Possibility to improve rice polishing utilisation in broiler diets by enzymes or dietary formulation based on digestible amino acids

Möglichkeiten der Verbesserung der Verwertung von Reiskleie in Broilerrationen durch den Einsatz von Enzymen oder durch die Formulierung der Rationen auf der Basis von verdaulichen Aminosäuren

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Introduction

Rice polishing/bran is an alternative feedstuff for many developing countries where rice is a major cereal grain (ATTIA et al. 2003). The yield of rice polishing/bran ranged from 5 to 10% and this depends on the degree of milling of the brown rice (FARRELL 1994; RAO 2002). Both full fat rice polishing/bran and defatted rice polishing/bran is a rich source of nutrients (FARRELL 1994; ATTIA et al. 2003) and a range of bioactive phytochemicals (RAO 2002). The optimum utilisation of rice polishing/bran may be restricted by its antinutritional substances i.e. NSP, phytin and low availability of amino acid (FARRELL 1994; ATTIA et al. 2003). Supplementation with feed enzymes or dietary formulations based on true amino acid digestibility (TAAD) could upgrade the poorly utilised feedstuffs in feeding monogastric animals (SIMON 1998; BRUFAU et al. 2002; ATTIA et al. 2003). ABOOSADI et al. (1996) and FARRELL and MARTIN (1998) found that broiler diets containing either 20 or 40% rice bran supplemented with a multienzymes mixture containing xylanase, α-amylase, β-glucanase and proteases, without or with 170 U/kg phytase had no beneficial effects on performance of broilers. However, a beneficial impact of the feed enzymes, and phytase on performance of broilers was reported (FARRELL and MARTIN 1998; ATTIA et al. 2003).

The quality of rice polishing/bran may be affected by different factors as variety of rice, type of milling machine, oil extraction, degree of adulteration with rice hulls (FARRELL 1994; ATTIA et al. 2003). Due to different types of rice polishing/bran in the Egyptian market, the possibility of enhancing the utilisation of rice polishing for broiler chicks when fed during early growth period by supplementation with phytase (Natuphos®), an enzyme mixture (Optizyme®), phospholipase A₂, or by dietary formulation based on TAAD warrant further investigations.

Materials and methods

Birds

The experiments were carried out during year 2002, in the Bostan Farm, belongs to Animal and Poultry Nutrition and Production Department, National Research Council.

In each experiment, one hundred and forty four, day old Hubbard broiler chickens were kept under similar management condition with 24 h lighting. Chickens were raised in battery brooder, and randomly distributed to 6 experimental treatments, each consisting of 3 replicates of 8 unsexed chickens each. However, birds were sexed at the end of the experiment by size of comb and wattle and general appearance. Chickens were offer free access to water and mash feed.

Diets

In trials 1 and 2, six isocaloric and isonitrogenous diets that meet nutrient requirements for broiler chickens based on NRC (1994) were prepared (Table 1). Diets were formulated on a base of textbook values for feedstuffs (NRC 1994) and chemical composition of rice polishing (CP 13.7%; EE 15%; CF 7.1%) and 12.73 MJ ME /kg according to ATTIA et al. (2003).

In trial 1, rice polishing was included at 0, 15% and 0, 20% in the grower (7-28 d of age), and finisher diets (29-42 d of age), respectively. Rice polishing containing-diet was fed without or with 500 FTU of microbial phytase (Natuphos®¹) and/or 500 U of phospholipase A₂² per kg diet. Additionally, diet containing 15/20% rice polishing in the growing/finishing period was formulated based on TAAD. Amino acids in the diets were calculated to fulfill the requirement for essential amino acids according to NRC (1994) (Table 1). The TAAD values for rice polishing were according to ATTIA et al. (2003). The digestible TSAA, lysine, threonine, valine, leucine and isoleucine (Table 2) of the control diet and that containing-rice polishing were equalised by supplementation with crystalline amino acids product of Degussa AG, feed additives division. However, the calculation was based on maize, soy-

¹One unit (FTU) is equal to the enzyme activity that liberates 1 µmol ortho-phosphate from 5.1 mmol of sodium phytin per minute at 37º C and pH 5.5. Marketed by BASF, Germany

²Produced with Kluyveromyces lactis, produced by DSM Food Specialties, Delft, The Netherlands.
bean meal and rice polishing only, due to use of constant ratio (10%) of the commercial protein concentrate. Moreover, amino acids of bone meal were not included due to its constant ratio and negligible contribution. Changing sand contents did the adjustment in the experimental diet.

Due to the lack of significant effect of phospholipase and dietary formulation based on TAAD on productive traits in trial 1, these treatments were excluded in trial 2 in which rice polishing was included at 0, 10 and 20% and 0, 15 and 30% in the growing (1-28 d of age), and finishing diets (29-42 d of age), respectively. Each rice polishing containing-diet was fed without or with 500 FTU microbial phytase (Natuphos®). Additionally, diet containing 20/30% rice polishing during the growing/finishing period was supplemented with 500 FTU of microbial phytase (Natuphos®) plus 0.10% of multienzymes mixture (Optizyme®1), to study the additive effect of multienzymes mixture on enhancing nutrient utilisation of diets containing high level of rice polishing supplemented with phytase alone. Ca and available P of phytase supplemented-diets were adjusted according to BASF (1999). Increasing sand contents made the balance in the experimental diets.

1Multienzymes product containing proteases, amyloglucosidase, xylanase, β-glucanase, cellulases and hemicellulases. Product of Optivite International LTD.
Observations

Chickens were leg banded and individually weighed at 7, 28 and 42 d of age in trial 1, and 1, 28 and 42 d of age in trial 2. The residual feed was weighed at the same days and total feed intake as well as FCR was calculated on a replicate basis. At the end of each experiment (42 d of age) five birds (2 females and 3 males) from each treatment were selected and slaughtered for determination of carcass yield and internal organs.

Blood samples were collected from the slaughtered birds in heparinized tube. Plasma was separated by centrifugation at 3000 rpm for 10 min and stored at -18°C until analysis. Concentrations of plasma total protein and total lipids were determined using commercial kits (Roche Diagnostics, GmbH, D-68298 Mannheim, Germany), triglycerides, cholesterol (Sigma Diagnostics, procedure No. 401). Plasma glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) were determined according to REITMAN and MAN FRANKEL (1957). Colour intensity (HUSANI et al. 1950) and pH value (AITKEN et al. 1962) were determined.

In trial 2, a total collection method was employed to determine apparent digestibility of experimental diets. Meanwhile, fecal nitrogen was separated following the method of JAKOBSEN et al. (1960). Proximate chemical analyses of the excrement, experimental diets, mixed breast and internal organs. Physical characteristics of meat including tenderness, water holding capacity (WHC) (V OLOVINSKAIA and KEKMAN 1962), colour intensity (HUSANI et al. 1950) and pH value (AITKEN et al. 1962) were determined.

Table 2. Total and digestible amino acid composition of the growing and finishing experimental diets

<table>
<thead>
<tr>
<th>Total a and digestible amino acids composition</th>
<th>Rice polishing in the diet for trial 1</th>
<th>Rice polishing in the diet for trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growing diet 0.0 150 150</td>
<td>Growing diet 0 100 200</td>
</tr>
<tr>
<td>Methionine b</td>
<td>5.9 5.9 5.9 4.2 4.2</td>
<td>4.2 5.6 5.6 5.6 4.1</td>
</tr>
<tr>
<td>TSAA b</td>
<td>9.3 9.5 9.5 7.0 7.2</td>
<td>7.2 9.1 9.2 9.3 7.2</td>
</tr>
<tr>
<td>Digestible TSAA c</td>
<td>6.6 6.6 6.6 4.5 4.4</td>
<td>4.5 --- --- --- --- --- --- --- ---</td>
</tr>
<tr>
<td>Lysine b</td>
<td>12.3 12.4 12.4 9.2 9.3</td>
<td>9.3 11.4 11.4 11.6 10.0 10.0 10.0</td>
</tr>
<tr>
<td>Digestible lysine c</td>
<td>8.3 8.2 8.3 5.5 5.3</td>
<td>5.5 --- --- --- --- --- --- --- ---</td>
</tr>
<tr>
<td>Threonine b</td>
<td>8.8 8.8 8.8 7.0 7.0</td>
<td>7.0 8.0 8.0 8.0 7.4 7.4 7.4</td>
</tr>
<tr>
<td>Digestible threonine b</td>
<td>5.8 5.6 5.8 4.1 3.9</td>
<td>4.1 --- --- --- --- --- --- --- ---</td>
</tr>
<tr>
<td>Arginine b</td>
<td>15.5 16.1 16.1 11.9 12.6</td>
<td>12.6 13.7 14.1 14.5 11.4 12.0 12.6</td>
</tr>
<tr>
<td>Digestible arginine b</td>
<td>10.3 10.8 10.8 7.0 7.6</td>
<td>7.6 --- --- --- --- --- --- --- ---</td>
</tr>
<tr>
<td>Valine b</td>
<td>10.5 10.8 10.8 8.4 8.7</td>
<td>8.7 9.9 10.0 10.2 8.5 8.7 8.9</td>
</tr>
<tr>
<td>Digestible valine b</td>
<td>7.4 7.4 7.4 5.5 5.4</td>
<td>5.5 --- --- --- --- --- --- --- ---</td>
</tr>
<tr>
<td>Leucine b</td>
<td>19.4 18.9 18.9 16.4 15.8</td>
<td>15.8 18.1 17.8 17.4 16.1 15.5 14.9</td>
</tr>
<tr>
<td>Digestible leucine b</td>
<td>14.2 13.4 14.2 11.3 10.4</td>
<td>11.3 --- --- --- --- --- --- --- ---</td>
</tr>
<tr>
<td>Isoleucine b</td>
<td>9.7 9.7 9.7 7.6 7.5</td>
<td>7.5 8.9 8.8 8.8 7.4 7.4 7.3</td>
</tr>
<tr>
<td>Digestible isoleucine b</td>
<td>6.7 6.5 6.7 4.7 4.4</td>
<td>4.7 --- --- --- --- --- --- --- ---</td>
</tr>
</tbody>
</table>

2digestible values are based on plant organ components only (maize, soybean meal, and rice polishing) since the commercial protein concentrate was included at constant ratio in all diets [10%].

Results

Trial 1

There were no significant differences in body weight gain (BWG) during 7-28, 29-42 and 7-42 d of age, and similar trend was observed in FCR (Table 3). However, feed intake showed significant differences only during 7-28 d of age in which groups fed phytase supplemented-diets consumed significantly less feed than groups fed phospholipase supplemented-diet or TAAD-diet.

There were no significant differences in percentage of dressing, liver, heart, giblets and abdominal fat (Table 3). However, gizzard percentage was significantly larger of rice polishing fed-groups than that of the positive control (Table 3). Also, feeding rice-polishing containing-diet without phytase addition or dietary formulation based TAAD increased pancreas percentage significantly. Though, all treatments showed significantly higher percentage pancreas compared to diet without rice bran.

Phytase increased moisture and CP of meat significantly compared to the negative control. Phospholipase increased EE of meat compared to the positive control and had no significant impact on CP and moisture content of meat. Similar trend was shown in CP and EE of meat of TAAD-diet. Only meat colour intensity of meat physical characteristics was significantly higher of rice polishing containing-diet fed without or with phospholipase addition or formulated based on TAAD than other treatment groups.

Rice polishing containing-diet significantly decreased plasma total protein, whilst phytase and/or phospholipase and TAAD-diet significantly increased it to the level of the
control group (Table 3). Also, plasma cholesterol was significantly lower of rice polishing containing-diets than that of the positive control, except for TAAD-diet, which showed similar value to that of the positive control.
There was a significant decrease in BWG and impairment in FCR during 1-28, 29-42 and 1-42 d of age period due to including rice polishing in the diet for broiler at 20/30% (Table 4). Phytase without or with multienzymes mixture improved growth and FCR significantly compared to their negative control, with the combination of phytase plus multienzymes yield better results than phytase alone. Groups fed rice polishing containing-diet consumed more feed than the positive control only during days 1-28 of age. Furthermore, group fed 20/30% rice polishing supplemented with phytase plus multienzymes mixture consumed more feed than all experimental groups except that fed 20/30% rice polishing supplemented with phytase alone (Table 4). However, feed intake for the whole experimental period was the highest by 10/15% (-) group due to higher feed consumed by this group during the 2nd experimental period.

Apparent digestibility of crude protein (CP) and ether extract (EE) was significantly lower of rice polishing containing-diets than that of the positive control (Table 4). Also, including rice polishing at 20/30% in the growing/finishing diets significantly decreased apparent digestibility of CF compared to all other treatment groups. Phytase improved apparent digestibility of CP of group fed 10/15% and 20/30% rice polishing, with more apparent effect in the latter group.

Percentage of dressing, front or hind part and giblets of broiler chicks were not significantly affected by level of rice polishing (Table 4).
polishing and enzyme supplementation (Table 4). Rice polishing significantly decreased plasma total protein while upon phytase addition plasma protein was recovered (Table 4). Plasma cholesterol was significantly decreased when rice polishing was fed with or without enzyme addition. There was a significant increase in plasma GOT of groups fed 10/15% and 20/30% rice polishing containing-diet, except for group fed 10/15% rice polishing phytase supplemented diet. There was a significant increase in plasma GPT due to feeding rice polishing containing-diet without or with enzyme additions compared to the positive control (Table 4).

Discussion

Rice polishing at 15/20% in the growing/finishing diet had no adverse impact on growth performance of broilers, consequences phytase, phospholipase and their combination or dietary formulation based on TAAD had little effect on BWG and FCR in trial 1 (Table 3). Indeed, the level of rice polishing chosen in trial 1 was based on ATTIA et al. (2003) who showed that as little as 7.5% of rice polishing in broiler diets during 28-49 d of age impaired FCR significantly, while 15% level had adverse impact on both BWG and FCR. It is therefore, anticipated that this level can adversely affect performance. However, rice polishing at 10/15% in the growing/finishing diets had no significant effect on BWG and FCR when fed from 1-d of hatch on (Table 4), this may be due to difference in chemical and physical characteristics of different meals. Even though, one has to admit that BWG and FCR of rice polishing containing-diet were in favour to the positive control (Tables 3 and 4). On the other hand, increasing level of rice polishing in broiler diets to 20/30% in the growing/finishing diet resulted in significant reductions of 27.8% in BWG and 30.7% in FCR, with the retard in BWG was more severe during early growth period (32%) than that during the latter finishing stage (25.9%). This indicates that tolerance of birds was improved overtime which could be due to development of digestive canal. This decrease in BWG might be due to the reduction in the apparent digestibility of CP and EE, and this parallels the decrease in plasma protein and hypertrophy of the pancreas. While, higher plasma GOT and GPT may reflect liver damage. This in agreement with the results reported by FARRELL (1994) ATTIA et al. (2003) who found that trypsin inhibitor (39.7 units/ mg protein) is an antinutritional factor in the rice bran.

A high phytic acid of a feedstuff may reduce availability of protein/amino acid, ME and several minerals i.e. Ca, P, Zn, Cu and Mn. In this regard, RUTHERFORD et al. (1997) in vivo study showed that free lysine forms a complex with phytin (~20% was bound) and half of this was liberated upon addition of phytase. RAVINDRAN et al. (1995) SEBASTIAN et al. (1998) and KIES et al. (2001) reviewed the negative impact of phytin on the availability of ME, protein/amino acid and several essential minerals and concluded that phytic acid had a negative impact on these nutrients especially for monogastrics species. Clearly, there was no negative effect of dietary rice polishing up to 20/30% on mortality rate of broiler chicks in these experiments. ATTIA et al. (2003) found similar results.

Phytase alone or combined with a multienzymes mixture (proteases, amyloglucosidase, xylanase, β-glucanase, cellulases and hemicellulases) partially increased BWG by 14.3 and 25.8%, and improved FCR by 8.2 and 15.7% compared to the negative control, respectively (Table 4). It should be mentioned however, that this improvement could be attributed not only to phytase, but also to other enzymes from phytase producing organisms. Similarly, MARTIN and FARRELL (1998) and ATTIA et al. (2003) observed that including rice bran at 15 or 30% in the growing/finishing diet for broiler chickens during 28-49 d of age resulted in significant impairments in BWG and FCR which could be partially compensated by phytase, Optizyme, phospholipase or dietary formulation based on TAAD. However, ABOOSADI et al. (1996), ADREZAL et al. (1996) and FARRELL and MARTIN (1998) showed that phytase or cell wall-degrading enzymes addition to rice bran containing-diets had no beneficial impact on growth performance of broilers.

The enhancements in BWG and FCR of rice polishing containing-diets due to enzyme additions compared to their respective negative control were associated with improving apparent digestibility of CP and CF (Tables 3 and 4). This indicates an increase in the availability of nutrients due to phytase as reviewed (SEBASTIAN et al. 1998; KIES et al. 2001) and reported by ATTIA (2003) and ATTIA et al. (2003), and multienzymes mixture (SIMON 1998; ATTIA et al. 2003). It is interesting to report that addition of both phytase and multienzymes mixture to the diet resulted in a more significant increase in plasma protein when rice polishing was fed with or without enzyme addition, the enhancement amount to 10 and 8.1% in BWG and FCR, respectively (Table 3). Due to different modes of action of the two enzymes investigated in trial 2, this indicates that the feeding value of rice polishing may be enhanced greatly by this method. This may provide evidence that besides phytin there are other anti-nutritional factor i.e. NSP in rice polishing. Also, MARTIN and FARRELL (1998) and ATTIA et al. (2003) found that multienzymes mixture improved broiler performance fed rice bran containing-diet. Also, phytase supplementation alone or combined with multienzymes mixture resulted in improved apparent digestibility of CP and CF, and this resulted in increasing CP in broiler meat, and plasma protein (Table 4). It should be mentioned however that, phospholipase showed little impact in growth performance in trial 1, but increased fat accumulation in meat, may be due to its direct impact in fat assimilation (Table 3).

Clearly, the increase in CF content in the rice polishing diets could explain the significant increase in percentage gizzard, and the decrease in plasma cholesterol (Tables 1, 3 and 4). The latter observation is in agreement with the reports by TALWINDER et al. (1991), QURESHE et al. (2001) and RAO (2002). They concluded a tocotrienol-rich fraction and novel tocotrienols of rice bran significantly lowered serum low-density lipoprotein cholesterol levels in human and swine which expressing hereditary hypercholesterolemia.

Conclusion and application

Rice polishing at 10/15% in the growing/finishing diet for broilers had no adverse effect on growth performance. Phytase or the combination of phytase and multienzymes addition to 20/30% rice polishing diets partially compensated performance, suggesting that utilisation of rice polishing could improved by such techniques.

Summary

The effect of 500 FTU phytase/kg, and 500 U phospholipase A2/kg, or their combination or formulating the diet based on true digestible amino acid (TAAD) on improving utilisation of diet containing 15% in grower and 20% in finisher diet of rice polishing (15/20% rice polishing) was investigated in trial (1). The effect of phytase alone when

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added to broiler diets containing either 10/15% or 20/30% rice polishing, or a combination of 500 FTU of phytase and 1 g/kg of multienzymes mixture (Optizyme®) to 20/30% rice polishing diet was studied in trial 2. Including rice polishing at 15/20% in trial 1 or 10/15% in trial 2 in the diet for broilers did not affect BWG and FCR, therefore enzymes or dietary formulation based on TAAD showed no positive impact. In trial 2, rice polishing at 20/30% in broiler diets significantly reduced BWG and FCR, whilst phytase or phytase + multienzymes mixture partially improved growth performance, though the combination yielded superior effect. Phytase significantly improved apparent digestibility of CP, and consequently increased plasma protein and CP of meat.

Key words
Broiler, nutrition, rice polishing, phytase, enzymes, performance

Zusammenfassung
Möglichkeiten der Verbesserung der Verwertung von Reiskleie in Broilerrationen durch den Einsatz von Enzýmen oder durch die Formulierung der Rationen auf der Basis von verdaulichen Aminosäuren

Es wurden zwei Versuche zum Einsatz von Reiskleie in Broilerrationen durchgeführt. Im ersten Versuch wurden 500 FTU Phytase/kg und 500 U Phospholipase A2/kg einzeln sowie in Kombination der Versuchsreis mit Reiskleiegehalten von 15% (Grower) und 20% (Finisher) zugesetzt. In einer weiteren Behandlung wurden die Rationen mit denselben Reiskleiegehalten auf der Basis der tatsächlichen Aminosäurenverdaulichkeit (TAAD) kalkuliert. Im zweiten Versuch wurden Rationen mit 10% Reiskleie im Grower und 15% im Finisher bzw. mit 20% im Grower und 30% im Finisher verwendet. Diesen wurde Phytase (500 FTU/kg) zugesetzt. Zusätzlich wurde in einer Behandlung der Ration mit 20/30% (G/F) Reiskleie neben der Phytase (500 FTU/kg) ein Multienzymkomplex (1 g/kg Optizyme®) zugegeben.


Stichworte
Broiler, Fütterung, Reiskleie, Phytase, Enzyme, Leistung

References
BASF AG. 1999: Natuphos® Phytase matrix values for optimum manure phosphorus reduction and feed profitability in poultry. pp 89-100 In, Use Of Natuphos® Phytase In Layer Nutrition And Management, Proceedings of the 1999 BASF Technical Symposium, Atlanta, Georgia
BRUFAUL, J., M. FRANCHESCHI and A.M. PEREZ-VENDRELL 2002: Exogenous enzymes in poultry feeding. Recent developments. 11th European Poultry Conference, Bremen (Germany)
SEBASTIAN, S., S.P. TOUCHBURN and E.R. CIARVERI 1998: Impli-
cations of phytic acid and supplemental microbial phytase in poultry nutrition, A Review. World’ Poultry Sci. J. 54, 27-47


VOLOVINSKAIA, V.P. and B.Y. KELMAN 1962: Modification of the water holding capacity method of meat. F. D. Industry, 11, 80 Moscow

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