of using antibiotics (some categories, such as antibiotics not important in human medicine). However, this type of analysis is never easy or

straightforward, as a multitude of factors should be taken into consideration. Here, we attempt to discuss two contrasting broiler production systems, conventional versus no antibiotic ever (NAE), as they represent both ends of the spectrum, regarding the use of antibiotics or no use at all being allowed. The discussion is focused primarily on differences in animal health, growth performance, and food safety. Other areas, such as economics and sustainability are outside the scope of this discussion, but will briefly be touched on, as ultimately, both are directly impacted by the main topics of focus.

Animal Health

Any commercial broiler production system inevitably carries risks in terms of health challenges, due to the inherent biological and complex nature of raising a large number of animals within the same environment and multiple groups or populations in proximity (ie., multiple houses or farms in the same area). Therefore, any differences observed about disease incidence and severity should not be interpreted as being simply caused by the use or not of antibiotics. This consideration is critical, due to the fact that disease risk factors should be managed and mitigated independently of what production system is in place, without having to rely on antibiotics as essential preventive tools. Obviously, antibiotics do play an important role in the management of infectious diseases (prevention and control). However, they should not be treated as a “magic bullet” type of intervention and should always be used judiciously. Many other tools are available for veterinarians to minimize or even eliminate the need for preventive use of antibiotics, as long as risk factors are effectively managed. Some examples of non-antibiotic tools available include vaccines, probiotics, prebiotics, synbiotics postbiotics, minerals, organic acids, yeast products, phytochemicals, enzymes, and many others. There is plenty of scientific evidence on the potential applications and efficacy of these non-antibiotic tools (Ayalew et al., 2022; Alagawany et al., 2021; El-Sabroun et al., 2023). However, it needs to be emphasized that all these non-antibiotic tools should not be treated as “antibiotic alternatives”. They are different tools, with different modes of action, and therefore, should not be used with the simple purpose of replacing antibiotics. This is a very common mistake made in NAE broiler production systems.

In general, conventional production systems with antibiotic usage are believed to experience lower disease incidence and mortality rates compared to NAE systems. However, NAE production systems mostly function very similarly to conventional systems, making only minor changes or adjustments, primarily focusing on some general management practices and heavy reliance on non-antibiotic feed additives to replace antibiotics (as “antibiotic alternatives”). More comprehensive changes and adjustments are necessary during the process of withdrawing antibiotics and switching to a NAE production system. Without the routine use of antibiotics for disease prevention and control, NAE broiler production systems may face increased pathogens and disease pressure, if risk factors are not appropriately addressed. Proper disease management strategies, including vaccination protocols, biosecurity measures, as well as environmental and flock management, are crucial to mitigate the impact of these diseases. Additionally, strategies to strengthen the innate and adaptive immune systems of the birds, such as nutritional and feed additive programs, are critical to improve disease resistance in NAE systems. By effectively mitigating risk factors, the need for antibiotics is minimized, allowing for a smoother transition to a NAE production system. To successfully accomplish such a transition, a change in mindset and disease management approach is required.

In NAE production systems, managing the risk of common diseases, such as coccidiosis and necrotic enteritis, requires a multifaceted approach, beyond just relying on single interventions, such as feed additives. These pathogens and diseases have been challenging the broiler industry for decades, even during periods of heavy antibiotic use, and still causing significant losses (Fathima et al., 2022; Mesa-Pineda et al., 2021). Therefore, it is reasonable to expect increased incidence and mortality rates in NAE systems, if a comprehensive assessment and adjustment targeting known risk factors has not been done and implemented.

Gaucher et al. (2015) compared multiple flocks raised under conventional and NAE conditions, and reported increased isolation frequency of *Clostridium perfringens*, and outbreaks of clinical necrotic enteritis, as well as subclinical cases of necrotic enteritis in the NAE flocks. Bueno et al. (2023) conducted a systematic review study to compare the efficacy of antibiotic and non-antibiotic interventions for the prevention and treatment of necrotic enteritis. The study showed a beneficial trend toward the use of antibiotics for reduced *Clostridium perfringens* counts, lower necrotic enteritis lesion scores, better intestinal histologic measurements, and reduced mortality rate. On the other hand, in a study by Bean-Hodgins et al. (2023), under

commercial and research settings, diseases and mortality did not differ between different production systems. These contrasting reports serve to demonstrate how outcomes have not been consistent in attempted comparisons. In fact, Engster et al. (2002) had already highlighted diverging effects of antibiotics in different commercial locations, calling for caution when comparing different programs in different flocks.

A challenging issue worth highlighting that emerged with the rapid shift of the U.S. broiler production systems to the NAE approach is related to animal welfare and professional ethics. When a disease is identified in a flock (or house), treatment becomes necessary to control its spread and protect the welfare of the birds, minimizing the advance and severity of the disease, and consequent suffering for the birds. In this case, when antibiotics are administered, birds can no longer be processed through the NAE line, and therefore are diverted to be processed as conventionally raised broilers to be commercialized at a lower price. The economic implication of the situation often creates pressure to delay or even refuse treatment of the affected flocks. However, it is very important to keep in mind that antibiotics constitute essential tools for veterinarians to guarantee the health of the animals under their responsibility, fulfilling their professional oath (AVMA, 2023). This conflicting, ethical dilemma has been reported multiple times, and requires special attention in NAE production systems (Singer et al., 2019). To be fair, on the other hand, the excessive use of antibiotics in conventional production systems can also be considered an ethical issue, as protecting public health is also part of the veterinarian's oath.

Growth Performance

There is no doubt that the use of antibiotics in conventional broiler production has significantly contributed to the growth and competitiveness of the U.S. poultry industry. As feed represents the main cost of production, accelerated growth rates (i.e., reaching a target market weight faster) and efficient feed utilization (i.e., low feed conversion ratio) are essential for broiler production. Many different factors influence these growth performance parameters, including the use of feed additives, obviously depending on the appropriate conditions for its application. In the case of antibiotics, as they contribute to a controlled disease environment,

improved growth metrics can be expected, and in fact determined the initial reason for their extensive use in animal production, starting decades ago (Jones and Ricke, 2003).

Growth performance parameters are crucial factors in assessing the productivity and efficiency of broiler production systems. Comparative studies have been very limited in scope, as the vast majority has focused on well-controlled, experimental conditions, which do not reflect the reality of commercial production systems, required for this type of assessment. Nevertheless, even under well-controlled conditions, studies have shown varying results, with some reporting actually inferior growth performance with the use of antibiotics, in most cases, used as growth promoters. Under commercial conditions, however, antibiotics have not been used as growth promoters for a while in the U.S., but instead only to prevent and control diseases. Therefore, factors such as pathogen presence and levels, and disease pressure play a critical role in comparative assessments but can rarely be “standardized” across production systems for a variety of eco-epidemiological factors.

A comparative study by Gaucher et al. (2015) showed that production systems with no use of antibiotics or anticoccidials were associated with a significant increase in feed conversion ratio, and a decrease in mean live weight at slaughter and in daily weight gain. Cardinal et al. (2019) also conducted a comparative analysis and reported that broilers from conventional production systems had higher weight gain and better feed conversion than those from production systems that used no antibiotics. The same authors also reported higher production costs in production systems not using antibiotics. In contrast, Bean-Hodgins et al. (2022) reported no difference in growth performance between production systems, under commercial or research conditions. Moreover, Engster et al. (2002) had already called out the need to consider variations among locations, as their study revealed inconsistent effects in flocks with and without antibiotics.

It should be considered that comparisons have mostly been made, based on the general conditions developed during decades of antibiotics use, with only small changes done towards a new or different production system. What this statement means is that the foundation of current broiler production systems has been developed decades ago with the extensive use of antibiotics occurring until recently, and the shift to withdrawing antibiotics from these production systems occurring only recently, while the traditional production foundation has mostly been maintained, with only minor adjustments made. With this consideration in mind, the real question to ask is:

“Is NAE broiler production viable under the same general conditions of conventional production, or should production systems be modified for NAE production?”

Food Safety

Antimicrobial resistance is a major global public health challenge. A multitude of possible causes and sources exist. However, the development and spread of foodborne pathogens and antibiotic resistance (through bacteria and genes) in the food chain have become a major concern. As poultry is a major source of animal protein in diets around the world, it occupies a prominent position as a potential source of foodborne pathogens and antimicrobial resistance to humans. In the case of broiler production, the risk of antibiotic residues and prevalence of antibiotic-resistant bacteria (commensals and pathogens, as well as the resistance genes they may carry) represent a food safety risk to humans, particularly due to the frequent occurrence of foodborne pathogens, such as *Salmonella* and *Campylobacter*. The risk of antibiotic residues in poultry products is normally extremely low, as we assume that producers in conventional production systems do follow proper administration and withdrawal periods available on the labels. In the case of NAE production systems, this risk is essentially nonexistent, as antibiotics are not allowed at any time. Then, the main potential risk is related to the occurrence of foodborne pathogens, as well as the occurrence of antimicrobial resistant bacteria (pathogens or commensals) and genes.

Studies investigating antimicrobial resistance in different production systems have not been able to clearly demonstrate the difference between them. Results have been inconsistent, with antimicrobial resistance found in all production systems. It is clear that use of antibiotics in conventional production systems affects the incidence of antimicrobial resistance by increased selection pressure. However, it is unclear what determines the occurrence of antimicrobial resistance bacteria and genes in NAE production systems, as no antibiotics are used. The same conflicting observations have been reported for the incidence of foodborne pathogens, such as *Salmonella* and *Campylobacter*, which have been consistently found in both production systems (Mak et al., 2022; Poudel et al., 2022; Rama et al., 2022; Wang et al., 2023). This is a very complex area that still needs far more research to help the industry better understand what the

benefits and risks are. So far, it is evident that the verdict is still out on the potential food safety implications of conventional versus NAE broiler production systems.

Economics and Sustainability

It is very well-known that the growth performance of broilers is a critical parameter to evaluate the economic viability of different production systems, as feed is the main production cost. However, a much broader context for this comparison should be taken into consideration, due to the multitude of factors involved and the complexity of the broiler industry. Several factors influence the economic viability of any production system, including production costs, market prices, and consumer demand, which all affect each other. While there are inherent challenges and potential higher costs associated with NAE production, it is important to assess the overall economic landscape to determine viability, on a case-by-case basis.

It is reasonable to assume that NAE broiler production may incur higher costs compared to conventional broiler production, particularly due to potential increased health challenges, and consequent reduced growth performance, as previously discussed. However, the extent of cost differences varies considerably on a case-by-case basis, as many variables are considered, such as geographical location, labor quality and availability, facilities and environmental conditions, management practices, utilization of different tools and programs for disease prevention and control, and the list goes on. Therefore, it is important to note that the economic viability of NAE broiler production is context-specific and can vary among individual farms and regions.

Market prices for NAE broiler products play a crucial role in determining the economic viability of this production approach, particularly when consumer demand for this type of product has been increasing. However, the magnitude of consumer demand and the willingness to pay higher prices can vary across different regions and consumer segments. Producers need to carefully evaluate the market demand and potential customer base to determine the economic viability of NAE broiler production. It is obvious that customer perception affects market dynamics, but competition is a critical factor determining the potential price premium and the ability to fully offset any potential production cost increase associated with NAE production. The market for poultry products is very diversified, and consequently, different producing companies

have their own market strategy regarding the types of poultry products offered and contractual arrangements, all affecting the value to be captured.

The U.S. broiler production industry has made tremendous progress in becoming more efficient and sustainable over the past decades (Beal et al., 2023; National Chicken Council, 2023). However, sustainability is a very broad topic, frequently not treated appropriately in discussions focusing on animal production. Oftentimes, the focus is narrowed primarily toward environmental impact, ignoring the economic and social components. When defining sustainability in the context of animal production, it is critical to take into consideration that it is about food production, and as such, it goes well beyond simply its relationship with the environment, having a tremendous impact also on the economic and social components of sustainability. Consumers want cheap, safe and high-quality food, as it determines their accessibility (i.e., food security), health and quality of life. On the other hand, producers and production systems must achieve certain levels of efficiency and profitability, so they are able to continue to produce and supply food, as well as to support their own quality of life. To be truly sustainable, the animal production system must support all of components defined under “sustainability”, which are: environment, economic and social.

While NAE systems may require more time to achieve market weight and be relatively less efficient, therefore utilizing more resources and having a higher environmental impact, they address concerns about public health and align with consumer preferences. On the other hand, by been relatively more productive and efficient, conventional production systems utilize less resources and have a lower environmental impact, providing higher food accessibility through higher amounts and cheaper food to consumers (i.e., food security).

As mentioned before, it is not the purpose here to discuss economics and sustainability of conventional and NAE broiler production systems, as these are very complex topics, out of our area of expertise. This is still an evolving field and requires a lot more in-depth analysis than we can provide. However, the intent was just to touch on its complexity and the need for a more balanced view.

Conclusions

The comparison between conventional and NAE broiler production systems is not easy or straightforward, as distinct, and sometimes conflicting areas must be taken into consideration. Conventional production systems prioritize growth performance through antibiotic usage as a safety net, leading to high productivity and efficiency, and low costs. In contrast, NAE production systems focus emphasize public health and consumer preference through the complete removal of antibiotic usage, which requires many adjustments to maintain productivity and efficiency, as animal health challenges become more difficult to manage, and affect growth performance. NAE production may lead to higher production costs due to the increased expenses associated with alternative management practices, biosecurity measures, and potential use of more expensive interventions (e.g., vaccines, feed additives, etc.). However, consumer demand for NAE products can also allow to higher market prices, and consequently, some room to compensate for them. For this possibility to become a reality, there is a need for alignment across the entire production and commercialization chain. Simply focusing on continuously cutting production costs cannot guarantee competitiveness and economic viability in the food industry. The contemporary poultry industry must find a way to strike a balance between being a successful business, while attending to the challenges posed by consumers, and society. This is known as “sustainability”!

What is clear from this overview is that the outcome of the comparison between production systems is not clear. Both conventional and NAE production methods have their merits and limitations, and the choice between them depends on various factors, including considerable case-by-case variation. The path forward will likely involve innovative approaches that combine the strengths of both systems to achieve optimal productivity and efficiency, and sustainability in broiler production. As the poultry industry continues to evolve, additional assessments and research are essential to provide accurate and up-to-date insights into the comparative impacts of these production methods. However, there is very little publicly available quantitative evidence regarding the impact of different production systems to be found in scientific studies and industry reports, particularly pertaining the U.S. The vast majority of the information needed to conduct comparative assessments and studies is kept confidential, which ends up contributing to our inability to make decisions on the best way to move forward, besides feeding consumer suspicion and skepticism.

There is no doubt that the broiler production industry will succeed. It has for decades, and it will for sure continue to do so. However, the need for changes in several areas lays ahead.

Summary

There is a lot of discussions in the industry about the viability of different broiler production systems. The rapid shift away from antibiotics experienced in the U.S. broiler industry has created some challenges. In this presentation, we aim to discuss two contrasting broiler production systems, conventional versus no antibiotic ever (NAE), as they represent both ends of the spectrum, regarding the use of antibiotics or no use at all being allowed. The discussion is focused primarily on differences in animal health, growth performance, and food safety. Other areas, such as economics and sustainability are outside the scope of this discussion, but are briefly included, as ultimately, both are directly impacted by the main topics of focus. In general, comparisons are not always clear, with diverging outcomes, even though in general, it is accepted that production costs tend to be relatively higher in NAE production systems. However, both conventional and NAE production systems have their merits and limitations, and the choice between them depends on various factors, including considerable case-by-case variation. Clearly, a “one-size fits all” approach does not apply in this industry. The path forward will require innovative approaches that combine the strengths of both systems to achieve optimal productivity and efficiency, and sustainability in broiler production. As the poultry industry continues to evolve, additional assessments and research are essential to provide accurate and up-to-date insights into the comparative impacts of these production methods.

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