Scientific Research Publishing

Advances in Biological Chemistry, 2022, 12, 246-253
https://www.scirp.org/journal/abc
ISSN Online: 2162-2191
ISSN Print: 2162-2183

The Positive Effects of Proprietary Undenatured B-Glucans on Growing Pigs

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How to cite this paper: Kristiansen, B. and Amen, R.J. (2022) The Positive Effects of Proprietary Undenatured B-Glucans on Growing Pigs. *Advances in Biological Chemistry*, **12**, 246-253.
https://doi.org/10.4236/abc.2022.126020

Received: October 5, 2022
Accepted: December 25, 2022
Published: December 28, 2022

Abstract

Beta-glucan that is typically isolated from the fungi or yeast, by solvent extraction, is a commonly used supplement. However, the solvent extraction of beta-glucan from these sources destroys the tertiary structure of the compound, and reduces the immuno-stimulating efficacy of the denatured beta-glucan when compared to undenatured beta-glucan (UDBG[1]). The objective of this study was to investigate growth performance of piglets, from weaning, that received diets containing undenatured beta-glucan (UDBG) for the following four weeks (up to an average live weight of 26.4 kg). The study was conducted with 128 Noroc pigs from 24 litters at the experimental pig house of the Norwegian University of Life Sciences. There were four dietary treatments; one group was fed a control diet containing no UDBG, three other groups were fed a diet containing 0.02 mg UDBG/kg, 0.2 mg UDBG/kg; or 2.0 mg UDBG/kg. In week 1 - 2, the pigs fed 2.0 mg UDBG per kg of feed gained 12% faster than the control diet. The numerical increase in weight gain during the first period after weaning is indicative of an improved immune status of the piglets fed the higher inclusion levels of the UDBG diets. Additionally, the piglets fed the highest level of UDBG (2.0 mg/kg) were found to have a better viability compared to the other groups, as determined by the Veterinary staff. No clinical problems related to the dietary treatments were observed. The animals revealed good growth and an average daily gain (ADG) for all pigs were 559 g for the overall experimental period. The growth performance was calculated for the two first weeks of the study, the remaining last two weeks of the study, and for the overall four-week experimental period. Significant effects of UDBG on weight gain and feed intake were found during the early weeks, but diminished later in the trial. The addition of UBDG to diets had a significant positive effect on several blood hematological parameters including the index of anisocytis, neutrophilic granulocytes, and lymphocytes. A significant positive linear effect of increasing dietary levels of UBDG was also found for hemoglobin and hematocrit.

[1]Undenatured Beta-Glucan used in these studies came from GlycaNova A.S.

Keywords

Undenatured Beta-Glucan, Pig Growth, Hematology, Feed Consumption, Feed:Gain

1. Introduction

Beta-glucans from various sources, including mushrooms and yeast have been shown to have some positive effects on the immune system in animals and humans. These beta-glucans have typically been extracted from the botanical source with solvents or other treatments that destroys the tertiary structure of the beta-glucans. When the fruiting body of fungi, is treated by a proprietary fermentation process [1] [2], it was shown that the beta-glucan could be isolated in its undenatured tertiary structure, thus preserving its biological efficacy.

The safety of beta-glucans, including UDBG, has been exhaustively studied over the recent past and has shown the tested beta-glucans to be safe [3] and efficacious in rodents, and in humans [4] with less than optimal immune systems.

A series of tests have been conducted to test the applicability of UDBG as a feed supplement in production of marine animals which are known to have problems with weight loss and/or high mortality during early development. Shrimp larvae and trout were given different levels of UDBG added to the feed material. In all cases the stressed shimp and trout that were fed UDBG demonstrated reduced morbidity and mortality.

It is universally accepted that an increase in early animal growth typically leads to a reduction in mortality and morbidity in the animal husbandry industry. This is critical for the industries to insure profitability. As such, research conducted by different research institutions sought to determine if beta-glucan maintained in its undenatured tertiary state would be more efficacious in immune system stimulation than the denatured beta-glucan when administered to certain commercial mammals.

This study was designed to determine if feeding weaned piglets UDBG would result in increased weight, and overall health and physiology, in the early period of maturation.

2. Methods and Material

The maximum capacity of the experiment facilities was 64 pigs; therefore, the study was conducted over three periods; Period 1 with 48 pigs in total (12 pigs per treatment), Period 2 with 65 pigs in total (16 pigs per treatment), and Period 3 with 16 pigs in total (four pigs per treatment). The experimental period lasted for 28 days

The newly weaned piglets received diets from time of weaning that contained one of three different levels (0.02, 0.20, or 2.0 mg/kg feed) of a diet containing UDBG[2], or a control diet, for the following four weeks (**Table 1**). The diets were

[2]The diets containing UDBG are called LentiGuard.

Table 1. The dietary treatments were as follows.

Group	Treatment	Dietary level of UDBG	Diet name
1	Control (Conventional Norwegian Basil Diet	0	Control
2	UDBG	0.02 mg/kg	0.02 L
3	UDBG	0.2 mg/kg	0.2 L
4	UDBG	2.0 mg/kg	2.0 L

All diets were produced by Borgen Aktiemølle, N-3158 Andebu, Norway.

based on wheat, barley and soy bean meal [5] [6] [7]. The diets contained the necessary minerals and vitamins to meet the requirements of the animals.

UDBG was added to the diets during feed manufacture. The UDBG was diluted in water to a volume of 2.5 L/ton of feed mixture, added to the mixer after all the other dry ingredients, and then mixed. After mixing, the feed was pelleted using a 3 mm matrix. The diets were designed to contain equal levels of the amino acids, lysine, methionine + cysteine, and threonine. These levels exceeded dietary requirements of the piglets. The piglets received the diets *ad libitum* from automatic feeders. The feed consumed by each pen of piglets was recorded weekly and the average daily feed intake and feed efficiency as feed:gain, was calculated.

A cumulative feed sample from each dietary treatment was taken once weekly for chemical analysis, and the samples were kept in sealed plastic bags in a refrigerator until the experiment was finished. Samples of each type of test feed and the control feed (each weighing approximately 500 g) were taken for chemical analysis. The analyses of chemical composition (dry matter, crude protein as Kjeldahl-N × 6.25, fat as HCl hydrolysis with petroleum ether extraction, crude fiber and ash), and the amino acids lysine, methionine, cysteine and threonine were performed at AnalyCen, Moss, Norway.

The study was conducted with a total of 128 Noroc pigs (Norwegian Landrace × Yorkshire) × (Norwegian Landrace × Duroc) from 24 litters, at the experimental pig house of the Norwegian University of Life Sciences, Ås, Norway. Only healthy animals with normal body conditions were used in the study. The male piglets were castrated about seven days after birth. Pigs were allotted to the four dietary treatments on the basis of litter, initial weight and gender. There were equal numbers of female and castrated male pigs on each treatment.

Pigs were housed in an environmentally controlled nursery in 2.5 × 2.5 in pens with partially slotted floors. Sawdust was provided as bedding. Room temperature was, on average, 22.5˚C ranging from 18˚C - 28˚C. High and low temperatures in the nursery were recorded in the morning and afternoon and the records were retained.

All animals were weighed on the first day of treatment (day 1) and weekly thereafter. The average daily weight gain (ADG) for each pig was calculated all visible signs of ill health and any behavioral changes were recorded daily, and

any deviation from normal was recorded. Fecal scores were assigned by the staff in the swine house, and were based on the following scale: 1, normal, solid feces; 2; solid feces; 3, loose feces; 4, soft feces; and 5, liquid diarrheal feces. Blood samples were taken from 14 pigs in each treatment (six pigs per treatment in Period 1, and eight pigs per treatment in Period 2), at the end of the experimental period. The blood samples were analysed for hematological indices at the Central Laboratorium at the Norwegian School of Veterinary Science, Oslo, Norway.

Statistical analyses were performed using the GLM procedure of SAS [8] for a complete randomized block design. Treatment, litter and sex were included in the statistical model as explanatory effects. Means were separated according to the least significant difference (LSD) test. Variance in the data is expressed as standard error of the mean (SEM). A test for orthogonal contrasts was also performed. All results are presented as LSMEANS for each treatment, and the variance in the data is expressed as standard error of the mean (SEM). Significant differences among treatments are shown as $P < 0.05$, tendency for differences defined as P between 0.05 and 0.10.

3. Results and Discussion

On average, the pigs in the three UDBG diet groups consumed 7.5 mg, 77.8 mg, and 797 mg UDBG, respectively during the four-week trial (Figure 1). However, during the first two weeks the average daily feed intake was significantly greater for the diet containing 2.0 mg of UDBG (Figure 2). No health problems related to the dietary treatments were observed. The piglets revealed good growth relative to what is found at commercial pig farms in Norway. On average for all of the pigs, the daily gain (ADG) was 559 grams. The piglets generally showed good viability, which was evaluated subjectively. Especially in Period 1, the piglets fed the highest level of UDBG (2.0 mg/kg) were found to have a better viability compared to the other groups.

There were no significant differences among the dietary treatment groups in either weight gain or daily feed intake of piglets during week 1 - 2, week 3 - 4, or the overall study period. However, during the two first weeks, the pigs fed the 2.0 mg UDBG/kg diet numerically gained 12% to 15% faster relative to the control diet

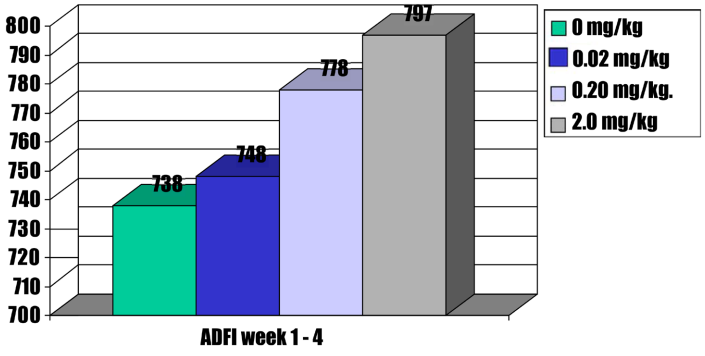

Figure 1. Effect of UDBG on average daily feed intake (ADFI) in the piglet period (week 0 - 4 after weaning).

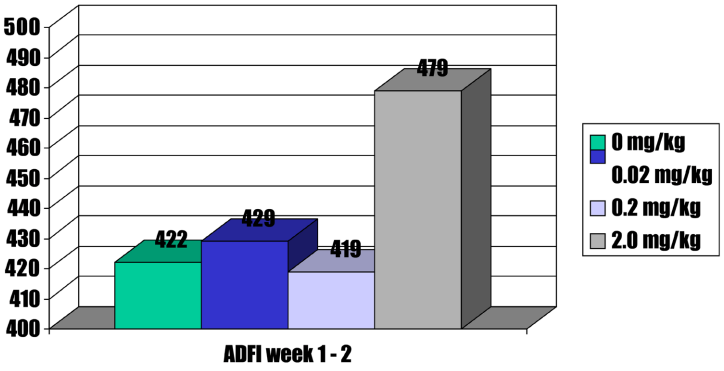

Figure 2. Effect of LentiGuard on average daily feed intake (ADFI) of the piglets during the two first weeks afterweaning).

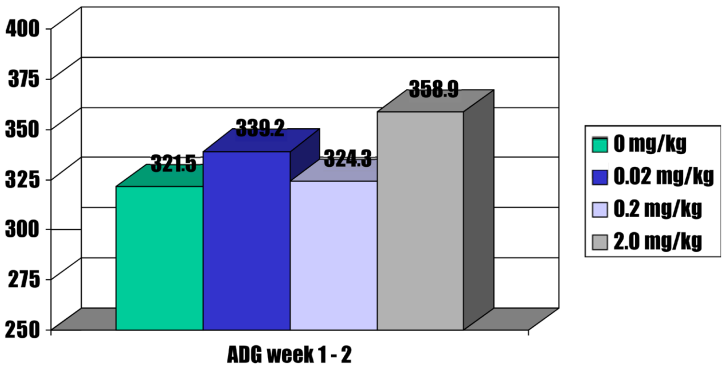

Figure 3. Effect of LentiGuard on average daily gain (ADG) of the piglets during the first two weeks after weaning.

(Figure 3), and those that were fed the two higher concentrations of UDBG, grew faster overall during the trial than those administered 0.2 mg and 0 mg/kg. During the two last weeks, and the overall study period, the differences among the treatment groups were small. A numerical increase in feed intake of up to 21% during week one and 8% overall [7].

The addition of UDBG to diets had a significant positive effect on several blood hematological parameters including the Index of anisocytosis (RDW – RBC Distribution Width) ($P < 0.04$), relative number of neutrophilic granulocytes ($P < 0.005$), and relative number of lymphocytes ($P < 0.025$) (Figure 4). An imbalance of the index of anisocytosis and the percentage of the neutrophilic granulocytes are indicators of immune system imbalance. This imbalance was noted in the pigs prior to UDBG administration. However, following the UDBG diet, a significant positive effect on these blood hematological parameters was observed.

The index of anisocytosis decreased linearly with increasing levels of UDBG, and values for the control diet was significantly higher than the 0.02 mg/kg and the mg/kg diets. The relative number of neutrophilic lymphocytes was significantly higher on the 2.0 g/kg diet compared to the other diets, while the relative number of lymphocytes was lowest on the 2.0 g/kg diet compared to the others. However, the total number of white blood cells was not significantly affected by

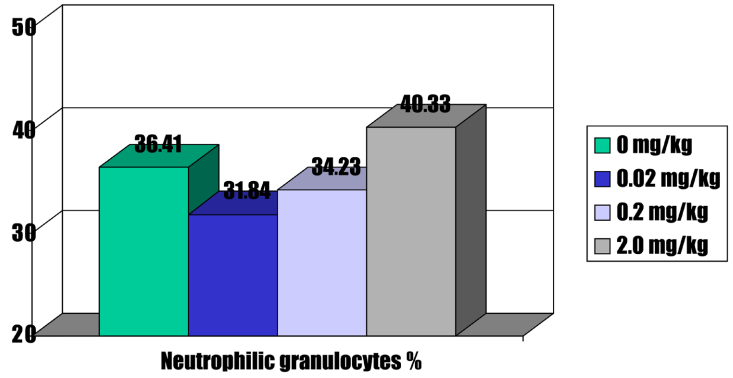

Figure 4. Effect of LentiGuard on neutrophilic granulocytes, in % of total white blood cells.

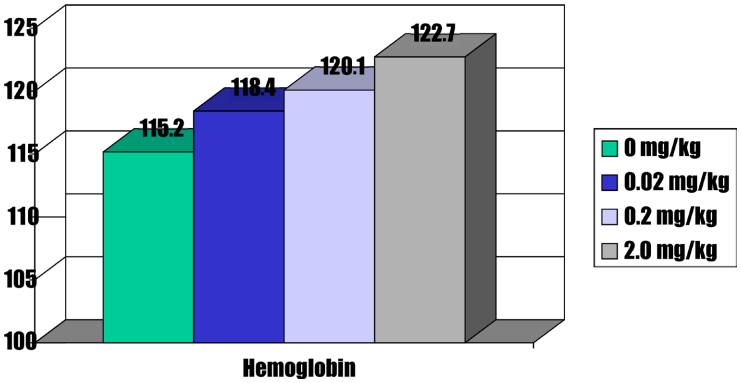

Figure 5. Effect of LentiGuard on hemoglobin, g/L.

the dietary treatments.

In addition, a positive linear effect of increasing levels of UDBG in the feed was found to increase hemoglobin ($P < 0.044$) and the hematocrit ($P < 0.034$) [8] (Figure 5).

The feed conversion ratio: Feed:Gain (kg feed: kg gain) differed significantly among treatments for the two last weeks (week 3 - 4), and for the overall piglet period. The pigs fed the highest levels of UDBG diet (2.0 mg/kg feed) had the poorest Feed:Gain values. The differences between the two lowest levels of UDBG did not differ significantly when compared to the control diet. The difference between the highest levels of UDBG and the control diet, that is 0.076 kg feed/kg gain, corresponds to 1.2 kg feed for a piglet with a weight gain of 15 kg in the piglet period. The poorer Feed:Gain values observed for the pigs fed the highest levels of UDBG was most likely caused by a higher feed intake in these pigs. High feed intake during the first days after weaning is beneficial for the pigs because this gives them a better start during the critical time around weaning. However, a higher feed intake results in a higher passage rate of the digest a through the gastrointestinal tract of the pigs, which in turn results in a reduced nutrient uptake and reduced digestibility of the nutrients. This may explain the reduced feed conversion ratio found for the piglets fed the highest levels of UDBG. There were no significant differences among the dietary treatment

groups for any of the weeks after weaning, or for the overall piglet period, according to the GLM procedure of SAS.

No health problems related to the dietary treatments were observed. The piglets revealed good growth compared to that found at commercial pig farms in Norway. In general, the piglets showed good viability, as evaluated subjectively by the Veterinary staff. Especially in Period 1, the piglets fed the highest level of UDBG (2.0 mg/kg) were found to have a better viability compared to the other groups.

No difference in fecal scores was found among dietary treatments.

4. Conclusions

There was no significant effect of UDBG on weight gain of piglets. However, interesting differences in weight gain were found numerically among treatments. In week 1 - 2, the pigs fed 2.0 mg UDBG per kg of feed gained 12% - 15% faster than the control diet. The numerical increase in weight gain during the first period after weaning is indicative of an improved immunstatus of the piglets fed the higher inclusion levels of UDBG. Overall, the pigs fed the 2.0 mg UDBG diet gained 2.0% faster than the control diet, the pigs fed the 0.2 mg UDBG diet gained 3.3% faster, while the pigs fed the lowest inclusion level gained 1.3% slower than the control diet.

In Period 1, the piglets fed the highest level of UDBG (2.0 mg/kg) were found to have a better viability compared to the other groups, as determined by the Veterinary staff.

The addition of UDBG to diets had a significant effect on several blood hematological parameters including the index of anisocytis, neutrophilic granulocytes and lymphocytes. A significant positive linear effect of increasing dietary levels of UDBG was also found for hemoglobin and hematocrit.

No clinical health problems were encountered during the experimental period. All animals grew well; in average the daily gain (ADG) was 559 grams for the overall experimental period. No difference in fecal scores was found among dietary treatments. The growth rates over the whole fattening period should be regarded from a practical point of view as very satisfactory, irrespective of the treatment.

No significant differences among the dietary treatment groups were found for feed intake of piglets. However, feed intake of piglets fed UDBG was increased up to 11.6% during week 1 - 2 and up to 7.9% overall. Especially, pigs fed the highest inclusion level of UDBG experienced a large numerical increase in feed intake.

With regards to feed:gain, there was no significant effect of UDBG during the first two weeks (week 1 - 2). During week 3 - 4 and overall, pigs fed 2.0 mg UDBG had significantly higher feed:gain than the control pigs while the inclusion of 0.02 and 0.2 mg UDBG had no effect on feed:gain.

In this study, piglets from the university herd were used, and they were kept

under highly hygienic conditions, and thus their exposure to pathogens was very low, as documented in the observations of fecal consistency. It is expected that the effect of UDBG would be greater if pigs were kept under more stressed hygienic condition or exposed to different challenge.

The clinicians suggested that a second study that starts at a weaning age of three weeks (21 days) instead of 4 weeks (28 days), when piglets experience a low immune status, should be conducted.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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