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Calculating Calcium Levels of Meat and Bone Meal

Research is frequently conducted on nutrient availability. Phosphorus and calcium have been extensively examined. Often, the availability of these nutrients is examined independently. The interaction and relationship between calcium and phosphorus in feed ingredients makes the case for studying both nutrients and their availability simultaneously.

One source of Ca in poultry diets is meat and bone meal (MBM). Meat and bone meal is defined as a rendered product of tissue and bones (not including hair, horn, hoof and blood) with a minimum of 40 g/kg P and a maximum of 550 g/kg crude protein. Additionally, in MBM, the Ca concentration should not be more than 2.2 times the P concentration (AAFCO, 2000). The NRC (1994) lists MBM as containing approximately 100g/kg Ca, but variations of Ca concentrations are reported in MBM, depending on the origin of the MBM source (bovine, porcine, or mixed) and the proportion of meat and bones. The concentration variations can range from 40-150 g/kg (Drewyor and Waldroup, 2000; Sulabo and Stein, 2013). These variations may cause the digestible Ca content of MBM to vary in diets. The species being fed, MBM source and calculation methods used to determine Ca availability are all possible reasons for observed differences in nutrient concentrations.

There are several methods available for calculating nutrient digestibility, but there is no specific established method for determining Ca digestibility in poultry. Previous research utilizing different methods to determine amino acid digestibility in feed ingredients may be used to estimate Ca digestibility (Ravindran and Bryden, 1999; Lemme et al., 2004, Anwar et al., 2015a). It is important to note that Ca availability in diets is typically described in terms of bioavailability relative to calcium carbonate. For many decades, researchers have assumed that Ca availability is very high from any calcium sources (Blair et al, 1965 Peeler, 1972; Reid and Weber, 1976).

Anwar et al. (2015b), conducted two studies in 2015 to look at true ileal Ca digestibility using

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two different calculation methods (direct and regression) on four MBM samples in broiler diets. When nutrient contents are analyzed using the direct method, digestibility levels must be corrected for endogenous Ca losses to accurately determine true ileal Ca digestibility.

The Experiment

Researchers used 240 male broilers (Ross 308) in this experiment. Five experimental diets were formulated. Four of the diets contained MBM samples from a mixture of bovine and ovine origin and a fifth Ca- and P-free diet (Tables 1 and 2). Diets were analyzed for dry matter (DM), crude protein (CP), crude fat (CF), ash, Ca, phosphorus (P), particle size distribution and for bone and soft tissue fractions. Meat and bone meal provided the only source of Ca and P in the experimental diets.

Findings

Table 1 shows the range of Ca and P concentrations in the four MBM diets. Calcium concentrations of MBM-1, MBM-2, MBM-3, and MBM-4 were 71, 118, 114 and 81 g/kg, respectively. The CP, Ca and P concentrations of the experimental MBM diets meet the requirements for the AAFCO (2000) definition of MBM. Concentrations of Ca in the diets were observed to be directly related to the ash content. Table 1 also shows the bone and soft tissue proportions of the MBM samples. Researchers in this study found that ash and Ca concentration in the MBM samples increased with the increasing bone fractions in the samples. Researchers suggest that this may be indicative of how difficult it can be to secure representative samples because of the particle size of Ca-rich bone fractions in the MBM ingredients. (Anwar et al, 2015b). Particle size distribution of the four MBM samples were classified as fine (< 0.5 mm), medium (0.5 – 1.0 mm) and coarse (> 1.0 mm). The proportion of fine particles in the diets ranged from 5-14%, medium size particles ranged from 34-63% and coarse particles were 29-35%.

Table 2 presents the analyzed Ca and P concentrations of the experimental diets. For MBM-1 and MBM-3, the calcium concentrations were 1.59 and 1.41 g/kg higher. Dietary calcium levels in MBM-2 and MBM-4 dietary concentrations were close to the calculated values.

The birds fed MBM-1 experienced higher daily weight gain than the birds on the other diets. There was no statistically significant difference in the weight gains of birds fed MBM-3 and MBM-4. Birds fed MBM-2 experienced significantly lower daily gains than the other birds.

The apparent ileal digestibility of Ca for the four MBM diets varied widely. True ileal endogenous Ca loss was determined to be a mean of 88 ± 21 mg/kg of dry matter intake on the birds fed the Ca- and P-free diet. In theory, the endogenous Ca losses were negligible in this experiment, which makes an argument for not correcting for endogenous Ca loss. In practice, Ca losses may be higher in diets containing P and phytate-P. Calcium deficiencies influence P and phytate-P availability. When diets are Ca-deficient, the plasma Ca concentrations may be low which increases parathyroid hormone concentrations and results in increasing Ca absorptions in the intestines (Proszkwoiecc-Weglarz and Angel, 2013).

What this means for the industry

Several factors can influence the absorptions of Ca and P utilization in broiler performance. This current research by Anwar et al., (2015a and 2015b) demonstrates the differences between two different calculation methods for determining true Ca digestibility. The

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Table 1. Analyzed nutrient composition and percentage composition of bone and soft tissue fractions of the four meat and bone meal (MBM) samples (g/kg, as fed basis).[1]

	MBM-1	MBM-2	MBM-3	MBM-4
Dry Matter	925	943	956	953
Crude Protein	536	488	474	482
Crude Fat	114	93	88	128
Ash	237	357	362	251
Calcium	71	118	114	81
Phosphorus	37	60	59	41
Ca:P ratio	1.91	1.96	1.92	1.97
Bone and soft tissue fractions				
Bone	40.2	50.5	52.1	42.6
Soft tissue	59.8	49.5	47.9	57.4
Bone:Soft tissue	1:1.49	1:0.98	1:0.92	1:1.35

[1] Samples were analyzed in duplicate.

Table 2. Ingredient composition and analysis (g/kg, as-fed basis) of meat and bone meal (MBM) diets.

	MBM diets				Ca- and P-free diet
	MBM-1	MBM-2	MBM-3	MBM-4	
Corn Starch	349.35	370.85	369.85	355.6	451.45
Dextrose	349.35	370.85	369.85	355.6	451.45
Dried egg albumen	100	100	100	100	--
Meat and bone meal	115	70	72	102	--
Cellulose	50	50	50	50	50
Soybean oil	20	20	20	20	20
Potassium bicarbonate	8	10	10	8.5	14.8
Sodium bicarbonate	3	3	3	3	3
Sodium chloride	--	--	--	--	4
Titanium dioxide	3	3	3	3	3
Trace mineral-vitamin premix[1]	2.3	2.3	2.3	2.3	2.3
Calculated analysis					
Metabolizable energy, (kcal/kg)	3504	3573	3570	3524	3726
Crude protein	144.7	117.1	117.1	132.2	1.4
Calcium [2]	8.30	8.30	8.30	8.30	0.01
Total phosphorus [2]	4.44	4.34	4.43	4.33	0.06
Non-phytate phosphorus	4.44	4.34	4.43	4.33	
Ca:Non-phytate phosphorus	1.86	1.92	1.87	1.91	
Analyzed values					
Dry Matter	906	907	907	907	903
Calcium	9.89	8.03	9.71	8.25	0.14
Total phosphorus	4.34	3.54	4.45	3.64	0.24

[1] Supplied per kilogram of diet: vitamin A, 12,000 IU; cholecalciferol, 4,000 IU, thiamine, 3 mg; riboflavin, 9 mg; pyridoxine, 10 mg; folic acid, 3 mg; biotin, 0.25 mg; cyanocobalamin, 0.02 mg; dl-α-tocopherol acetate, 80 mg; niacin, 60 mg; Ca-D pantothenate, 15 mg; menadione, 4 mg; choline chloride, 600 mg; Co, 0.25 mg; I, 1.5 mg; Mo, 0.25 mg; Se, 0.26 mg; Mn, 100 mg; Cu, 10 mg; Zn, 80 mg; Fe, 60 mg; antioxidant, 100 mg.

[2] Calculated based on analyzed values of MBM samples

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regressive method automatically corrects for endogenous levels and represents true digestibility values of the nutrients. The direct method requires correcting for endogenous nutrient loss and represents apparent digestibility values.

The direct calculation method is simpler, cheaper and less labor intensive to determine MBM nutrient availability. Meat and bone meal has a Ca:P ratio of 2:1, which is an ideal balance between the two nutrients and potentially optimal for Ca absorption. This experiment found that true ileal Ca digestibility coefficients ranged from 0.413 to 0.560, which indicates that the Ca in MBM is not highly available. It is also logical to assume that the true Ca digestibility levels may be even lower in diets that contain phytate.

The digestibility of Ca varies because of several factors. The values of feed ingredients must continually be evaluated and the method used for calculating digestibility must also be considered.

Information for this article taken from:

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