**Effects of citric acid and microbial phytase on phytate phosphorus utilization and growth of chicken**

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## Introduction

Improving P-utilization has become increasingly importance, primarily due to phosphorus pollution from animal production. A number of studies have shown that microbial phytase is an efficient tool for increasing phytate-P utilization, thereby reducing the amount of supplemental inorganic P in poultry diets. However, possibilities for increasing the efficiency of phytate degradation by supplemented microbial phytase is still a very interesting area of research. BOLING et al. (1) reported that addition of citric acid in combination with microbial phytase increased tibia ash content and weight gain of chicken fed corn-soybean diets significantly. The objective of the current study was to investigate effects of microbial phytase in combination with citric acid in the presence of different native phytase activity. Corn and wheat untreated resp. after defined hydrothermal treatment were used as the grain component of chicken diets to vary the native activity of dietary phytase.

## Material and Method

360 day old chicks were used in two experiments with age of 3–38d (180 chicks) and 7-42d (180 chicks) fed corn-soybean meal (CSM) and wheat-soybean meal (WSM) diets. Ten birds per group were located in a cage system as one replication (6 replications per diet) , feed and water were supplied *ad libitum*. Corn and wheat (B, C and E, F) were subjected to hydrothermal treatment with steam addition (100$^{o}$C for 10 minutes). All diets were applied in pellet form and supplemented with 500 U/kg of a microbial phytase (SP-1002ct). A mixture of citric acid:Na-citrate (1:1,w/w, 30 g/kg diet) was added only to diets C and F. All diets were deficient in available phosphorus (1,6-1.8 g/kg), the total phosphorus content of the diets was equal to 4.5 gP/kg. Treatments and experimental diets are summarised in table 1 and 2.

Table 1. Experimental treatments

| Groups | Phytase (FTU/kg) | Citric acid : Citrate (1:1 w/w; g/kg) |
|---|---|---|
| Corn-soybeanmeal diet (CSM) | | |
| A | 500 | - |
| B | 500 | - |
| C | 500 | 30 |
| Wheat-soybeanmeal (WSM) | | |
| D | 500 | - |
| E | 500 | - |
| F | 500 | 30 |

Table 2. Diet composition

| INGREDIENTS (%) | Corn-soybeanmeal diets | | | Wheat-soybeanmeal diets | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| Corn | 53.8 | 53.8 | 53.3 | - | - | - |
| Wheat | - | - | - | 54.9 | 54.9 | 54.1 |
| Soybeanmeal | 37.0 | 37.0 | 37.0 | 34.5 | 34.5 | 34.5 |
| Soybean oil | 2.0 | 2.0 | 2.8 | 3.5 | 3.5 | 4.5 |
| Wheat starch | 3.6 | 3.6 | 0.6 | 3.6 | 3.6 | 0.6 |
| $CaCO_3$ | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 |
| NaCl | 0.4 | 0.4 | 0.1 | 0.3 | 0.3 | 0.1 |
| Premix | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Citrate | - | - | 3.0 | - | - | 3.0 |
| NUTRIENTS | | | | | | |
| Crude Protein,% DM | 21.9 | 21.9 | 21.8 | 22.0 | 22.0 | 21.9 |
| ME, MJ/kg | 13.6 | 13.6 | 13.4 | 13.7 | 13.7 | 13.5 |
| Total P, g/kg | 4.6 | 4.6 | 4.6 | 4.7 | 4.7 | 4.6 |
| Available P, g/kg | 1.7 | 1.7 | 1.6 | 1.7 | 1.8 | 1.8 |
| Phytase activity (U/kg)* | 464 | 418 | 571 | 1046 | 431 | 401 |

***)Result of laboratory analysis**

At the end of the experiments selected animals were analysed for body composition (DM, N, P). The results are used for calculations of nutrient deposition.

**Results and Discussion**

In the first step of data analysis the results of growth experiments in terms of average daily gain (ADG), feed intake (FI) and feed conversion ratio (FCR) as well as nutrient deposition are summarised in Table 3.

Table 3. Growth parameters and nutrient deposition after application of the experimental diets over 35 days

| Parameters | Corn-soybeanmeal diet | | | Wheat-soybeanmeal diet | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| Growth Experiment | | | | | | |
| Protein deposition, g | $224.6^{ab}$ | $215.9^{a}$ | $278.0^{c}$ | $344.0^{b}$ | $296.5^{a}$ | $340.6^{ab}$ |
| P-deposition, g | $5.8^{a}$ | $5.4^{a}$ | $7.0^{b}$ | $8.2^{a}$ | $6.9^{b}$ | $7.8^{ab}$ |
| P-utilization, % | $69.3^{a}$ | $63.4^{a}$ | $68.0^{a}$ | $64.3^{a}$ | $59.9^{a}$ | $60.5^{a}$ |
| ADG, g/d | $36^{a}$ | $34^{a}$ | $45^{b}$ | $54^{a}$ | $46^{b}$ | $55^{a}$ |
| FI, g/d | 61 | 61 | 77 | 99 | 89 | 101 |
| FCR, g/g | $1.7^{a}$ | $1.8^{b}$ | $1.7^{a}$ | $1.8^{a}$ | $1.9^{b}$ | $1.8^{a}$ |

$^{a,b,c,d}$ different superscripts indicate significant differences within the diet using Duncan's test.

After the CSM-diet with citric acid feed intake and growth ($P<0.01$), protein deposition and P-deposition ($P<0.05$) increased significantly. The observed effects are more pronounced in comparison to BOLING et al., 2001, however FCR was not enhanced. After WSM-diets no additional effect of citric acid could be observed. It can be assumed from earlier studies that hydrothermal treatment of wheat resulted in a change in solubility of pentosans and the antinutritive effects of increased solubility of pentosans could have overlaped the results. The degradation of native phytase activity by wheat-treatment (table 2) could be also an influencing factor. Consequently, under these conditions the citrate inclusion seemed to compensate these negative effects but did not express any additional effect on performance, nutrient deposition and feed conversion. Complexation of calcium by citric acid (PILEGGI et al. 1956) may also be a factor with influence on the experimental results.

## Conclusions

Citric acid (30 g/kg) in a corn soybean chicken diet with low native phytase activity and supplementation of microbial phytase increased growth performance, protein and phosphorus deposition significantly. Further experiments are essential for a more physiological explanation and clarification if this observations are effects of acidification, changes of solubility of phytates during passage of GIT and/or other conditions affecting the efficiency of supplemented microbial phytase.

## References

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