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# Non-Starch Polysaccharides (NSP) Enzyme Improves the Nutrient Digestibility of Weaned Piglet Fed a Cottonseed Meal-Based Diets

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**Abstract:** NSP is the major factor introducing a low digestibility of cottonseed meal in piglets. The present study was conducted to determine the effect of NSP enzyme on the nutrient digestibility of weaned piglets fed a cottonseed meal-based diets. About 15 weaned piglets (14±1.4 kg) were selected and ileal fistula surgery was done to determine the DE, CP, DM and NSP's apparent digestibility. The results indicated that NSP enzyme improved piglet's apparent digestibility ($p<0.05$) in varying degrees; pectinase resulted in obvious degradation of the cell wall and increased piglets' DE (26.69%) and CP of ileal digesta (20.33%) and compound enzyme was better in improving cottonseed meal based diets than single enzyme.

**Key words:** Cottonseed meal, NSP enzyme, piglets, apparent digestibility, surgery, degradation

## INTRODUCTION

Fibre is resistant to digestion by endogenous enzymes in mammals and it will decrease the digestibility of feed nutrients and increase endogenous protein and fat losses (Noblet and Perez, 1993; Delange *et al*., 1989). Dietary fibre, particularly soluble Non-Starch Polysaccharides (NSP) has high water-binding capacity (Antoniou and Marquardt, 1981; Jensen and Jorgensen, 1994; Yin *et al*., 1994; Bach Knudsen, 2001; Yin and Tan, 2010). Thus, the nutrition is not easy to be absorbed, because the complexes of NSP and water wrap the nutrition and prevent the enzyme digestion on feed. NSP is the major composition of cell wall and is hard to degraded by enzyme which results in the limit in digestion of enzyme on feed (Hesselman and Aman, 1986; Aman *et al*., 1989; Bedford and Classen, 1992; Yin *et al*., 2001a-d). Some studies found that the content of SNSP in diet influenced the AME of diet (Leclere *et al*., 1993) and there was a negative correlation between the content of SNSP in diet and the AME of diet.

Cottonseed meal is a good protein feed and has been widely used as feed ingredient (Yin *et al*., 1993). However, the high content of NSP limits its application in feed industry. Thus, researchers conducted a study to determine the impact of soluble NSP enzymes on cottonseed meal's digestibility in pig.

## MATERIALS AND METHODS

**Piglets and treatments:** Twenty seven Duroc x Landrace x Yorkshire weaned piglets (Hunan GuangAn Bio-Technology Company) feed the basal diet (Table 1) were selected and had fully slatted floors, nipple drinkers and electronic feeding stations according to the methods of Yao *et al*. (2008) and Deng *et al*. (2009). These piglets were kept in single crates and were assigned to 9 treatments (3 sows per treatment). After 7 days, these piglets were executed ileum-fistula surgery and conducted 40 days experiment. NSP enzymes were provided by Wuhan new HUAYANG feed Co., Ltd. (WuHan city, China).

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Table 1: Composition of basal diet

| Diet | Starch | Cottonseed meal | Soy oil | Sugar | $CaHCO_3$ | $CaCO_3$ | Total |
|---|---|---|---|---|---|---|---|
| Ratio (%) | 37.2 | 45 | 2 | 10 | 1 | 1 | 100 |
| Diet | Acidifier | NaCl | $TiO_2$ | Vitamin | Minerals | Choline chloride | - |
| Ratio (%) | 2 | 0.3 | 0.1 | 0.3 | 1 | 0.1 | - |

**Sampling procedures:** The collected digesta were freeze-dried for one weak in freeze-drying machine. The energy, Crude Protein (CP), NSP, Titanium dioxide and amino acids of digesta and feed were determined. CP was determined by the Kjeldahl Nitrogen Determination Method. Energy was determined by adiabatic calorimeter. Titanium dioxide was determined by spectrophotography according to Yin *et al.* (2000). Amino acids were determined by 6N Hydrochloric Acid Hydrolysis Method according to Huang *et al.* (2005) as:

$$\text{Apparent nutrient digestibility (\%)} = \frac{\text{1-nurtient content in digesta} \times TiO_2 \text{ content in feed}}{\text{Nutrient content in feed} \times TiO_2 \text{ content in digesta}} \times 100\%$$

**Statistical analyses:** Values are presented as the mean±SD. All data were analyzed using one-way ANOVA (SAS Institute, NC, USA). Duncan's multiple range test was used to compare differences among the treatment groups. Probability values $p<0.05$ were taken to indicate statistical significance (He *et al.*, 2012).

## RESULTS AND DISCUSSION

**The influence on dry matter apparent digestibility of different NSP enzymes:** The results indicated that supplementation with NSP enzymes in cottonseed meal diet can improve dry matter apparent digestibility ($p<0.05$) (Fig. 1). The Treatment 5 (supplementation with pectinase) got the best effect among all treatments, improved the dry matter apparent digestibility by 28%. Generally, supplementation with combination of different enzymes in diet is better than supplementation with single enzyme.

**The influence on energy apparent digestibility of different NSP enzymes:** The results indicated that supplementation with NSP enzymes in cottonseed meal diet can improve energy apparent digestibility ($p<0.05$) (Fig. 2). The Treatment 5 (supplementation with pectinase) got the best effect among all treatments, improved the dry matter apparent digestibility by 26.69%. However, supplementation with combination of different enzymes in diet is no better than supplementation with single enzyme ($p>0.05$).

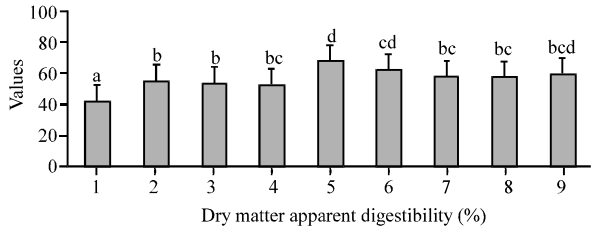


Fig. 1: Effects of adding multi-enzyme on the AD of DM. [a-d]Means within each column with no common superscript differ at $p<0.05$

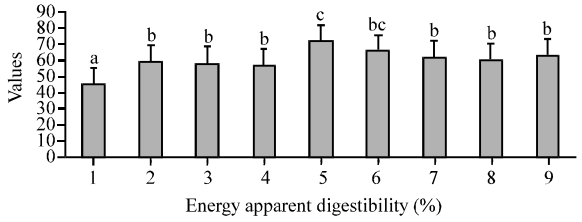


Fig. 2: Effects of adding multi-enzyme on the ADE. [a-c]Means within each column with no common superscript differ at $p<0.05$

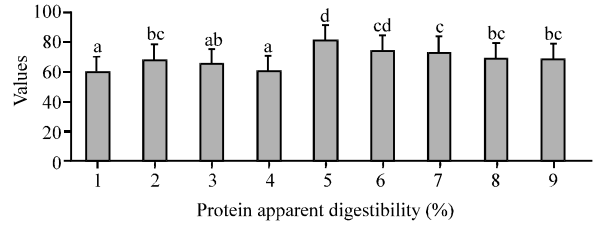


Fig. 3: Effects of adding multi-enzyme on the AD of CP. [a-d]Means within each column with no common superscript differ at $p<0.05$

**The influence on crude protein apparent digestibility of different NSP enzymes:** The results indicated that supplementation with NSP enzymes in cottonseed meal diet can improve crude protein apparent digestibility ($p<0.05$) (Fig. 3). The Treatment 5 (supplementation with pectinase) got the best effect among all treatments, improved the dry matter apparent digestibility by 20.33%. Generally, supplementation with combination of different enzymes in diet is slightly better than supplementation with single enzyme ($p<0.05$).

Table 2: Effects of adding multi-enzyme on the AD of SNSP

| Treatments | Arabinose | Xylan | Manna | Galactose | Glucose | Total SNSP |
|---|---|---|---|---|---|---|
| 1 | 24.50±1.39$^{a}$ | 08.47±0.97$^{a}$ | 38.68±1.11$^{a}$ | 09.68±0.25$^{a}$ | 79.06±0.28$^{a}$ | 43.90±0.74$^{a}$ |
| 2 | 54.89±1.02$^{g}$ | 43.85±0.94$^{e}$ | 42.37±0.99$^{b}$ | 33.50±1.29$^{d}$ | 80.86±0.64$^{b}$ | 61.61±0.81$^{d}$ |
| 3 | 33.80±0.65$^{b}$ | 23.48±0.98$^{b}$ | 61.05±0.96$^{e}$ | 19.05±1.02$^{b}$ | 86.04±0.65$^{d}$ | 54.52±0.60$^{b}$ |
| 4 | 41.23±1.20$^{e}$ | 30.79±1.62$^{c}$ | 47.92±1.08$^{c}$ | 41.93±1.27$^{e}$ | 90.04±0.44$^{ef}$ | 62.48±0.65$^{de}$ |
| 5 | 60.29±0.06$^{h}$ | 31.61±0.41$^{c}$ | 49.50±1.42$^{c}$ | 48.14±0.82$^{f}$ | 83.10±0.76$^{c}$ | 64.57±0.31$^{f}$ |
| 6 | 38.17±0.83$^{c}$ | 38.63±0.53$^{d}$ | 54.78±0.74$^{d}$ | 28.67±0.61$^{c}$ | 86.50±0.36$^{d}$ | 57.63±0.52$^{c}$ |
| 7 | 45.34±0.73$^{f}$ | 45.77±1.22$^{e}$ | 49.31±1.04$^{c}$ | 43.32±1.34$^{e}$ | 89.19±0.17$^{e}$ | 63.70±0.83$^{ef}$ |
| 8 | 40.81±0.69$^{de}$ | 30.39±0.58$^{c}$ | 64.94±0.22$^{f}$ | 31.79±0.43$^{cd}$ | 91.14±0.24$^{f}$ | 61.36±0.20$^{d}$ |
| 9 | 59.12±1.10$^{h}$ | 36.66±0.98$^{d}$ | 63.12±0.77$^{ef}$ | 41.33±2.46$^{e}$ | 91.00±0.37$^{f}$ | 64.73±0.66$^{f}$ |

$^{a-d}$Means within each column with no common superscript differ at $p<0.05$

Table 3: The design of experiment

| Groups | Enzyme | Enzyme activity (U kg$^{-1}$) |
|---|---|---|
| Control | Null | 0 |
| 2 | Xylan | 4000 |
| 3 | Mannanase | 4000 |
| 4 | Glucanase | 2000 |
| 5 | Pectinase | 3000 |
| 6 | Xylanase + mannanase | 4000 + 4000 |
| 7 | Xylanase + glucanase | 4000 + 2000 |
| 8 | Mannanase + glucanase | 4000 + 2000 |
| 9 | Xylanase + mannanase + glucanase | 4000 + 4000 + 2000 |

**The influence on SNSP apparent digestibility of different NSP enzymes:** The results indicated that supplementation with NSP enzymes in cottonseed meal diet can improve SNSP apparent digestibility including arabinose, xylose, mannose, galactose and glucose ($p<0.05$) (Table 2). Based on total SNSP, Treatment 2, 3, 5, 7, 8 and 9 increased the apparent digestibility by 35.79, 37.3, 26.26, 38.46, 12.08 and 20.83%, especially.

Compared with the control group (Treatment 1), supplementation with NSP enzymes in diet can improve dry matter, energy and crude protein apparent digestibility of cottonseed meal diet which is similar to the previous studies of Ye *et al*. (2011).

The crude protein apparent digestibility of cottonseed meal in the present study is lower than in the other studies, even if supplemented with NSP enzymes. The possible reason is that the cottonseed meal content in diet is too high (45%) and the cottonseed meal contains very much NSP. From Fig. 1, 2 and Table 3, Treatment 5 (supplementation with pectinase) got the best effect in CP, DM and DE apparent digestibility. Pectin is the major composition of cell wall. Pectinase maybe break down the cell wall and then the nutrient will be released from the inner.

Weaned piglets have a high glucose apparent digestibility (79.06%) however, a low xylan and galactose apparent digestibility (Table 3). Among Treatment 2-5, xylanase can significantly improve the xylan and arabinose apparent digestibility. The improved degree is much high than no-xylanase (Table 3). Mannanase can significantly improve the mannan and glucose apparent digestibility. The improved degree is much high than other single enzyme (Table 3). Glucanse has a higher glucose apparent digestibility than other single enzyme. Pectinase improved significantly galactose and arabinose apparent digestibility and has a improvement on the other carbohydrate in a different degree. The improvement effects of pectinase on apparent digestibility are similar to combination of enzymes.

Generally, combination of enzymes is superior to single enzyme in apparent digestibility. Based on the SNSP, the highest to lowest ranking of apparent digestibility is Treatment 9, 7, 5, 4, 8, 2, 6, 3 and Treatment 1.

## CONCLUSION

The results indicated that NSP enzyme improved piglet's apparent digestibility ($p<0.05$) in varying degrees; pectinase resulted in obvious degradation of the cell wall and increased piglets' DE (26.69%) and CP of ileal digesta (20.33%). Compound enzyme was better in improving cottonseed meal-based diets than single enzyme.

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