***Animal* Journal**

**Standardized total tract digestible phosphorus requirement of 6- to 13-kg pigs fed diets without or with phytase**

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**Table S1** *Swine diet formulation, phase 1 (day 0 to 11; as-fed basis)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Phytase1 | 0 FYT/kg diet | | | | | |  | 2 000 FYT/kg diet | | | | | |
| STTD2 P, % of NRC3 | 80 | 90 | 100 | 110 | 125 | 140 |  | 100 | 110 | 125 | 140 | 155 | 170 |
| Ingredients, % |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Corn | 45.77 | 45.23 | 44.69 | 44.13 | 43.40 | 42.59 |  | 46.48 | 45.93 | 45.12 | 44.35 | 43.55 | 42.80 |
| Soybean meal | 22.72 | 22.76 | 22.80 | 22.85 | 22.89 | 22.94 |  | 22.67 | 22.71 | 22.77 | 22.84 | 22.88 | 22.93 |
| HP 3004 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 |  | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 |
| Dried whey | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |  | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| Beef tallow | 2.10 | 2.30 | 2.50 | 2.70 | 2.95 | 3.25 |  | 1.85 | 2.05 | 2.35 | 2.60 | 2.90 | 3.15 |
| Monocalcium P (21% P) | 0.40 | 0.65 | 0.90 | 1.15 | 1.52 | 1.90 |  | 0.02 | 0.27 | 0.65 | 1.02 | 1.40 | 1.77 |
| Limestone | 0.74 | 0.79 | 0.84 | 0.90 | 0.97 | 1.05 |  | 0.63 | 0.69 | 0.76 | 0.84 | 0.92 | 1.00 |
| Salt | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |  | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| L-Lysine HCl | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |  | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| DL-Methionine | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |  | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| L-Threonine | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |  | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| L-Tryptophan | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |  | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| L-Valine | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |  | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Trace mineral premix5 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |  | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Vitamin premix6 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |  | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Vitamin E (20000 IU) | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |  | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Choline chloride | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |  | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| Phytase | - | - | - | - | - | - |  | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Zinc oxide | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 |  | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 |
| Selenium premix | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |  | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |  | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Calculated composition | |  |  |  |  |  |  |  |  |  |  |  |  |
| Standardized ileal digestible AA, % | | |  |  |  |  |  |  |  |  |  |  |  |
| Lysine | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |  | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Isoleucine:Lysine | 57 | 57 | 57 | 57 | 57 | 57 |  | 57 | 57 | 57 | 57 | 57 | 57 |
| Leucine:Lysine | 111 | 111 | 110 | 110 | 110 | 110 |  | 111 | 111 | 111 | 110 | 110 | 110 |
| Methionine:Lysine | 38 | 38 | 38 | 38 | 38 | 38 |  | 38 | 38 | 38 | 38 | 38 | 38 |
| Methionine & Cystine:Lysine | 58 | 58 | 58 | 58 | 58 | 58 |  | 58 | 58 | 58 | 58 | 58 | 58 |
| Threonine:Lysine | 64 | 64 | 64 | 64 | 64 | 64 |  | 64 | 64 | 64 | 64 | 64 | 64 |
| Tryptophan:Lysine | 19 | 19 | 19 | 19 | 19 | 19 |  | 19 | 19 | 19 | 19 | 19 | 19 |
| Valine:Lysine | 71 | 71 | 71 | 71 | 71 | 71 |  | 71 | 71 | 71 | 71 | 71 | 71 |
| Total Lysine, % | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 |  | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 |
| CP, % | 21.17 | 21.14 | 21.12 | 21.10 | 21.05 | 21.01 |  | 21.20 | 21.18 | 21.14 | 21.11 | 21.06 | 21.02 |
| Net energy, MJ/kg | 10.76 | 10.76 | 10.76 | 10.76 | 10.76 | 10.76 |  | 10.76 | 10.76 | 10.76 | 10.76 | 10.76 | 10.76 |
| Analyzed composition | |  |  |  |  |  |  |  |  |  |  |  |  |
| DM, % | 92.00 | 91.71 | 92.13 | 91.85 | 91.58 | 92.02 |  | 91.37 | 91.56 | 91.82 | 91.63 | 91.93 | 91.94 |
| CP, % | 21.30 | 22.20 | 21.40 | 21.70 | 21.10 | 21.80 |  | 22.40 | 22.40 | 20.40 | 20.90 | 21.10 | 21.00 |
| Ca7, % | 0.70 | 0.78 | 0.83 | 0.84 | 0.95 | 1.02 |  | 0.61 | 0.69 | 0.75 | 0.88 | 0.88 | 0.98 |
| P7, % | 0.58 | 0.64 | 0.69 | 0.73 | 0.81 | 0.90 |  | 0.48 | 0.54 | 0.61 | 0.73 | 0.75 | 0.86 |
| Phytase, FYT/kg | - | - | - | - | - | - |  | 1 796 | 1 782 | 1 574 | 1 488 | 1 364 | 2 002 |

1 Ronozyme HiPhos 2500 (DSM Nutritional Products, Inc., Parsippany, NJ); FYT/kg = phytase unit.

2 STTD = standardized total tract digestible.

3 The NRC (2012) requirement estimate for nursery pigs from 5 to 7 kg, expressed as a percentage of the diet, is 0.45% STTD P. Therefore, treatment concentrations represented 80, 90, 100, 110, 125, 140, 155, and 170% of the NRC (2012) requirement.

4 Enzymatically treated soy product (Hamlet Protein, Inc., Findlay, OH).

5 Provided per kg of diet: 26.6 mg Mn from manganese oxide, 93.6 mg Fe from iron sulfate, 100.8 mg Zn from zinc sulfate, 14.4 mg Cu from copper sulfate, 1.44 mg I from calcium iodate.

6 Provided per kg of diet: 14 330 IU vitamin A, 2 205 IU vitamin D3, 53 IU vitamin E, 400.8 mg vitamin K, 7.7 mg riboflavin, 33.1 mg pantothenic acid, 55.1 mg niacin, 0.04 mg vitamin B12, 2.2 mg folic acid, 0.022 mg thiamin, 0.022 mg pyridoxine, and 0.002 mg biotin.

7 Averaged across analyzed values from Ward Laboratories, Inc. (Kearney, NE), Cumberland Valley Analytical Services Inc. (Maugansville, MD), and Midwest Laboratories (Omaha, NE).

**Table S2** *Swine diet formulation, phases 2 and 3 (day 11 to 25 and day 25 to 46, respectively; as-fed basis)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Phase 2 | | | | | | | | | | | | | Phase 3 |
| Phytase1 | 0 FYT/kg diet | | | | | |  | 2 000 FYT/kg diet | | | | | |
| STTD2 P, % of NRC3 | 80 | 90 | 100 | 110 | 125 | 140 |  | 100 | 110 | 125 | 140 | 155 | 170 |
| Ingredients, % |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Corn | 53.71 | 53.26 | 52.75 | 52.31 | 51.60 | 50.90 |  | 54.53 | 54.03 | 53.34 | 52.63 | 51.92 | 51.22 | 61.32 |
| Soybean meal | 28.29 | 28.32 | 28.36 | 28.39 | 28.44 | 28.49 |  | 28.23 | 28.27 | 28.31 | 28.37 | 28.42 | 28.47 | 33.07 |
| HP 3004 | 3.75 | 3.75 | 3.75 | 3.75 | 3.75 | 3.75 |  | 3.75 | 3.75 | 3.75 | 3.75 | 3.75 | 3.75 | - |
| Dried whey | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |  | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | - |
| Beef tallow | 1.00 | 1.15 | 1.35 | 1.50 | 1.75 | 2.00 |  | 0.70 | 0.90 | 1.15 | 1.40 | 1.65 | 1.90 | 1.00 |
| Monocalcium P (21% P) | 0.53 | 0.75 | 0.97 | 1.19 | 1.53 | 1.86 |  | 0.10 | 0.32 | 0.65 | 0.98 | 1.32 | 1.65 | 1.65 |
| Limestone | 0.81 | 0.86 | 0.91 | 0.95 | 1.02 | 1.09 |  | 0.70 | 0.74 | 0.81 | 0.88 | 0.95 | 1.02 | 1.08 |
| Salt | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |  | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| L-Lysine HCl | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |  | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| DL-Methionine | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |  | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.18 |
| L-Threonine | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |  | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.18 |
| L-Tryptophan | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |  | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| L-Valine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |  | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.09 |
| Trace mineral premix5 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |  | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Vitamin premix6 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |  | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Phytase | - | - | - | - | - | - |  | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | - |
| Zinc oxide | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |  | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Selenium premix | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |  | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |  | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Calculated composition |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Standardized ileal digestible AA, % | | |  |  |  |  |  |  |  |  |  |  |  |  |
| Lysine | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 |  | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.30 |
| Isoleucine:Lysine | 60 | 60 | 60 | 60 | 60 | 60 |  | 60 | 60 | 60 | 60 | 60 | 60 | 59 |
| Leucine:Lysine | 118 | 118 | 118 | 118 | 117 | 117 |  | 119 | 119 | 118 | 118 | 118 | 117 | 120 |
| Methionine:Lysine | 37 | 36 | 36 | 36 | 36 | 36 |  | 37 | 37 | 36 | 36 | 36 | 36 | 35 |
| Methionine & Cystine:Lysine | 58 | 58 | 58 | 58 | 58 | 58 |  | 58 | 58 | 58 | 58 | 58 | 58 | 58 |
| Threonine:Lysine | 64 | 64 | 64 | 64 | 64 | 64 |  | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| Tryptophan:Lysine | 19 | 19 | 19 | 19 | 19 | 19 |  | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| Valine:Lysine | 71 | 71 | 71 | 71 | 71 | 71 |  | 71 | 71 | 71 | 71 | 71 | 71 | 71 |
| Total Lysine, % | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |  | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.45 |
| CP, % | 21.89 | 21.86 | 21.84 | 21.82 | 21.78 | 21.75 |  | 21.93 | 21.90 | 21.87 | 21.83 | 21.80 | 21.76 | 21.52 |
| Net energy, MJ/kg | 10.41 | 10.41 | 10.41 | 10.41 | 10.41 | 10.41 |  | 10.41 | 10.41 | 10.41 | 10.41 | 10.41 | 10.41 | 10.41 |
| Analyzed composition |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| DM, % | 90.12 | 90.73 | 91.15 | 91.35 | 91.49 | 90.64 |  | 91.38 | 91.15 | 90.86 | 90.99 | 91.30 | 90.76 | 90.27 |
| CP, % | 21.60 | 22.10 | 21.70 | 21.90 | 22.10 | 21.30 |  | 22.90 | 21.90 | 22.50 | 22.10 | 22.30 | 23.00 | 22.00 |
| Ca7, % | 0.83 | 0.93 | 0.90 | 0.83 | 1.00 | 0.95 |  | 0.63 | 0.65 | 0.73 | 0.87 | 0.82 | 1.03 | 0.91 |
| P7, % | 0.54 | 0.59 | 0.65 | 0.70 | 0.76 | 0.80 |  | 0.46 | 0.53 | 0.58 | 0.66 | 0.70 | 0.90 | 0.74 |
| Phytase, FYT/kg | - | - | - | - | - | - |  | 2 394 | 2 081 | 1 785 | 2 026 | 2 000 | 2 342 | - |

1 Ronozyme HiPhos 2500 (DSM Nutritional Products, Inc., Parsippany, NJ); FYT/kg = phytase unit.

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