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Laminaria japonica Polyascchride Improves Protein Metabolism of Weaned Piglets

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ABSTRACT

Post-weaning diarrhea is one of the most common diseases in piglets, which will seriously affect the growth performance of weaned piglets and may even cause their death. LJP has been proven to improve the growth performance of weaned piglets. Protein metabolism is very important for growth, but there is little research on protein metabolism in weaned piglets by LJP. The aim of this study was to evaluate the effect of supplementing different levels of LJP (0, 100, 200 and 400 mg/kg) in the diet on protein metabolism in weaned piglets. A total of 120 piglets with similar initial body wight (6.13±0.21 kg) and age (21±1 day) were randomly assigned into 4 groups, each group had 5 replicates of 6 piglets. Four different levels of LJP (0, 100, 200 and 400 mg/kg) were added to the feed of four groups of piglets and kept for 21 days. The results showed that the content of total serum proteins was significantly increased in piglets supplemented with 200 and 400 mg/kg LJP and the content of albumin was significantly increased in piglets supplemented with 400 mg/kg LJP ($p<0.05$), compared with the control group. In conclusion, the addition of 200 and 400 mg/kg of LJP to the ration increased protein content in the serum and contributed to the growth and health of weaned piglets.

Key words: Laminaria japonica polysaccharides, Protain metabolism, Serum biochemistry indicators, Weaned piglets.

Post-weaning diarrhea (PWD) is a major common disease in piglets. Some studies have shown that weaning will reduce the growth performance of piglets and impair their immune function (Cao *et al*., 2022). The digestive system of weaned piglets is not yet fully developed and intestinal dysfunction often occurs at this time, which can affect the body's nutrient absorption (Pluske, 2013 and Modina *et al*., 2019). In addition, weaned piglets face a substantial change in food and living environment, often appear stress reaction, resulting in reduced feed intake, which is very detrimental to the growth and development of weaned piglets (Uddin *et al*., 2021). Feeding a low protein diet was effective in reducing the incidence of PWD (Heo *et al*., 2009). Weaned piglets are susceptible to a variety of pathogens when exposed to different environments (Pluske, 2013) and weaning may lead to reduced protein digestibility in piglets (Hedemann *et al*., 2003), excessive undigested protein in the intestine will create opportunities for the colonization of pathogenic bacteria, which will increase the incidence of PWD. Thus increasing the protein metabolism of weaned piglets may be able to reduce the incidence of PWD and promote growth of weaned piglets.

Laminaria japonica polysaccharide (LJP) is a kind of natural biomolecule existing inside the kelp cells that reduces the levels of inflammatory factors and has anti-inflammatory effects (Gao *et al*., 2022). LJP is also a natural antioxidant, capable of realizing antioxidant damage by scavenging free radicals and has some potential to slow down aging (Li *et al*., 2022). In addition to anti-inflammatory and anti-injury effects, LJP also inhibits apoptosis and has strong antiviral activity (Yue *et al*., 2017), it also inhibits macrophage foaming and stimulates macrophages to promote body immunity (Li *et al*., 2020 and Fang *et al*., 2015). LJP has been extensively studied as a feed additive. Heim *et al.* (2015) showed that LAM supplementation to sows not only improved piglet growth performance, but also gut health as well as immune status of piglets. Brugger *et al.* (2020) also showed that Laminaria japonica enhanced the performance of weaned piglets. It has been observed that the addition of LJP to the feed was effective in improving intestinal morphology, regulating intestinal flora, reducing intestinal dysfunction and may improve production performance in weaned piglets (Rattigan *et al*., 2020). LJP also improved the growth performance of weaned piglets under high temperature conditions (Wang *et al*., 2021). These studies have shown that LJP not ony promotes health but also improves growth performance of weaned piglets. Protein metabolism plays an important role in the growth of the organism. However, there is limited information concerning the effects of LJP on the protein metabolism of weaned piglets.

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In the present study, we hypothesized that the addition of LJP to the diet would regulate protein metabolism and improve growth performance in weaned piglets. The serum physiological and biochemical index is an important indicator to visually evaluate the level of substance metabolism and changes in the internal environment in animals, the objective of present study was to evaluate the effects of LJP on normal physiological functions, protein metabolism and serum biochemical indices in weaned piglets.

This experiment was conducted at the Shanxia Pig Farm in Shicheng County, Ganzhou City, Jiangxi Province, China in 2023.

Animals and experimental design

A total of 120 healthy crossbred piglets (Berkshire × Licha Black) of similar weight (6.13±0.21 kg) and age (21±1 day) were randomized into four treatment groups with five replicates and each replicate had six piglets that were housed in pens. All piglets were kept in the same feeding conditions for 21 days and each group was offered a basic ration with different levels of LJP (0, 100, 200 and 400 mg/kg) added to the basic ration. The basic diets for piglets were formulated based on the National Research Council (2012) and detailed in Table 1.

Sample collection

At the end of the experiment, one piglet was randomly selected from each pen (24 piglets in total). Blood was taken from the jugular vein of each piglet and centrifuged for 10 min (3000r/min) after standing and the upper layer after centrifugation was the serum. Finally, the serum obtained was stored at -20°C.

Determination of serum biochemical indicators

The commercial test kits for the determination of serum total protein (TP), albumin (ALB), globulin (GLB), albumin-globulin ratio (A/G), uric acid (UA), creatinine (CREA), alanine aminotransferase (ALT) and aspartate aminotran sferase (AST) levels were purchased from the Nanjing jiancheng Bioengineering Institute. The level of TP was determined using the BCA method and optical density (OD) value was recorded at 562 nm. The content of GLB was determined using bromphenol green method and the OD value at 630 nm was recorded. The content of UA was measured using enzyme colorimetric method and the OD value was recorded at 510 nm. CREA concentration was determined by the sarcosine oxidase method recording OD value at 546 nm. The level of ALT was measured by Lai shi method recording OD value at 510 nm. The level of AST was measured by micro plate method reading OD value at 510 nm.

Statistical analysis

SPSS27 software was used to analyze the data. Using each piglets as an experimental unit and multiple tests were performed using the Tukey's honest significant difference test and differences were considered statistically significant at $p<0.05$.

The effect of dietary LJP on serum biochemical parameters of weaned piglets is shown in Table 2. Protein is the material basis of all life, which constitutes a variety of physiologically active substances in the body, such as a variety of digestive juices, enzymes, hormones and so on. Low protein metabolism will lead to growth restriction of pigs. The results of this experiment showed that the addition of 200 and 400 mg/kg LJP significantly increased TP activity ($p<0.05$) in piglets compared to the control group and the addition of 400 mg/kg LJP significantly increased ALB activity in piglets compared to the control group ($p<0.05$). Both TP and ALB play important roles in protein metabolism *in vivo* and can reflect the nutritional metabolic status of protein in the body (Zhou *et al*., 2015 and Liu *et al*., 2015). An increase in the content of both can indicate that protein metabolism is vigorous, protein absorption and utilization enhances and growth performance of the animal improves (Zou *et al*., 2019). Li *et al*. (2022) reported that LJP can promote alanine, aspartate and glutamate metabolism, which is similar to the results of the present experiment. Protein metabolism is actually the metabolism of amino acids. Protein synthesis and catabolism require the action of a variety of transaminases. ALT and AST are two intracellular enzymes that catalyze the conversion of amino acids to ketoacids and their activities reflect the strength of amino acid

Table 1: Ingredient and calculated nutrient composition of the bassal diet (as fed bassis,%).

Items	Composition
Ingredients	
Expanded corn	57.50
Expanded soybean	12.00
Soybean meal	8.00
Whey powder	8.00
Lactose	8.00
Fish meal	3.00
Limestone	0.70
Calcium hydrogen phosphate	1.50
Salt	0.30
Premix[1]	1.00
Analysed nutrient content, %	
Crude protein	20.50
Calcium	0.94
Phosphorus	0.75
Calculated nutrient content, %	
ME, MJ/kg	14.30
Lysine	1.45
Methionine	0.45

[1]1 The premix provides the following per kilogram of diet: VA l5 000 U, VD3 2000 U, VE 30.00 IU, VK 3.75 mg, VB1 2.50 mg, VB2 7.00 mg, VB6 2.4 mg, VB12 0.03 mg, nicotinic acid 40.00 mg, calcium pantothenate 25.00 mg, Folic acid 25.00 mg, biotin 0.25 mg, cholinechloride 600 mg, Cu 20 mg, Fe l20 mg, Zn l60 mg, Mn 100 mg, I 0.54 mg, Se 0.27 mg.

Table 2: Effect of dietary LJP on serum biochemical parameters of weaned piglets.

Items	LJP, mg/kg				SEM	*P*-value
	0	100	200	400		Anova
TP, g/L	56.46^{b}	62.03^{ab}	66.94^{a}	70.15^{a}	2.26	0.005
ALB, g/L	30.10^{b}	32.18^{ab}	38.42^{ab}	40.63^{a}	2.31	0.025
GLB, g/L	26.36	29.86	28.51	29.52	2.25	0.745
A/G	1.15	1.16	1.42	1.40	0.15	0.522
UA, μmol/L	184	139	175	129	21	0.287
CREA, μmol/L	218	195	160	173	31	0.621
ALT, U/L	31.72	26.70	30.46	32.97	3.92	0.739
AST, U/L	17.67	15.81	16.87	10.60	2.91	0.422

metabolism (Vijayavel *et al*., 2006). However, in this experiment, ALT and AST levels were not significantly different from the control group, which might be due to the fact that the enzyme secretion function of weaned piglets is not still fully developed and the metabolism of amino acids is subject to change, there is a certain effect on protein synthesis and tissue deposition (Montagne *et al*., 2007). Weaned piglets have a fragile intestinal tract, kelp extract has the potential to modulate intestinal health (Yang *et al*., 2019) and Rattigan *et al.* (2020) showed that the addition of LJP to diets modulates the intestinal flora of weaned piglets (Rattigan *et al*., 2020) and that normal intestinal flora stimulates material metabolism and immune responses in the body. Consequently, the improved effect of LJP on protein metabolic function in weaned piglets might be related to the modulation of intestinal flora and the improvement of intestinal function. In addition, there were no significant differences in other indicators of liver and kidney functions compared with the control group, which indicated that LJP had no effect on the liver and kidney function of weaned piglets.

CONCLUSION

The current study found that the addition of 200 and 400 mg/kg LJP to the diet significantly increased TP levels in weaned piglets and that the addition of 400 mg/kg LJP significantly increased their ALB levels. In addition, LJP had no significant effect on hepatic and renal functions. Therefore, LJP is expected may be improve the ability of protein metabolism in weaned piglets and the use of LJP as a feed additive plays a beneficial role in the development of weaned piglets.

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Conflict of interest

The authors declare that there are no conflicts of interest in relation to the manuscript.

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