Table 1. Ingredient and calculated nutrient composition of diets provided to Hubbard x Cobb 500 broilers from 1-21 d of age.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ingredient | | NC | PC | 2% PLB | 4% PLB |
|  | | % | % | % | % |
| Corn | | 54.57 | 54.57 | 54.57 | 54.57 |
| Soybean Meal | | 32.06 | 32.06 | 32.06 | 32.06 |
| Animal and Vegetable Blend | | 3.96 | 3.96 | 3.96 | 3.96 |
| MBM | | 2.50 | 2.50 | 2.50 | 2.50 |
| Limestone | | 1.28 | 1.04 | 0.97 | 0.89 |
| Salt | | 0.29 | 0.29 | 0.29 | 0.20 |
| Methionine | | 0.36 | 0.36 | 0.36 | 0.36 |
| NB30001 | | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | | 0.23 | 0.23 | 0.23 | 0.23 |
| Threonine | | 0.11 | 0.11 | 0.11 | 0.11 |
| Dicalcium Phosphorus | | 0.02 | 1.21 | 0.90 | 0.58 |
| Coban2 | | 0.05 | 0.05 | 0.05 | 0.05 |
| BMD3 | | 0.08 | 0.08 | 0.08 | 0.08 |
| Sand | | 4.04 | 3.09 | 1.57 | --- |
| PLB | | --- | --- | 2.00 | 4.00 |
| Calculated Nutrient Analysis | | | | | |
| ME (kcal/kg) | 1,375 | | 1,375 | 1,375 | 1,375 |
| CP (%) | 21.46 | | 21.46 | 21.75 | 22.04 |
| Digestible Lysine (%) | 1.18 | | 1.18 | 1.18 | 1.18 |
| Digestible TSAA (%) | 0.90 | | 0.90 | 0.90 | 0.90 |
| Digestible Threonine (%) | 0.77 | | 0.77 | 0.77 | 0.77 |
| Calcium (%) | 0.96 | | 0.96 | 0.96 | 0.96 |
| Available Phosphorus (%) | 0.23 | | 0.45 | 0.45 | 0.45 |

1 Supplied per kg of diet: manganese, 0.02%; zinc 0.02%; iron, 0.01%; copper, 0.0025%; iodine, 0.0003%; selenium, 0.00003%; folic acid, 0.69mg; choline, 386mg’ riboflavin, 6.61mg; biotin, 0.03mg; vitamin B6, 1.38mg; niacin, 27.56mg; pantothenic acid, 6.61mg; thiamine, 2.20mg; manadione, 0.83mg; vitamin B12, 0.01mg; vitamin E, 16.53 IU; vitamin D3, 2133 ICU; vitamin A, 7716 IU.

2Active drug ingredient Monensin Sodium 60 gpb (90 g/ton inclusion), Elanco Animal Health, Indianapolis, IN. As an aid in the prevention of coccidiosis caused by *Eimeria necarix*, *Eimeria tenella*, *Eimeria acervulina*, *Eimeria brunette*, *Eimeriamivati*, and *Eimeria maxima*.

3Bacitracin Methylene Disalicylate 50 g/lb (50 g/ton inclusion), Alpharma, Fort Lee, NJ. For increased rate of weight gain and improved feed efficiency.

Table 2. Proximate analysis values, mineral content, and heavy metal composition of PLB derived from built-up broiler litter.

|  |  |
| --- | --- |
| Nutrient1 | Value |
| Moisture | 2.16% |
| Crude Protein | 14.40% |
| Crude Fat | 0.40% |
| Calcium | 9.12% |
| Phosphorus | 3.04% |
| Sodium | 1.98% |
| Non-phytate phosphorus2 | 2.90% |
| Arsenic | 22 ppm |
| Nickel | 31 ppm |
| Chromium | 27 ppm |
| Cobalt | 5 ppm |
| Lead | 0.2 ppm |
| Cadmium | 0.1 ppm |

1New Jersey Feed Labs, Inc. Trenton, NJ. [12].

2nPP = Total Phosphorus – (0.282 X Total Phytic Acid) [20].

Table 3. Descriptive feed manufacture data1 for diets PC, NC, 2 and 4% PLB (with or without phytase).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatment | Production Rate (tonne/hr) | Hot Pellet Temperature  (°C) | New Holmen Pellet Tester  (%) | PDI2  (%) | MPDI3  (%) | Particle Size (microns)4 |
| PC | 1.09 | 82.0 | 30.0 | 58.0 | 44.8 | 1,027 |
| NC | 1.02 | 80.2 | 37.5 | 65.9 | 53.4 | 980 |
| 2% Biochar | 1.03 | 80.5 | 38.1 | 63.3 | 50.1 | 1,105 |
| 4% Biochar | 1.00 | 81.2 | 38.9 | 68.0 | 53.6 | 1,043 |
| PC + Phytase | 1.08 | 81.2 | 32.2 | 55.4 | 41.6 | 975 |
| NC + Phytase | 1.08 | 80.1 | 34.8 | 62.9 | 52.2 | 992 |
| 2% Biochar + Phytase | 1.08 | 82.4 | 35.6 | 60.7 | 47.7 | 1,058 |
| 4% Biochar + Phytase | 1.06 | 82.1 | 38.3 | 69.1 | 54.6 | 1,029 |

1Descriptive data (n = 2)

2Pellet Durability Index

3Modified Pellet Durability Index

4Particle size was determined with a Ro-Tap particle size analyzer model RX-29 type 110V 60H2 [38].

Table 4. Effects on performance variables for 1-21 day broilers when fed PC, NC, 2 and 4% PLB (with or without phytase).

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diet  Formulation | Phytase Addition | | Starting Pen Weight (kg/pen) | EBW1 (kg/bird) | LWG2 (kg/bird) | FI3 (kg/pen) | Mortality Percentage (%) | FCR4 (kg:kg) | Tibia Ash Percent5  (%) | Tibia Ash5 (mg/chick) | Tibia Ash5,6  (mg/g of gain) |
| PC | NO | | 0.949 | 0.732abc | 0.690abc | 22.44a | 1.613b | 1.43cde | 33.55ab | 1,016ab | 1.47ab |
| YES | | 0.948 | 0.739ab | 0.698ab | 21.96a | 0.538b | 1.38e | 36.21a | 1,045ab | 1.49ab |
| NC | NO | | 0.950 | 0.430e | 0.389e | 12.43b | 16.538a | 1.54a | 23.82c | 437c | 1.11c |
| YES | | 0.954 | 0.723bc | 0.682bc | 22.58a | 1.613b | 1.46bcd | 29.98b | 906b | 1.31bc |
| 2% PLB | NO | | 0.947 | 0.701cd | 0.658cd | 22.73a | 2.700b | 1.53ab | 34.86ab | 945ab | 1.49ab |
| YES | | 0.955 | 0.762a | 0.721a | 23.19a | 1.613b | 1.41de | 34.52ab | 1,079a | 1.49ab |
| 4% PLB | NO | | 0.953 | 0.674d | 0.633d | 21.59a | 1.088b | 1.49abc | 33.15ab | 978ab | 1.48ab |
| YES | | 0.955 | 0.734abc | 0.692abc | 22.32a | 1.625b | 1.42cde | 35.36ab | 1,045ab | 1.50a |
| ANOVA P value | | | 0.5584 | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **0.0011** |
| SEM7 | | | 0.0036 | 0.0130 | 0.0130 | 0.6160 | 1.2698 | 0.0253 | 1.7479 | 49.7537 | 0.0675 |
| Fisher’s LSD8 | | | 0.0104 | 0.0371 | 0.0371 | 1.7509 | 3.6089 | 0.0720 | 4.9961 | 141.4 | 0.192 |
| Marginal Means | | | | | | | | | | | |
| PC | | -- | 0.948 | 0.735a | 0.694a | 22.20a | 1.075b | 1.40b | 34.88a | 1,030a | 1.48a |
| NC | | -- | 0.952 | 0.577c | 0.535c | 17.51b | 9.225a | 1.50a | 26.90b | 672b | 1.21b |
| 2% PLB | | -- | 0.951 | 0.731a | 0.690a | 22.95a | 2.156b | 1.47a | 25.11a | 995a | 1.50a |
| 4% PLB | | -- | 0.954 | 0.704b | 0.663b | 21.95a | 1.356b | 1.46a | 33.83a | 1,029a | 1.49a |
| ---- | | NO | 0.949 | 0.634b | 0.593b | 19.79b | 5.559a | 1.50 | 31.34b | 844b | 1.39 |
| ---- | | YES | 0.953 | 0.740a | 0.698a | 22.51a | 1.347b | 1.41 | 34.02a | 1019a | 1.45 |
| Main Effects and Interaction Probabilities | | | | | | | | | | | |
| Diet Formulation | | | 0.4678 | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **0.0062** | **< 0.0001** | **< 0.0001** | **< 0.0001** |
| Phytase Addition | | | 0.1636 | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | **0.0472** | **< 0.0001** | 0.1914 |
| Diet Formulation X Phytase Addition | | | 0.6885 | **< 0.0001** | **< 0.0001** | **< 0.0001** | **< 0.0001** | 0.6815 | 0.4536 | < **0.0001** | 0.4752 |
| Contrast (P-value) | | | | | | | | | | | |
| PC vs 2% PLB | | | 0.7481 | 0.0982 | 0.0982 | 0.7464 | 0.5476 | **0.0086** | **0.0168** | **0.0300** | **0.0104** |
| PC vs 4% PLB | | | 0.4456 | **0.0032** | **0.0031** | 0.3327 | 0.7713 | **0.0760** | **0.0148** | **0.0479** | **0.0225** |
| PC + phytase vs 2% PLB + phytase | | | 0.2461 | 0.1036 | 0.1058 | 0.3975 | 1.0000 | 0.6017 | **0.0095** | **0.0204** | **0.0104** |
| PC + phytase vs 4% PLB + phytase | | | 0.2008 | 0.9122 | 0.9246 | 0.8826 | 0.9945 | 0.8798 | 0.6507 | 0.5554 | 0.8596 |

1Ending bird weight

2Live weight gain

3Feed intake

4Feed conversion ratio corrected for mortality weight

5Tibiae were ether extracted to remove residual fat prior to being ashed

6Tibia ash mg/g of gain = tibia ash (mg/chick) / LWG (g)

7Standard Error of the Mean (n = 8)

8Fisher’s Least Significant Difference

a-cMeans within a column not sharing a common superscript differ (P< 0.05)

Table 5. Effects on digesta viscosity for 1-21 day broilers when fed PC, NC, 2 and 4% PLB (with or without phytase).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Diet Formulation | | Phytase Addition | 10 times g 30 seconds (cP) | 10 times g 60 seconds (cP) | 20 time g 30 seconds (cP) | 20 times g 60 seconds (cP) |
| PC | | NO | 8.58 | 9.77 | 7.21 | 7.28 |
| YES | 12.56 | 12.57 | 8.49 | 8.25 |
| NC | | NO | 9.23 | 9.39 | 7.05 | 7.60 |
| YES | 12.28 | 12.19 | 7.61 | 7.75 |
| 2% PLB | | NO | 10.76 | 11.52 | 7.17 | 6.98 |
| YES | 12.01 | 12.42 | 7.93 | 8.13 |
| 4% PLB | | NO | 11.67 | 12.35 | 8.15 | 8.08 |
| YES | 10.55 | 11.17 | 7.14 | 7.41 |
| ANOVA P value | | | 0.6864 | 0.8235 | 0.8212 | 0.9537 |
| SEM1 | | | 1.7581 | 1.7333 | 0.7561 | 0.8308 |
| Fisher’s LSD2 | | | 4.9963 | 4.9262 | 2.149 | 2.3613 |
| Marginal Means | | | | | | |
| PC | -- | | 10.57 | 11.17 | 7.85 | 7.76 |
| NC | -- | | 10.76 | 10.79 | 7.33 | 7.67 |
| 2% PLB | -- | | 11.38 | 11.97 | 7.55 | 7.55 |
| 4% PLB | -- | | 11.11 | 11.76 | 7.64 | 7.74 |
| ---- | NO | | 10.06 | 10.75 | 7.39 | 7.48 |
| ---- | YES | | 11.85 | 12.08 | 7.79 | 7.88 |
| Main Effects and Interaction Probabilities | | | | | | |
| Diet Formulation | | | 0.9663 | 0.9011 | 0.9224 | 0.9942 |
| Phytase Addition | | | 0.1473 | 0.2844 | 0.4601 | 0.4949 |
| Diet Formulation X Phytase Addition | | | 0.4699 | 0.6204 | 0.4701 | 0.6736 |
| Contrast (P-value) | | | | | | |
| PC vs 2% PLB | | | 0.3859 | 0.4784 | 0.9740 | 0.7987 |
| PC vs 4% PLB | | | 0.2206 | 0.2989 | 0.3830 | 0.5045 |
| PC + phytase vs 2% PLB + phytase | | | 0.1752 | 0.2852 | 0.5010 | 0.4748 |
| PC + phytase vs 4% PLB + phytase | | | 0.4346 | 0.5726 | 0.9481 | 0.9182 |

a-eMeans within a column without a common superscript differ significantly (P ≤ 0.05)

1Fisher’s Least Significant Difference

2Standard Error of the Mean (n = 8)

Table 6. Effects on percent amino acid digestibility1 for 1-21 day broilers when fed PC, NC, 2 and 4% PLB (with or without phytase).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diet  Formulation | | Phytase Addition | | Aspartic Acid  (%) | Threonine (%) | Glutamic Acid  (%) | Proline (%) | Glycine (%) | Alanine (%) | Cysteine (%) | Valine (%) | Methionine (%) | Isoleucine (%) | Leucine (%) | Lysine (%) |
| PC | | NO | | 1.68 | 0.54 | 3.15bc | 0.76 | 0.59 | 0.66 | 0.14c | 0.75 | 0.46e | 0.66 | 1.28 | 1.12cd |
| YES | | 1.85 | 0.67 | 3.33ab | 0.91 | 0.72 | 0.83 | 0.24a | 0.85 | 0.49bc | 0.75 | 1.45 | 1.23a |
| NC | | NO | | 1.72 | 0.60 | 3.17bc | 0.89 | 0.67 | 0.80 | 0.17bc | 0.80 | 0.52ab | 0.71 | 1.42 | 1.16abc |
| YES | | 1.70 | 0.60 | 3.30ab | 0.82 | 0.62 | 0.71 | 0.16bc | 0.73 | 0.46de | 0.66 | 1.34 | 1.12bcd |
| 2% PLB | | NO | | 1.91 | 0.66 | 3.47a | 0.92 | 0.71 | 0.81 | 0.22ab | 0.85 | 0.48cde | 0.74 | 1.44 | 1.22ab |
| YES | | 1.76 | 0.63 | 3.22abc | 0.82 | 0.64 | 0.69 | 0.18bc | 0.73 | 0.53a | 0.66 | 1.31 | 1.17abc |
| 4% PLB | | NO | | 1.87 | 0.63 | 3.31ab | 0.88 | 0.67 | 0.75 | 0.20ab | 0.80 | 0.50cd | 0.71 | 1.37 | 1.18abc |
| YES | | 1.65 | 0.60 | 3.00c | 0.82 | 0.61 | 0.68 | 0.20abc | 0.71 | 0.48cde | 0.64 | 1.29 | 1.04d |
| ANOVA P value | | | | 0.1809 | 0.1898 | **0.0398** | 0.1784 | 0.3689 | 0.0983 | **0.0199** | 0.1086 | **< 0.0001** | 0.2246 | 0.2876 | **0.0186** |
| SEM2 | | | | 0.0771 | 0.0415 | 0.0945 | 0.0451 | 0.0434 | 0.0470 | 0.0180 | 0.0404 | 0.0100 | 0.0336 | 0.0602 | 0.0371 |
| Fisher’s LSD3 | | | | --- | --- | 0.2688 | --- | --- | --- | 0.0513 | --- | 0.0287 | --- | --- | 0.1056 |
|  | **Marginal Means** | | | | | | | | | | | | | | | |
| PC | | | -- | 1.76 | 0.60 | 3.23 | 0.83 | 0.65 | 0.74 | 0.19 | 0.80 | 0.48b | 0.71 | 1.37 | 1.17 |
| NC | | | -- | 1.71 | 0.55 | 3.24 | 0.85 | 0.65 | 0.76 | 0.17 | 0.76 | 0.49ab | 0.68 | 1.38 | 1.14 |
| 2% PLB | | | -- | 1.75 | 0.61 | 3.15 | 0.85 | 0.64 | 0.71 | 0.20 | 0.76 | 0.48b | 0.68 | 1.33 | 1.11 |
| 4% PLB | | | -- | 1.83 | 0.65 | 3.35 | 0.87 | 0.67 | 0.75 | 0.20 | 0.79 | 0.51a | 0.70 | 1.37 | 1.19 |
| ---- | | | NO | 1.79 | 0.61 | 3.28 | 0.86 | 0.66 | 0.75 | 0.18 | 0.80 | 0.48 | 0.70 | 1.38 | 1.17 |
| ---- | | | YES | 1.74 | 0.60 | 3.21 | 0.84 | 0.65 | 0.73 | 0.20 | 0.76 | 0.49 | 0.68 | 1.35 | 1.14 |
|  | **Main Effects and Interaction Probabilities** | | | | | | | | | | | | | | | |
| Diet Formulation | | | | 0.5147 | 0.1982 | 0.2296 | 0.9000 | 0.8731 | 0.8656 | 0.2989 | 0.6895 | **0.0346** | 0.8398 | 0.8814 | 0.1525 |
| Phytase Addition | | | | 0.3302 | 0.8175 | 0.3110 | 0.5144 | 0.7748 | 0.4642 | 0.3134 | 0.1531 | 0.4692 | 0.2545 | 0.4887 | 0.2583 |
| Diet Formulation X Phytase Addition | | | | 0.0834 | 0.0632 | **0.0161** | **0.0328** | 0.0948 | **0.0240** | **0.0097** | **0.0537** | **< 0.0001** | 0.0800 | 0.0746 | **0.0206** |
|  | **Contrast (P-value)** | | | | | | | | | | | | | | | |
| PC vs 2% PLB | | | | **0.0465** | **0.0465** | **0.0174** | **0.0160** | **0.0573** | **0.0325** | **0.0083** | **0.0991** | 0.1537 | 0.1327 | 0.0610 | **0.0477** |
| PC vs 4% PLB | | | | 0.0977 | 0.1341 | 0.2249 | 0.0849 | 0.1738 | 0.1979 | **0.0465** | 0.3834 | **0.0281** | 0.3048 | 0.2740 | 0.2534 |
| PC + phytase vs 2% PLB + phytase | | | | 0.4894 | 0.1245 | 0.5846 | 0.3759 | 0.3260 | 0.6748 | 0.1423 | 0.6900 | **< 0.0001** | 0.9217 | 0.7513 | 0.3394 |
| PC + phytase vs 4% PLB + phytase | | | | 0.7597 | 0.3088 | 0.2586 | 0.3902 | 0.6456 | 0.7006 | **0.0559** | 0.5057 | 0.1657 | 0.6332 | 0.8690 | 0.1616 |

1Pecent digestible amino acid refers to the percentage of digestible amino acid within the total diet (ex. A diet containing 1.28% lysine and digesta containing an average of 0.45% lysine and resulting in an average of 76% digestibility. Thus, 76% of the original 1.28% lysine results in an average of 0.97% lysine for this treatment).

2Standard Error of the Mean (n = 8)

3Fisher's Least Significant Difference

a-eMeans within a column not sharing a common superscript differ (P < 0.05)