

Effects of Dietary FOS and CPP on growth performance and serum biochemical parameters for weaned piglets

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Abstract. The present experiment was conducted to study the effects of different levels of oligosaccharide(FOS) and complex CPP preparation (CPP) in diets on growth performance and serum biochemical parameters for weaned piglets. 240 crossbred DLY(Duroc× Landrace× Yorkshire) 21-day-old weaning piglets, about 7.2 kg in initial body weight were selected and randomly divided into 6 groups, with 2 repeats for each group, 20 each repeat(half male and half female.). Group 1, as the control group, was fed base diet(BD), group 2 was fed BD adding 0.10% aureomycin, group 3, 4, 5, 6, respectively, was fed BD adding 0.05% CPP, 0.05% FOS, 0.20% FOS and 0.10% FOS + 0.05% of CPP. Feeding trial was conducted for 35 days. Results: (1) The combination of 0.10%FOS and 0.05%CPP(group 6) were added, the average daily gain of weaned pigs increased by 13.71 % (P < 0.05) and the feed conversion ratio was reduced by 7.41 % (P < 0.05) compared with control. The diarrhea rate of piglets decreased by 94.63 % (P < 0.01) compared with the control (p < 0.05), and decreased by 62.86 % (P < 0.05) compared with group 2.(2)There was no significant difference in the apparent digestibility of nutrient, such as ether extract and crude protein, by adding FOS and CPP individually or jointly in diet of weaned piglets, but apparent digestibility of crude fiber increased ,to certain extent, and there was no significant difference with diet adding 0.10 % of antibiotics (group 2)(P > 0.05).(3) There was no significant difference in serum biochemical indexes, such as serum total protein, albumin, urea nitrogen, cholesterol, triglycerides, alanine aminotransferase, aspartate aminotransferase and sugar by adding FOS and CPP individually or jointly in diet of weaned piglets (P > 0.05);there was no significant effect in serum immunoglobulin IgG and IgM (P > 0.05), but the serum IgE content was increased in different degrees. Conclusion: Adding FOS and CPP in diet for weaned piglets can improve the growth performance, reduce diarrhea rate of piglets, and promote digestion and absorption of feed nutrients, without significant difference between them and diet adding antibiotics. Among them, the effect of adding 0.10%FOS+0.05%CPP was the best.

1 Introduction

Feeding antibiotics have always been one of the main measures to prevent diarrhea in weaned piglets and promote the growth of animals. but the abuse of antibiotics has caused secondary infections in the intestinal tract of animals, the generation of drug-resistant bacteria, drug residues in products ,and threats to the ecological environment and food safety. In this experiment, according to the principle of intestinal microecological balance in piglets, the effects of dietary supplementation of Fructooligosaccharide and compound probiotics on growth performance, serum biochemical indices and health status of weaned piglets were studied. It was explored the feasibility of its substitution for antibiotics, and was provided scientific basis for the rational application of new compound microecological agents instead of feeding antibiotics in animal health culture.

2 Materials and methods

2.1 Test material

FOS: FOS content 30%; CPP: It mainly contains *Clostridium butyricum*, *Bacillus subtilis*, etc. Number of viable bacteria 3×10^9 /g. Aureomycin premix,(AP) , Marketed products, aureomycin content 10%.

2.2 Laboratory Animals and Groups

240 crossbred DLY(Duroc× Landrace× Yorkshire) 21-day-old weaning piglets, about 7.2 kg in initial body weight were selected and randomly divided into 6 groups, with 2 repeats for each group, 20 each repeat(half male and half female.). group 1,as the control group,fed base diet(BD),group 2 fed BD adding 0.10% aureomycin,

group 3, 4, 5, 6, respectively, fed BD adding 0.05% CPP, 0.05% FOS, 0.20% FOS, 0.10% FOS + 0.05% of CPP. Feeding trial was conducted for 35 days. Nutritional requirements of 8-20kg piglets recommended by NY/T65-2004 for basic diets.

2.3 Feeding management

Before the experiment, the whole pigsty was completely disinfected and empty for more than 7 days. Transfer selected test pigs into sterilized pigsty, Weaning piglets around 21 days old after grouping, pre-test for 7 days, test period 35d. The pigsty was naturally illuminated, well ventilated and suitable for temperature and humidity. Feed 2-3 times a day. Feed freely and drink freely with a little surplus after each meal. Immunization vaccination and feeding management were carried out according to the routine methods in pig farms. Cleaning up the pigsty once a day, keeping house hygiene. Feeding and excretion of feces and urine in pigs were observed at any time, The feed intake of piglets was recorded. Observe and record the situation of diarrhea in pigs.

3 Investigation index

3.1 Growth Properties

The body weight, average daily gain (ADG), average daily feed intake (ADFI) and feed gain ratio (F/G) of each group were calculated.

The formulas for calculating various indicators are as follows:

Average daily gain (ADG) = (final-initial weight) / test days

Average daily feed intake (ADFI) = (feed-leftover) / test days

Feed gain ratio (F/G) = average daily feed intake/average daily gain

3.2 Diarrhea rate, Mortality, Elimination rate

Diarrhea should be judged as sparse dung and amorphous, The number of diarrhea in piglets per day was recorded.

Diarrhea rate = total number of piglets with diarrhea in the trial period / (number of piglets in the trial period * days in the trial period) * 100%.

Mortality = Number of deaths/Total *100%

Elimination Rate = Elimination Number/Total Number *100%

3.3 Apparent digestibility of dietary nutrients

Combined with feeding experiment, Acid Insoluble Ash method(AIA method)measured the apparent digestibility of dietary energy, dry matter, crude protein, crude fat, crude fiber, nitrogen-free extract and crude ash.

3.4 Serum Biochemical Indicators

Serum sample collection: One day before the end of the feeding trial, 2-3 piglets in good condition were selected repeatedly in each group, On an empty stomach in the morning, 5 ml anterior vena cava blood collection. Measuring TP, ALB, GLO, ALT, AST, ALP, BUN, T-CHO, TG, GLU, etc, and IgG, IgA, IgE, IgM.

4 Results and Analysis

4.1 Effects of FOS and Compound CPP on Performance of Weaned Piglets

Table 1 shows, The final weight of three groups, four groups, five groups and six groups increased by 1.75%, 6.12%, 4.55% and 9.04% respectively compared with the control group, The difference was significant (P < 0.05), There was no significant difference between 4, 5 and 6 groups and 2 groups (antibiotic group) (P > 0.05). There was no significant difference in daily gain between the three groups, four groups, five groups and six groups (P > 0.05). The daily gain of 6 groups was the largest, reaching 325.71 g/d. The daily feed intake of the six groups was significantly higher than that of the blank control group and the antibiotic control group (P < 0.05). The feed gain ratio of the four groups was significantly lower than that of the control group (P < 0.05). There was no significant difference between the other groups and the control group and the antibiotic group (P > 0.05).

Tab.1 Effects of FOS and CPP on growth performance of weaned piglets

Group	Initial weight	Final weight	Average daily gain	Average daily feed intake	Feed conversion ratio
1	7.13±0.04	17.15±0.07 ^d	286.43±1.01 ^c	0.47±0.01 ^b	1.62±0.03 ^a
2	7.25±0.07	18.35±0.21 ^{ab}	317.14±4.04 ^{ab}	0.47±0.01 ^b	1.48±0.02 ^b
3	7.15±0.07	17.45±0.35 ^c	294.29±2.12 ^{bc}	0.45±0.01 ^c	1.53±0.06 ^{ab}
4	7.23±0.11	18.20±0.17 ^{ab}	313.57±2.03 ^{ab}	0.47±0.01 ^b	1.49±0.11 ^b
5	7.15±0.07	17.93±0.18 ^{bc}	307.86±3.03 ^{abc}	0.46±0.01 ^{bc}	1.49±0.01 ^{ab}
6	7.30±0.14	18.70±0.28 ^a	325.71±4.04 ^a	0.49±0.01 ^a	1.50±0.02 ^{ab}

Note: The test data is expressed by means ±SD. In the same column, values with different letter superscripts mean significant difference (P<0.05), while with the same or no letter superscripts mean no significant difference (P>0.05), The same as below .

4.2 Effects of FOS and Compound CPP on Health Status of Weaned Piglets

Tab.2 Effects of FOS and CPP on state of health of weaned piglets

Group	Diarrhea rate	The rate of death and elimination
1	2.42±0.42a	0.29±0.02
2	0.35±0.01c	0.35±0.01
3	1.13±0.87 ^{bc}	0.29±0.02
4	0.31±0.03 ^c	0.35±0.01
5	1.73±0.95 ^{ab}	0.35±0.01
6	0.13±0.01 ^c	0.29±0.02

Table 2 shows, adding 0.05% compound CPP (2 groups)、0.10% FOS (3 groups) and the diarrhea rate of piglets could be significantly reduced by the combination of the two supplements (6 groups) ($P < 0.05$), and there was no significant difference between the two groups ($P > 0.05$), Six of them had the best effect. The diarrhea rate of piglets was 62.86% lower than that of antibiotics

($P > 0.05$), 94.63% lower than the control group ($P < 0.05$), but there was no significant effect on the mortality rate ($P > 0.05$).

4.3 Effects of FOS and CPP on apparent digestibility of dietary nutrients in Weaned Piglets

Tab.3 Effects of FOS and CPP on a parent digestibility of dietary nutrient in weaned piglets

Group	Crude protein/%	Ether extract/%	Crude fiber/%
1	73.07±3.46	79.39±3.19 ^b	34.88±3.30 ^b
2	74.67±2.89	83.14±2.81 ^{ab}	40.70±2.28 ^a
3	76.79±6.86	85.63±4.13 ^a	39.30±6.51 ^{ab}
4	72.20±1.74	78.98±1.84 ^b	35.42±2.71 ^{ab}
5	72.19±1.60	78.52±1.06 ^b	35.78±1.27 ^{ab}
6	71.75±1.68	81.35±1.33 ^{ab}	36.94±1.53 ^{ab}

Table 3 shows, the dietary crude protein digestibility of weaned piglets was not significantly affected by adding different levels of FOS and CPP ($P > 0.05$). The digestibility of crude fat in three groups (0.05% CCP) was significantly higher than that in the control group ($P < 0.05$), there was no significant difference in crude fat digestibility between the other groups and the control group ($P > 0.05$). The crude fibre digestibility of antibiotic group was significantly higher than that of control group ($P < 0.05$), there was no significant difference between the other experimental groups and the control group ($P > 0.05$).

5 Discuss

5.1 Effects of FOS and Compound CPP on Performance of Weaned Piglets

In this experiment, different levels of FOS and compound CPP were added to the diet of weaned piglets, which could increase daily gain, reduce feed gain ratio and improve the performance of piglets. Among them, the combination of 0.10% FOS and 0.05% compound CPP had the best effect on the growth performance of piglets. Compared with the control group, daily gain

increased by 13.71% ($P < 0.05$) and feed gain ratio decreased by 7.41% ($P < 0.05$). Secondly, adding 0.20% FOS preparation group and 0.05% compound CPP group had better effect. This may be due to probiotics with *Clostridium butyricum* and *Bacillus subtilis* as the main flora. It produces organic acids, hydrogen peroxide, various digestive enzymes. At the same time, FOS can also be used as a carbon source for intestinal probiotics, which Can not be used by harmful microorganisms such as *Escherichia coli* and *Salmonella*. The utilization rate of *Lactobacillus* and *Bifidobacterium* is very high. So synergy can be produced, which can enhance beneficial microbial flora in intestine of Weaned Piglets. It can inhibit the reproduction of harmful bacterial flora to promote intestinal health and improve growth performance of piglets. Tan Congling et al. (2010) adding FOS to the diet showed that FOS could improve the growth performance and feed conversion rate of piglets. The results of Wang Bin et al. (2010) showed that adding 0.10% CPP and 0.10% oligosaccharides alone could improve the performance of weaned piglets in varying degrees. Zhou Meng (2013) studied the effects of *Lactobacillus plantarum*, *Bacillus subtilis* and their complex bacteria groups on weaned piglets. The results showed that the feed gain ratio of weaned piglets decreased significantly. The growth performance of

weaned piglets was improved to a certain extent, and the effect was weakened with the growth of piglets. The results of this experiment are consistent with those of previous studies. Under the actual conditions of this pig farm, the effect of adding 0.10% FOS and 0.05% compound CPP is good, and the effect of 0.10% antibiotics on growth performance can be achieved.

5.2 Effects of FOS and Compound CPP on Health Status of Weaned Piglets

In this experiment, dietary supplementation of FOS and compound CPP could reduce diarrhea rate of weaned piglets. The effects of 0.20% FOS alone, 0.10% FOS and 0.05% compound CPP, 0.20% FOS and 0.05% compound CPP on diarrhea rate of weaned piglets were basically the same as that of 0.10% antibiotics. This indicates that FOS and CPP can improve the health of piglets and reduce diarrhea in piglets. The appropriate level of addition can achieve the same effect as antibiotics. This may be due to the synergistic effect of FOS and CPP, mainly *Clostridium butyricum* and *Bacillus subtilis*, on the proliferation of beneficial bacteria, thus regulating the intestinal microecological environment. It enables beneficial bacteria to dominate, compete for more colonization sites, reject pathogens, activate the intestinal immune system, and ultimately improve the intestinal immunity (Ducatellet al., 2015). The results showed that the combined addition of 0.10% FOS and 0.05% compound CPP had a better effect on diarrhea rate, which was 94.63% ($P < 0.05$) and 62.86% ($P > 0.05$) lower than that of the control group, and significantly improved the health level of weaned piglets.

5.3 Effects of FOS and CPP on apparent digestibility of dietary nutrients in Weaned Piglets

In this experiment, adding FOS and CPP alone or in combination to the diet of weaned piglets could promote the apparent digestibility of crude fat and crude fibre to a certain extent, which had no difference with the effect of 0.10% antibiotics ($P > 0.05$). This may be due to the synergistic effect of FOS and CPP, a large number of beneficial bacterial flora reproduction, direct or indirect participation in the synthesis of various digestive enzymes and vitamins, improve the digestion and metabolism of nutrients. The effect of adding 0.10% FOS was better under the actual conditions of this pig farm.

6 Conclusion

Adding FOS and CPP in diet for weaned piglets can improve the growth performance, reduce diarrhea rate of piglets, and promote digestion and absorption of feed nutrients, without significant difference between them and diet adding antibiotics. It is feasible to feed weaned piglets with FOS and compound CPP instead of feeding antibiotics under the experimental conditions.

Considering the analysis results of various indicators in this experiment and the actual situation of the

experimental pig farm, it is suggested that the effect of adding 0.10%FOS+0.05%CPP was the best.

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