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RESPONSE OF BROILER CHICKEN TO SOME DIETARY MODIFICATIONS WITH PHYTASE ENZYME AND VITAMIN D_3 SUPPLEMETATION

Thesis Presented

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ABSTRACT

A feeding trial was conducted to evaluate the impact of dietary supplementation of thermo-stable phytase enzyme (Quantum blue®) and a new analogue of Vitamin D_3 (AlpHαD_3®) singly or in combination on growth performance, bone mineralization, carcass traits and blood parameters in broiler chickens. A total of 720- unsexed, 1-d-old Ross 308 broilers were allocated randomly into six equal groups, 3 replicates each. The experimental period extended for 33 days. The six dietary groups were: the first group served as positive control and fed diet containing an adequate levels of available phosphorus (av. P) and calcium, while, the second group fed diet containing 30 % av. P and calcium requirements (negative control). The third and fourth groups were fed on diet containing the same levels of av.P and calcium as in the negative control one but supplemented with thermo stable-phytase enzyme (Quantum blue®) 500 and 1000 FTU/kg diet respectively. The fifth group was fed on diet containing the same levels of av.P and calcium as in the negative control but supplemented with 5 ppb of AlpHαD_3®, while group six was fed on diet containing the same levels of av. P and calcium as in the negative control but supplemented with 500 FTU/kg phytase in addition to 5 ppb of AlpHαD_3®. Results of the experiment showed that the dietary supplementation of phytase enzyme or vitamin D_3 significantly improved ($P \leq 0.05$) broiler chicken body weight gain, feed conversion ratio, serum Ca and ALP, carcass traits and tibia Ca/p compared with those fed un-supplemented diets. In addition, it can be concluded that, the use of thermo- stable phytase enzyme in broiler diets at 500 FTU/kg of feed along with vitamin D_3 supplementation at 5ppb resulted in better growth performance and carcass traits, improved Ca/P levels in tibia ash and Ca levels in the blood of broiler chicken.

Key words: Broiler chicken, Phytase, AlpHαD_3, Growth performance, Bone mineral levels, Carcass traits, Blood parameters.

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1. INTRODUCTION

There is an increasing demand for food due to the growing population in the world and the consequent increase in demand for protein. Poultry is considered as successful biological machine that can convert food of plant origin into avian protein, low in calories and cholesterol content.

In recent years, poultry industry was found one of the vital industries for commercial purposes and its improvement is one of the main objectives of both private and public sectors. The poultry industry accounts for 30% of global meat consumption (**FAO, 2010)**. This high consumption is associated with the affordable price and high nutritional value of chicken meat. Furthermore, poultry feed costs constitute about 65-70 % of the total variable cost in poultry industry (**Bin-Baraik, 2010)**. Therefore, the composition of poultry diets has significant role in this industry and maximum feed efficiency in poultry production has been considered a critical point in broiler rearing.

Therefore, nutritionists are seeking now to find ways to improve the utilization of all nutrients of the plant based diets in order to achieve high production with best cost and subsequently sustain the production (**Mukhtar *et al*., 2010)**.

Mineral nutrition is one of the nutritional strategies that focus on, how to maximize phosphorus (*P)* utilization in broilers. Phosphorus is the second most abundant mineral in the animal body, approximately 80% of which is found in the bones and teeth. The rest, 20% of P not presents in the skeletal tissues is widely distributed in the fluids and soft tissues of the body, where it serves a range of essential functions **(Underwood and Suttle, 1999)**.

Approximately two-thirds of the total P in plants, which are the major constituents of poultry diets, are in the form of phytate and are unavailable or poorly utilized by poultry **(Viveros *et al*., 2000)**. This unavailability is due to the very low phytase activity found in the digestive tract **(Pallauf *et al*., 1994)**. Therefore, poultry diets are supplemented with sources of inorganic P to meet the P requirements of the bird, which increases the cost of the diets and contributes to environmental pollution.

Additionally, the inclusion of feed enzymes in poultry diets to enhance the nutrient utilization and performance by counteracting the negative influence of targeted substrates has become conventional within the last two decades.

One of these enzymes is phytase enzyme which can increase the nutritive value of the plant feed by direct increase of phosphorus utilization and/or indirectly reducing the level of expensive non-organic phosphorus added to food.

The dietary supplementation of the exogenous phytase enzyme reduces nutrient variability of feedstuffs, counteracts the anti-nutritional effects of phytate and increases the accuracy of feed formulation.

Exogenous phytase is included in feed formulations not only to reduce inorganic phosphorus supplementation, but also to release minerals, particularly calcium, as well as amino acids and carbohydrates by the hydrolysis of phytate thus improving nutrient utilization **(Slominski, 2011)**.

The inclusion of higher levels of phytase in broilers diets improves broiler performance and the antioxidant status of poultry which can be related to a reduction in the anti-nutritive effect of phytate **(Karadas *et al*., 2010 and Pirgozliev *et al*., 2011)**.

Also, The status of bones, especially leg bones (tibia, femur, meta-tarsus), may have a direct impact on the quality of the poultry meat produced **(Orban *et al.*, 1999)**. Phosphorus deficiency resulting in breakage or defects of these bones during processing results in the downgrading of poultry meat. Therefore, manipulations of the P level in the diet, such as adding microbial phytase to improve P availability, have to be validated for their effects on bone status.

The extent of phosphorus utilization in poultry diets affected by the level of vitamin D_3 in the diet. Nutritional factors are known to improve locomotion problems; among these is vitamin D, due to its important role in calcium and phosphorus metabolism. Vitamin D supplementation is closely related to a decreased incidence of bone disorders because vitamin D is involved in various physiological processes, including the absorption of calcium and phosphorus, bone mineralization and mobilization **(Kasim *et al*., 2006)**.

Vitamin D and dietary phytase activity may function synergistically to enhance phytate phosphorus utilization. The effectiveness of microbial phytase may be enhanced by feeding it in combination with vitamin D. As vitamin D plays a role in Ca and P absorption, and therefore influences their utilization. Improving the efficiency of phytase could lead to reduce feed costs and to a greater use of phytase which would be of environmental importance **(Edwards, 1993)**.

So previous research of the issues relating to phosphorus has been dealt with the effect of adding the phytase enzyme or vitamin D_3 alone or in specific inclusion rates.

Accordingly, the aim of this study was designed to focus on the effects of thermo-stable phytase enzyme namely (Quantum blue®) added to the diets of birds in different doses with or without the addition of a new analogue of Vitamin D_3 (AlpHαD_3®) on the following points of broiler chick performance and health:

1) Growth performance parameters
2) Blood serum biochemical indices
3) Carcass traits
4) Bone mineral assay
5) Gut Histomorphological changes of Ross broiler chickens

2. REVIEW OF LITERATURE

2.1. Story of both phytase enzyme and vitamin D_3 in relation with Phytic acid

Phosphorus (*P)* is an essential element for all animals. It has more well-known functions in the body than any other minerals. It forms the structural component of the skeleton with Calcium. Phosphorus, which is a component of the cell wall and a constituent of several enzyme systems**,** plays an important role in cellular metabolism, as a part of the energy currency of the cell **(McDonald *et al.,* 2002; Pond *et al.,* 2005 and Todd and Roselina, 2008)**. Therefore, P is an essential mineral required for optimum genetic potential in growth and feed efficiency as well as skeletal development.

Poultry diets are mainly plant based, and composed of maize and soya bean meal. About 70% of phosphorus in plant raw materials exists as phytate form **(Rezaei *et al.,* 2007)**. Furthermore, poultry are unable to utilize this phytate phosphorus, as they lack endogenous phytase enzyme **(Yu *et al.,* 2004)**. Therefore, the addition of inorganic phosphorus supplements to poultry diets is essential in order to satisfy the phosphorus requirements of poultry. **Selle *et al.,* (2000)** stated that Phytic acid is a strong acid and has the ability to bind other minerals such as (Ca^{+2}, Mg^{+2}, Cu^{+2}, Zn^{+2}, Fe^{+2} and K^{+2}) and nutrients (proteins, starch, lipids, or both starch and lipids) in aqueous medium of the intestines rendering them unavailable for absorption.

Moreover, phytate is considered as an anti- nutrient for broilers, reducing protein and mineral absorption**,** increasing mucus production and interfering with broiler performance **(Cowieson *et al.,* 2004; Linares *et al.,* 2007; Plumstead *et al.,* 2008; Liu *et al.,* 2009 and Cowieson *et al*., 2011)**.

Unabsorbed P and nutrients are excreted in the faeces **(Nahm, 2007)** and therefore have to be supplemented in greater amounts, subsequently increasing the cost of production. Furthermore, the dietary addition of inorganic phosphorus supplements not only increases the feed and production costs **Ghahri *et al*, (2012)**, but It is resulting in great amounts of phosphorus in the manure that contribute to the environmental pollution **(Guo *et al*., 2009)**. Therefore, it is important to improve the bioavailability of P in the gastrointestinal tract of monogastric animals. One of the most practical and effective methods to achieve this objective is the addition of exogenous phytase enzyme and Vitamin D_3.

Due to the relatively high price of inorganic P-supplements and the restrictions designed to limit P pollution, it was essential to release a commercially available phytase enzyme **(Selle & Ravindran, 2007)**. Phytase is the only enzyme known to release phosphates from phytate **(Greiner and Konietzny, 2011),** making it available for absorption and utilization. New generations of the phytase enzyme come onto the market. These Phytases differ in terms of pH-activity profile, thermo stability and in resistance to digestive enzymatic degradation in the animal intestine **(Bedford and Cowieson, 2009)**.

Moreover, absorption of PP (phytate phosphorus) and Ca is increased by vitamin D_3 supplementation which stimulates the hydrolysis of PP**.** Vitamin D_3 supplementation decreases the incidence of bone disorders because it is involved in many physiological processes, including the absorption of calcium and phosphorus, bone mineralization and mobilization **(Kasim *et al*., 2006)**. Better results were obtained by using combination of phytase enzyme and vitamin D_3 in diets of broiler chicks fed low level of Ca and P **(Han *et al*., 2009)**.

2.1.1. Phytic acid (Phytate)

Phytate (Myo-inositol-1, 2, 3, 4, 5, 6-hexakis dihydrogen phosphate), is natural compound present in feedstuffs of plant origin **(Reddy *et al*., 1982)**. Phytic acid is the major storage form of phosphorus in seeds (**Jamal and Rabie, 2009)**. Phytate P constitutes 60-80% of the total P in grains and their by-products **(Manangi and Coon, 2008)**. Phytate is involved in controlling homeostasis of P levels in seeds **(Lott *et al*., 2000)** and plays an important role in plant growth and seed germination **(Aureli *et al*., 2011)**. The level of phytate P in a feedstuff generally depends on the part of the plant