Oral feeding with live yeast: impact on some GALT (gut-associated lymphoid tissue) parameters and cell proliferation in weaning piglets

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Summary

The objective of this study was to evaluate the effects of yeast dietary supplementation (Levucell® SB – CNCM I-1079, Lallemand, France), on piglets performances as well as on selected structural aspects of piglet ileum.

Feeding upon 0.01% of the yeast strain CNCM I-1079 in the diet for 30 d after weaning is able to improve daily gain of piglets after weaning and to show positive effects upon structural aspects of piglet ileal mucosa, such as histometrical parameters, epithelial proliferation rate, and number of mucosal macrophages.

Introduction

Live yeast dietary supplementation has been reported to produce a variety of beneficial responses in growth rate, feed intake, feed efficiency, milk composition, egg production, as well as reproduction effectiveness in different species (Kornegay et al., 1995). It is well known that probiotics display a lot of beneficial effects on gastrointestinal tract: involvement in production of essential nutrients at the level of the colonic mucosa, beneficial effects on intestinal immunity, recovery in case of disturbed gut mucosal barrier and prevention of microbial translocation, and competition with microbial pathogens.

The aim of this study was to investigate the effects of live yeast on growth performances and selected histometrical and morpho-functional aspects of piglet gut during the first month after weaning under field practical conditions.

Material and Methods

Fifty Landrace x Large White sows of homogeneous weight and parity were fed a diet with or without 0,1 % of a premix @ 0,5 % of Levucell SB 20 (i.e. 10^6 cfu/g of feed) of yeast (Levucell® SB – CNCM I-1079, Lallemand, France). Control (C) and treated (T) diets were fed starting on 85 d of gestation throughout lactation. At weaning (26 d), a total of 358 piglets of average 6.5 kg L.W., were allotted into four groups: two groups were arranged coming from control (C) sows, the other two coming from treated (T) sows. Piglets were respectively fed a starter diet supplemented with 0% yeast (C) and 0.01% of the same yeast (T), so that the following experimental groups resulted: CC, TC, CT and TT. Individual body weights and feed intakes were recorded at 0, 15, and 30 d postweaning. After 30 d post-weaning, 5 female piglets per group were slaughtered (n=20). The whole intestinal tract, and the liver were weighted. The distal

ileum was collected immediately after slaughtering from each animal. The samples were fixed in 4% paraformaldehyde in 0.01M phosphate buffered saline (PBS) pH 7.4 for 24 h at 4°C, dehydrated in alcohol, and embedded in paraffin. Serial microtome sections (4 μm-thick) were stained with hematoxylin and eosin and examined to determine the depth of intestinal crypts (C), the height of intestinal villi (V), and the ratio of villi and crypths measurements (V:C ratio; 10 per section) using an Olympus BX51 microscope equipped with DP software (Olympus, Italy). Other sections were processed for visualization of mucosal cells which were in S-phase of the cell cycle, by immunostaining with a monoclonal antibody against proliferating cell nuclear antigen (PCNA) (Sigma, Italy), and other sections were used to identify mucosal macrophages using a monoclonal anti-human macrophage antibody (Sigma, Italy). Mitosis index (epithelial cells) was counted in ten well-oriented villi/crypts for each section. Macrophages were counted in 10 fields of diffuse limphatic tissue (tissue area: 0.015 mm^2). Cells were expressed as the percentage of the total number of counted cells. The data were analyzed by ANOVA using the GLM procedure of the SAS Institute, Inc. (1985). Cells counts were co-variated for the number of recorded cells.

Results and Discussion

At the end of the trial the treated piglets (TT, CT) were heavier than control even though the difference was not significant (20.00 kg *vs* 19.63 kg). In addition, average daily gain (ADG) of treated (TT, CT) piglets resulted significantly higher than control piglets (0.43 kg/d *vs* 0.46 kg/d; P<0.001). TT and CT piglets showed higher ADG than CC and TC animals during the post-weaning period. This is in accordance with the results obtained by Jurgens et al. (1997), who reported a significant improvement in ADG and feed efficiency in pigs fed diet supplemented with active dry yeast.

As regards the gut structural aspects, we focused our attention on the ileum, because this organ is highly susceptible to pathologic changes in weaning piglets in the case of infections. Histological examination showed that the ileum of the treated piglets maintained its normal aspect after supplementation, and no differences within the groups regarding gut structure or cytology were observed. Histometric analysis and cells indices are presented in Table 1.

Table 1. Effects of added yeast on villus height (V), crypt depth (C), V:C ratio; mitosis and macrophages in diffuse limphatic tissue (DLT); liver and intestine weight (mean ± SEM).

	CC	TC	CT	TT	SEM
Villous height μm	195.13 ^{A}	193.46 ^{A}	242.97 ^{B}	242.99 ^{B}	3.19
Crypts depth μm	129.93 ^{A}	136.40 ^{A}	177.70 ^{B}	176.64 ^{B}	2.14
V:C ratio	1.53 ^{Aa}	1.42 ^{Bb}	1.39 ^{Bb}	1.39 ^{Bb}	0.02
Mitotic cells %	41.97 ^{a}	43.50 ^{a}	49.18 ^{b}	48.87 ^{b}	2.05
Macrophages in DLT %	4.00 ^{A}	4.02 ^{A}	4.82 ^{B}	4.93 ^{B}	0.07
Liver weight Kg	0.48	0.61	0.53	0.54	0.02
Intestine weight Kg	1.99	2.06	2.04	2.00	0.09

^{A,B}= P< 0.01 Within rows, means lacking a common superscript differ significantly (P<.01)

^{a,b}= P< 0.05 Within rows, means lacking a common superscript differ significantly (P<.05)

Histometric analysis in the ileum of CT and TT animals resulted in an increase in villus (V) height (P<.01) and in crypt (C) depth (P<.01), as well as in a decrease in V:C ratio (p<.01) compared with controls. The counts of mitotic epithelial cells resulted in an increase of mitosis in CT/TT piglets compared with CC/TC animals (P<.05). On the other hand, the weight of the entire intestines was not different within the four groups, so that the higher number of intestinal mitotic cells in CT and TT groups may not prelude to possible hypertrophic aspects. The higher proliferation rate of the intestinal epithelial cells in treated piglets could be explained by the fact that yeast have been shown effects of nonimmunologic gut defence, which is characterized by stabilization of the gut microflora (Salminen et al., 1998). Yeast have been shown to stimulate nonspecific host resistance to microbial antigens, enhancing the production of macrophages and, thereby, aid in immune responses, as well. Moreover, the higher mitotic index found in the treated piglets likely supports a good intestinal capability of restoring the mucosal thinning which frequently occurs at weaning (Isolauri et al., 1998). This is in accordance with the producing parameters: good conditions of the intestinal mucosa likely allow better ADG and growth performances. The mucosal macrophages were appreciably more numerous in animals supplied with live yeast (CT/TT) than in piglets without any supply (CC/TC) (P<.01). We can thus hypothesize upon morphological bases a good defensive capacity of ileal mucosa in the treated piglets against pathologies.

Conclusion

Inclusion of 0.01 % of live yeast (CNCM I-1079) to postweaning diet had beneficial effects on piglets growth performance and likely promoted a proper intestinal efficiency by a fast restoration of the mucosal thinning after weaning. Furthermore, innate immunity caused by macrophages acts as the first line of the host defence against viral infections. For this reason, if the supplements do stimulate the local immune system, yeast administration may possibly assist animals in intestinal disorders by the gut trophic action and the positive effects upon mucosal macrophages.

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