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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effect of Chicken Plasma Protein Powder on Performance and Cellular Immunity of Piglets

Wei Yao[1,2], Wang Zhi-Sheng[1,2] and Zhou An-Guo[1,2]
[1]Animal Nutrition Institute, Sichuan Agricultural University, Ya'an, Sichuan 625014, China
[2]Engineering Research Center of Animal Disease, Resistance Nutrition of China, Ministry of Education, Sichuan Agricultural University, Ya'an 625014, China

Abstract: The experiment was used to investigate the effect of Chicken's plasma protein powder on performance and immunity in 32 crossbred piglets weaned at 28 day of age (4 groups of 4 each, 8.78±0.07 kg live weight). During 0-14 d, pigs were offered for different diets in both treatments, while received the same diet during the rest time of experiment. The effects of chicken's plasma protein powder on performance, cellular immunity of weaned piglets were evaluated. The results indicated that during 0-14d, compared with the control group, Average Daily Gain (ADG), Average Daily Feed Intake (ADFI) of pigs fed with Chicken's plasma protein increased by 65.50%, 37.11%, respectively ($p<0.01$); F/G decreased by 16.41% ($p<0.01$). In 14-28 d, compared with the control group, performance of piglets in Chicken's plasma protein group was improved significantly. Compared with the control group, the serum interleukine-1 (IL-1) decrease by 8.8%, interleukine-1 receptor antagonist and interleukine-4 increased by 17.9%, 16.9%, respectively. The results suggested that Chicken's plasma protein powder could enhance performance and improve the body immune function of piglets.

Key words: Chicken's plasma protein powder, piglets, performance, immune function

INTRODUCTION

The immune system had been over-activated in weaning piglets and it caused the decrease of animal's performance. (Qian *et al*., 2006) Cytokines are small peptide molecules that are important mediators in the regulation of the inflammatory responses. Interleukins were produced by T lymphocytes, can play an role in the cellular immunity. Diet modulated immune functions in multiple ways and kept healthy. We had previously showed that plasma protein supplementation prevented the activation of lymphocyte populations of Payer's patches and mesenteric lymph nodes. Supplementing standard ration with animal plasma protein improved animal growth and performance in farm animals challenged with pathogenic *Escherchia coli* (Van Dijk and Enthoven, 2002) and animals in unsanitary environments (Zhao and Harper, 2007).

Therefore, the aims of this study were to evaluate the effects of diets supplemented with spray-dried chicken plasma protein on performance and the level of interleukins in serum in piglets, which fed in normal status, so as to afford a theoretical reference for applicating of chicken plasma protein powder in piglets.

MATERIALS AND METHODS

Experimental animals and diets: All animals were cared for according to the guidelines set by the Animal Protection Committee of the Ministry for Agriculture and Nature Protection, Schwerin, Germany. The animal feeding trial was performed using weaning pigs (DLY type) with an initial body weight of 8.78 kg.

DLY pigs were assigned randomly to 1 of the 2 dietary groups, with 4 pens/group (4 pigs/pen). Each pen was equipped with a feeder and a nipple water to allow the pigs free access feed and drinking water. Temperature (25-27°C) and a cycle of 16 h light: 8 h dark were maintained in the mechanically ventilated room. One group was fed the basal diet (control), the other group was fed chicken plasma protein diet. The basal diet met or exceeded the National Research Council (NRC) nutrient requirements for piglet, all diets are free from antibiotics (Table 1).

Performance, blood sampling: Piglets in each pen were weighed as a group on d 0 (weaning), 7, 14 and 28. Feed intake was determined weekly. Average Daily Gain (ADG), Average Daily Feed Intake (ADFI) and Gain: Feed ratio (G: F) were calculated per pen.

Eight hours after the last feeding, blood samples were collected through the anterior vena cave puncture into 10-mL heparin-free Vacutainer tubes. Blood samples were centrifugated at 3500 × g for 15 min to obtain sera, which were stored at -20°C for determination of IL-1, IL-4, IL -1 receptor antagonist (IL-1ra) and IgG, IgA, IgM. IL-4, IL-1, IL-1ra are determinated by radioimmunoassay kit determination and IgG, IgA, IgM are determinated by Immunoturbidimetry determination.

Statistical analysis: Weight gain, feed intake, feed efficiency, serum IL-4, IL-1, IL-1ra and IgG, IgA, IgM levels were subjected to analysis of variance using the

Table 1: Composition and nutrient levels of basal diets

	0-14d				
Stuff	Control	Chicken plasma protein	14-28d	Nutritional level	Content
Corn	61.610%	63.120%	61.340%	DE (MJ/kg)	14.20
Soybean meal	15.430%	10.400%	15.500%	CP (%)	18.00
Expanding soybean	9.800%	6.600%	9.850%	Ca (%)	0.80
Wheat bran	3.000%	3.000%	3.300%	AP (%)	0.65
Fish meal	3.000%	2.020%	3.030%	Dlys (%)	1.35
Glucose	0.000%	0.000%	3.000%	Dmet (%)	0.35
Sucrose	3.000%	3.000%	0.000%		
Chicken's plasma- protein powder	0.000%	7.500%	0.000%		
Rapeseed oil	0.810%	0.760%	1.000%		
Calcium carbonate	0.800%	0.715%	0.765%		
Dicalcium phosphate	1.300%	1.614%	1.330%		
Vitamin premix[1]	0.050%	0.050%	0.050%		
Mineral premix[2]	0.300%	0.300%	0.300%		
Chromic oxide	0.100%	0.100%	0.100%		
Salt	0.250%	0.000%	0.200%		
HCl-Lys[3]	0.500%	0.490%	0.500%		
DL-Met[3]	0.050%	0.031%	0.055%		
Total	100	100	100		

Notes: 1, each containing kg premix: Vitamin A 2200 IU; Vitamin D3 1500 IU; Vitamin K3 0.5 mg; Vitamin B1 0.5 mg; vitamin B2 20 mg; vitamin B6 2 mg; vitamin B1217.5 mg; niacin 30 mg; Calcium Pantothenate 10 mg; folic acid 1 mg 2, premix per kg can be expected to provide full price: Cu-6mg, Fe-100mg, Mn-4mg, Se-0.3 mg, I-0.3 mg

Table 2: Effect of chicken plasma protein on growth performance of weanling pigs[1]

Item	Control	Chicken plasma protein	SEM	P-values
Phase I (d 0 to 14)				
ADG,g	146.04^{A}	241.07^{B}	13.155	0.003
ADFI,g	292.12^{A}	400.53^{B}	13.68	0.004
F:G	2.01^{A}	1.68^{B}	0.055	0.003
Phase II (d 14 to 28)				
ADG,g	386.90^{A}	492.39^{B}	14.53	0.004
ADFI,g	785.64^{A}	919.48^{B}	17.695	0.003
F:G	2.03^{A}	1.87^{B}	0.04	0.009
Overall (d 0 to 28)				
ADG,g	266.47^{A}	366.73^{B}	12.82	0.009
ADFI,g	538.88^{A}	660.01^{B}	15.535	0.008
F:G	2.03^{A}	1.80^{B}	0.035	0.008

[1]Each mean represents 4 pens with 16 pigs per treatment. ^{A,B}Within a row, mean with different superscripts differ (P<0.01).

general linear model procedure of SAS10 according to a completely randomized one-factorial design. Statistical differences between groups were denoted by different letter superscripts. Individual piglet was used as the experimental unit for all data except that pen used as the unit for weight gain, feed intake, feed efficiency. Each experiment was repeated at least three times and data represent the mean ± SEM of all repeats.

RESULTS

Chicken plasma protein on performance of piglets: The ADG, ADFI in the chicken plasma protein improved and F/G decreased significantly in the whole time ($p<0.01$). In 0-14d, ADG, ADFI in chicken plasma protein powder group significantly raised by 65.50%, 37.11%, respectively ($p<0.01$), F/G declined by 16.41% ($p<0.01$). During 14-28 d, ADG, ADFI in chicken plasma protein powder group significantly raised by 27.27%, 17.04%, respectively ($p<0.01$), F/G declined by 7.88% ($p<0.01$) (Table 2).

Chicken plasma protein in 0-14,14-28 d after weaning of piglets serum cytokine content: Compared with control group, in 0-14 d, chicken plasma protein lowered serum IL-1 8.6% and IL-4, IL-1ra have a higher trend by 21.61%, 23.73%, respectively; 14-28 d serum IL-1 decreased by 10.92% and IL-4, IL-1ra increased by 16.96%, 6.78%, respectively in chicken plasma protein powder group.

chicken plasma protein in 0-14,14-28 d after weaning of piglets immunoglobulin content: Compared with control group, In 14-28 d, the content of IgG in chicken plasma protein powder group raised by 20.44% and the content of IgG, IgM is lower than the control group.

DISCUSSION

In the study, In day 0-28, supplementing chicken plasma protein powder could improve performance, expressing as average daily gain, the average intake was significantly improved ($p<0.01$), feed/gain declined

Table 3: Effects of chicken plasma protein on IL-1 and IL-4 of weanling pigs

Item	Control	Chicken plasma protein	SEM	P-values
d 0				
IL-1(ng/ml)	0.421	0.431	0.09	0.697
IL-4(ng/ml)	0.715	0.729	0.17	0.687
IL-1ra(ng/ml)	0.046	0.047	0.007	0.798
d 14				
IL-1(ng/ml)	0.279	0.255	0.15	0.212
IL-4(ng/ml)	0.772	0.878	0.23	0.675
IL-1ra(ng/ml)	0.059	0.073	0.006	0.314
d 28				
IL-1(ng/ml)	0.229	0.204	0.20	0.506
IL-4(ng/ml)	1.321	1.545	0.235	0.650
IL-1ra(ng/ml)	0.059	0.063	0.006	0.397

Table 4: Effects of chicken plasma protein (SDCP)onplasma immunoglobulin concentration of weanling pigs

Item	Control	Chicken plasma protein	SEM	P-values
d 14				
IgG (g/l)	4.031	3.462	0.3650	0.296
IgA (g/l)	0.919	0.871	0.1105	0.767
IgM (g/l)	0.471	0.539	0.1415	0.537
d 28				
IgG (g/l)	3.382	4.616	0.491	0.338
IgA (g/l)	1.268	1.076	0.128	0.365
IgM (g/l)	0.63	0.627	0.1105	0.974

evidently ($p<0.01$); Many studies report the changes in the expression of inflammatory cytokines in serum of humans and animal during weaning. (Oswald and Dozois, 2001). Local expression of IL-1, IL-6 and TNF-alpha mRNA has been largely documented after bacterial or viral infection in pigs. (Fossum, 1998) To our knowledge, there are no other reports on the cytokine expression we observed in the serum when supplementing with chicken plasma protein powder. Post-weaning piglets had undergone many stresses, for instance, feed sources, environment, psychological stress and so on, which formed an over-activated situation *in vivo*, inflammatory factory (such as: IL-1ß) raised rapidly. (Gu, 2003). The increasing of IL-1ß in post-weaning pigs is according to others. (Chen and Peng, 2001) Compared with the control group, chicken plasma protein decreases the serum IL-1ß by 8.60% in day 0-14; IL-1ra is a protein that is antagonist for IL-1, founding in animal, the activity of IL-1 can be closed through combination of IL-1 (IL-1) receptors. (Arend *et al*., 1998) The results suggest that chicken plasma protein powder can reduce the levels of IL-1ß and increase IL-1ra production. That is according to previous studies on intravenous immunoglobulin. (Sharief and Ingram, 1999) The possible reasons are that chicken plasma protein contains 15% immunoglobulin, which can exert its effect *in vivo*. (Pierce, 2005). T cells, a major producer of cytokines, can be separated into two distinct subsets, Th1 and Th2 cells, on the basis of the pattern of cytokines secreted. (Mosmann and Coffman, 1989) IL-1ß is a typical cytokines of Th1, It can lead to disequilibrium when is over-produced in the body and IL-4 is a typical Th2 cytokine with anti-inflammatory. In day 0-14, IL-4 in the chicken plasma protein group was raised by 21.7% compared to the Control.

The effect of humoral immunity are performed by B cells (plasma cells), which is secreting antibodies and antigens for removing the antigen-specific binding; The effect of cellular immunity is performed through T cells (anti-T cells), which is secreting perforin for making target cells apoptosis. They can keep body healthy either or both. (Lebman and Coffman, 1994) The type and quantity of immunoglobulin *in vivo* reflect animal's ability to resist diseases. IgG is the mainly immunoglobulin antibodies in the serum, approximately 85% of serum immunoglobulin is used for anti-infective immunity. The level of IgG in body is not only high, but lasted for a long time and it could play an antibacterial, antiviral, anti-toxins roles *in vivo*. In this study, in day 0-14, compared with the control group, chicken plasma protein powder deceased the serum IgA, IgM. The results are inconsistent with others (Gao *et al*., 2004).

It can be suggested that the chicken plasma protein can reduce the over-activation of the immune status by controlling the cellular immunity, so as to promote performance of pigs. In 0-14 d, supplementing chicken plasma protein powder could improve performance, expressing as average daily gain, the average intake was significantly improved ($p<0.01$), feed/gain declined evidently ($p<0.01$); It could be caused by decreasing of over-activated of immune responses and improving of cellular immunity. During 14-28 d, the chicken plasma protein was still to improving ADG, ADFI, which was according to the previous results on the broilers. (Li *et al*., 2002). The results suggested that supplementary of chicken plasma protein powder could shift nutrients that maintaining immunological activity to growth in our study. It maybe also the reason for reducing the secretion of antibody in plasma. But the evidence of it needs to be verified by exploring the regulatory mechanism of metabolism of nutrients *in vivo*.

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