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Review Article

Evaluation of Calcium Supplementation in Finisher Phase Broiler Feed: Impact on Poultry Performance and Health-A Review

Henri Eko PRASETYO [1]

[1] Animal Nutritionist & Business Development, PT. Dinamika Megatama Citra (DMC) Indonesia Company, Jl. Raya Mojosari Ngoro Km. 3, Pungging, Dusun Pungging, Pungging, Kec. Pungging, Kabupaten Mojokerto, JawaTimur61384

(*) Corresponding author:
Henri Eko PRASETYO
E-mail: henriekoprasetyo@gmail.com

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Calcium (Ca) is an essential macromineral in broiler nutrition, supporting skeletal development, muscle function, cellular signaling, and metabolic regulation. Although Ca requirements generally decline as broilers enter the finisher phase due to reduced skeletal mineralization, dietary Ca levels exceeding 0.9% are still used in some formulations. Excessive Ca may provide limited production benefits while adversely affecting nutrient utilization, mineral balance, digestive function, and skeletal health. This article evaluates the potential effects of dietary Ca concentrations above 0.9% in finisher diets on growth performance, feed efficiency, mineral utilization, gastrointestinal function, and skeletal health in modern broilers. Available evidence indicates that excessive Ca may reduce body weight gain and impair feed conversion efficiency, potentially through alterations in gastrointestinal pH and interactions with other nutrients. High Ca levels may also reduce phosphorus, zinc, and magnesium utilization, particularly when the Ca-to-available phosphorus ratio is poorly balanced. Phytase supplementation may partially mitigate these effects by improving phosphorus availability and reducing phytate-related mineral interactions. Overall, Ca in finisher diets should be formulated according to physiological requirements rather than maximized. Maintaining an appropriate Ca-to-available phosphorus ratio, adequate phytase supplementation, and balanced nutrient interactions may optimize performance, mineral utilization, and skeletal health. Further in vivo studies are warranted to establish precise Ca recommendations for modern broilers.

Keywords: Antioxidant, Broiler, Poultry nutrition

INTRODUCTION

Calcium (Ca) is an essential macromineral in poultry nutrition and is required for a wide range of physiological processes, including skeletal development, maintenance of bone integrity, neuromuscular function, blood coagulation, intracellular signaling, and metabolic regulation (Courcier *et al.*, 2012). In broiler chickens, dietary Ca is particularly important during the early growth period when rapid skeletal development and bone mineralization occur. Calcium homeostasis is tightly regulated through interactions among dietary intake, intestinal absorption, bone deposition and mobilization, renal excretion, and hormonal mechanisms involving parathyroid hormone, calcitonin, and vitamin D (Fleet, 2017). Consequently, both inadequate and excessive dietary Ca supply may disrupt mineral homeostasis and adversely affect bird health and productivity.

The requirement for Ca, however, is not constant throughout the production cycle. As broilers progress from the starter and grower stages to the finisher phase, the rate of skeletal development and mineral deposition generally declines relative to the rapid growth observed during earlier stages (Naeem, 2025). Accordingly, dietary Ca concentrations are commonly reduced during the finisher period to reflect the changing physiological requirements of the bird (Driver *et al.*, 2005). This adjustment is particularly relevant in modern broiler production, where feed formulation is increasingly focused on precision nutrition, nutrient efficiency, and minimizing unnecessary mineral excretion (Moss *et al.*, 2021). Supplying Ca above the physiological requirement may not provide additional benefits and could potentially interfere with the utilization of other minerals, particularly phosphorus, as well as alter intestinal mineral balance and digestive processes (Proszkowiec-Weglarz and Angel, 2013).

The issue of Ca supply becomes increasingly important in practical broiler nutrition because recommended dietary concentrations and commercial feeding practices do not always correspond closely (Applegate and Angel, 2014). In some field formulations, Ca concentrations of approximately 0.9% or higher may still be used during the finisher phase, despite the declining Ca requirement associated with advancing age (Driver *et al.*, 2005). Such practices may originate from the use of conventional formulation strategies, differences among genetic strains, feed ingredients, Ca sources, dietary phosphorus concentrations, or concerns regarding skeletal integrity and production performance. However, whether relatively high Ca concentrations remain beneficial, neutral, or potentially excessive during the finisher phase requires careful evaluation because the biological response to Ca depends not only on its absolute concentration but also on dietary phosphorus, vitamin D status, Ca source, particle size, and the overall mineral balance of the diet (David *et al.*, 2023).

From a production perspective, an appropriate Ca supply should support optimal growth, feed utilization, carcass development, and skeletal strength without imposing unnecessary nutritional costs. Excessive dietary Ca may reduce nutrient utilization or alter the availability of phosphorus and other minerals, whereas insufficient Ca can compromise bone mineralization, skeletal integrity, and physiological function (Proszkowiec-Weglarz and Angel, 2013). These effects are particularly relevant in rapidly growing broilers, in which skeletal development must remain adequate to support increasing body mass (Khalilzadeh *et al*., 2026). Therefore, determining an appropriate Ca concentration during the finisher phase requires consideration of both production outcomes and physiological indicators rather than relying solely on conventional formulation practices.

In addition to growth performance, dietary Ca may influence several health-related outcomes. Calcium participates in neuromuscular activity, cellular signaling, acid–base regulation, and maintenance of structural tissues, while disturbances in Ca–phosphorus homeostasis may affect bone metabolism and mineral deposition (Proszkowiec-Weglarz and Angel, 2013). Moreover, dietary Ca concentration can influence gastrointestinal mineral availability and interactions with other nutrients, potentially affecting nutrient digestibility and intestinal function (Zhang *et al*., 2025). These considerations suggest that evaluation of Ca supplementation should extend beyond body weight gain and feed conversion ratio to include indicators of bone quality, mineral utilization, nutrient digestibility, and overall physiological status.

Despite the fundamental importance of Ca in poultry nutrition, evidence regarding the optimal Ca concentration specifically during the finisher phase remains dispersed across studies with different broiler strains, dietary compositions, Ca sources, feeding durations, and response variables (David *et al*., 2023). Furthermore, differences in dietary Ca–available phosphorus ratios make direct comparison among studies challenging (Proszkowiec-Weglarz and Angel, 2013). The continued use of relatively high Ca concentrations in practical finisher diets therefore raises an important question: do these concentrations provide measurable benefits to broiler performance and health, or do they represent an unnecessary increase in mineral supplementation and potential environmental burden?

Therefore, this review evaluates the available evidence regarding dietary Ca supplementation in finisher-phase broiler chickens, with particular emphasis on its effects on growth performance, feed efficiency, skeletal and bone health, mineral utilization, nutrient digestibility, and physiological health indicators. The review also considers factors that may modify the response to dietary Ca, including Ca concentration, Ca source, dietary phosphorus level, Ca balance, and broiler age or strain. By integrating production and physiological evidence, this review aims to clarify whether Ca concentrations of approximately ≥0.9% in finisher diets remain within an appropriate and efficient range and to identify practical considerations for optimizing Ca nutrition in modern broiler production.

METHODOLOGY LITERATURE

Data were collected through literature studies from peer-reviewed journals and primary poultry nutrition references such as the Journal of Applied Poultry Research, Poultry Science, and Nutrition of the Chicken. The parameters analyzed included feed conversion ratio (FCR), body weight gain (BWG), and the incidence of leg disorders and nutrient digestibility.

IMPACT ON PERFORMANCE

Dietary calcium concentration during the finisher phase can substantially influence growth performance and feed utilization in broiler chickens, particularly when calcium is supplied beyond the birds' physiological requirements. Driver *et al*., (2005) reported that increasing dietary Ca to 1.00% during the finisher phase resulted in reduced body weight gain (BWG) and a higher feed conversion ratio

(FCR) compared with diets containing approximately 0.70–0.85% Ca. The authors suggested that the negative response to excessive Ca was associated with alterations in the gastrointestinal environment, particularly an increase in intestinal pH. An elevated intestinal pH may interfere with the activity of endogenous digestive enzymes and consequently reduce the digestion and absorption of key nutrients, including proteins and lipids. In addition, excessive Ca may interact with dietary phosphorus and other minerals, potentially reducing nutrient availability and impairing overall nutrient utilization (Coltherd *et al*., 2022). These findings indicate that increasing Ca concentration above the requirement does not necessarily translate into improved broiler performance and may instead compromise feed efficiency when the dietary Ca-to-phosphorus balance is not appropriately maintained. Therefore, Ca concentration in finisher diets should be optimized according to the birds' physiological requirements and considered together with available phosphorus, phytase supplementation, and the overall mineral balance of the diet (Selle *et al*., 2012).

EFFECT ON MINERAL BALANCE

Excessive dietary calcium can disrupt mineral homeostasis in broiler chickens by reducing the availability and absorption of other essential minerals. High Ca concentrations may interfere with the intestinal utilization of zinc (Zn) and magnesium (Mg), both of which are important for skeletal development, enzymatic activity, cellular metabolism, and tissue integrity (O'Dell, 1989). In addition, an inappropriate calcium-to-available phosphorus (Ca:Av.P) ratio may reduce phosphorus utilization by promoting the formation of poorly soluble calcium–phosphorus complexes in the gastrointestinal tract, thereby decreasing phosphorus availability for absorption (Tamim *et al*., 2004). This effect may become more pronounced when phytase supplementation is inadequate, because a substantial proportion of dietary phosphorus may remain bound to phytate and consequently less accessible to the bird. Therefore, maintaining an appropriate Ca:Av.P ratio, rather than evaluating calcium concentration alone, is essential for optimizing mineral utilization and preventing unnecessary mineral excretion (Proszkowiec-Weglarz and Angel, 2013). Strategic phytase supplementation may further improve phosphorus availability and provide greater flexibility in formulating diets with reduced mineral oversupply.

ROLE OF PHYTASE

Phytase supplementation plays an important role in mitigating the adverse effects associated with elevated dietary calcium by improving the utilization of phytate-bound phosphorus and maintaining mineral balance (Sommerfeld *et al*., 2018). By hydrolyzing phytic acid and releasing phosphorus that would otherwise be poorly available to broilers, phytase can increase phosphorus bioavailability and reduce the potential for Ca–phytate–mineral interactions within the gastrointestinal tract (Selle and Ravindran, 2007). This mechanism is particularly relevant when dietary Ca concentrations approach or exceed 0.9%, because excessive Ca may further reduce phosphorus availability through the formation of insoluble calcium–phytate complexes (Liu *et al*., 2018). Several studies have reported favorable responses to phytase supplementation at approximately 500–1,000 FTU/kg when dietary Ca levels were ≥0.9%, suggesting that adequate phytase activity may partially alleviate the constraints associated with high-Ca diets (Akinde, 2017). However, the effectiveness of phytase is influenced by dietary Ca and available phosphorus concentrations, phytate content, enzyme source and activity, and gastrointestinal conditions. Therefore, phytase should not be regarded as a means of completely offsetting excessive Ca supplementation, but rather as a complementary strategy within a balanced Ca–P formulation.

PHYSIOLOGICAL ASPECTS

Excessive dietary calcium may adversely affect mineral homeostasis and skeletal health when calcium intake exceeds the physiological requirements of broiler chickens. Persistently elevated calcium availability may contribute to disturbances in systemic calcium–phosphorus regulation and, under certain conditions, promote inappropriate mineral deposition in soft tissues (Stylianaki *et al*., 2020). In rapidly growing broilers, such disturbances are of particular concern because skeletal development must keep pace with rapid body weight accretion (Behboodi *et al*., 2021). An imbalance between Ca and phosphorus availability may also interfere with normal endochondral ossification and increase the susceptibility to skeletal abnormalities, including tibial dyschondroplasia (TD). Even subclinical forms of TD may compromise bone strength, locomotion, and leg integrity, potentially reducing bird mobility and welfare (Yan *et al*., 2021). Therefore, excessive Ca supplementation should be avoided unless justified by the birds' physiological requirements and supported by an appropriately balanced Ca:available phosphorus ratio (Corduk *et al*., 2013). Careful mineral formulation, together with adequate phosphorus availability and appropriate phytase supplementation, is consequently important for maintaining skeletal development and leg health, particularly in modern fast-growing broiler strains (Proszkowiec-Weglarz and Angel, 2013).

CONCLUSION

Calcium levels in finisher-phase broiler diets should generally be maintained within the range of 0.75–0.85% to support optimal growth performance and feed efficiency. Higher calcium inclusion levels (>0.9%) may be considered under specific formulation conditions, particularly when accompanied by appropriate available phosphorus (Av.P) adjustment to approximately 0.45–0.50%, adequate phytase supplementation, and careful consideration of interactions with other dietary nutrients. Nevertheless, further in vivo studies are warranted to clarify the long-term effects of high dietary calcium levels on broiler health, nutrient utilization, and production efficiency, and to establish more precise calcium recommendations for the finisher phase.

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