

DIETARY SUPPLEMENTATION OF A YEAST-WHEY PREPARATION FOR WEANED PIGLETS

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(Received 06 November 2019, Accepted 03 March 2020)

Weaning is a stressful period for the piglets and the sow. Stress during weaning is related to the change of diet which can affect the physiology of the gastrointestinal tract, as well as the microbial and immunological status of the animals. In the experiment a yeast-whey preparation was used to decrease the transient growth depression related to reduction of feed intake by the piglets. The piglets were assigned to three treatments. In the control group (I) the animals obtained standard feed mixture used routinely at the farm. In the case of piglets from II and III treatment, the yeast-whey preparation was added in the quantity of 4 and 7%, respectively.

Application of 7% yeast-whey preparation to the diet significantly increased the body weight of piglets ($p < 0.05$) and in consequence the average daily body weight gain ($p < 0.01$) in comparison with the control group of animals. Additionally, piglets which were fed the yeast-whey preparation diet had a higher feed intake ($p < 0.05$) and better feed conversion ratio ($p < 0.05$) than those fed a diet without the addition of this preparation. No significant differences were stated for most biological parameters ($p > 0.05$), except for the blood urea level, which was significantly lower ($p < 0.05$) in the treatments where the yeast-whey preparation was used. These results indicated that yeast-whey preparation efficiently suppressed post-weaning diarrhea and improved the performance of the animals.

Key words: weaned piglets, diarrhea, performance, yeast-whey preparation

INTRODUCTION

The weaning period is a strong stress factor both for the piglets and the sow. It is associated with many changes in the weaner's body, including its physiological (related to the gastrointestinal tract physiology and microbiota) and psychological status, thus affecting the reduced ability of the organism to immunologically defend itself [1-2]. Physiological

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changes affect GALT (gut-associated lymphoid tissue) [3], which are manifested by shortening of the intestinal villi and crypt hyperplasia and leads to increased vulnerability to bacterial infections, especially enterotoxic *E. coli* strains [2,4-5].

Weaning involves changes in the diet (the transition to solid feeds) and environment (impairment of earlier established hierarchy and escalation of aggressive behavior) [6-8]. This procedure results in transient growth depression which is linked to reduced feed intake [9]. Most often weaned piglets consume the first portion of feed after 24 hours, while in 10% this process can last even 48 hours. Most of the animals adapt to the new nutritional and environmental conditions within 1 - 2 weeks. However, some individuals show post-weaning wasting syndrome with growth depression. In order to counteract the growth depression and limit the risk of diarrhea, different dietary supplements are used which are alternatives to antibiotic growth promoters [7,10-12]. They include spray dried plasma, preparations from egg yolks, dried bovine colostrum, dried whey or yeasts *Saccharomyces cerevisiae* and isolated products of their fractionation (β -1,3/1,6-glucans, mannans). Active components used in feed mixtures for weaned piglets mostly aim to support the growth and development of the animals and to boost non-specific resistance to negative environmental factors [13-16].

The aim of the present experiment was to assess production performance and some chosen hematological and biochemical parameters in growing pigs which were fed a complete feed mixture supplemented with different concentrations of a yeast-whey preparation.

MATERIAL AND METHODS

The experiment was conducted on a pig farm in Korzękwice (Poland) and it was integrated with the production cycle at the farm; high zootechnical and veterinary standards were implemented.

The experiment commenced with assigning randomly weaned piglets (Polish Landrace x Polish Large White) to 3 groups (80 animals each) with an initial body weight of ca. 7.5 kg on the 28th day of life. The nutritional values of the prestarter mixtures are presented in Table 2. Group I comprised control animals fed a standard solid feed mixture used routinely on this farm (without the tested preparation). The prestarter mixtures for group II and III were supplemented with a yeast-whey preparation at a concentration of 4% and 7%, respectively. The yeast-whey preparation was prepared from slurry of dried brewer's yeast (*Saccharomyces cerevisiae*) and concentrated sweet whey. The nutritional value of the preparation is presented in Table 1. Piglets were fed the prestarter diet up to the end of the experiment (55 days of age), according to the experimental design. Animals consumed the mixture *ad libitum* from auto-feeders. The weaners had constant access to automatic drinkers with controlled water flow adjusted to their needs.

Table 1. Nutritional value of the yeast-whey preparation

Specification %	Yeast-whey preparation
DM, %	92.32
Metabolizable Energy, MJ	14.9
Crude protein, %	27.5
Crude fat, %	0.25
Crude ash, %	6.43
NFE, %	57.8
Sugars, %	55.0
pH	4.06
Amino acid (g/kg)	
Lysine	16.95
Methionine+Cysteine	7.55
Threonine	14.08
Tryptophan	3.03
Tyrosine	8.00
Valine	14.49
Phenylalanine	11.25
Arginine	13.96
Serine	15.00
Histidine	6.79
Leucine	19.97
Isoleucine	12.19
Alanine	16.69
Average content of the main trace elements in the yeast-whey preparation:	
Ca (g/kg)	8.40
P (g/kg)	7.98
Mg (g/kg)	1.16
Na (g/kg)	5.38
K (g/kg)	11.39
Cu (mg/kg)	8.00
Zn (mg/kg)	34.51
Fe (mg/kg)	32.77
Mn (mg/kg)	5.45
The yeast-whey preparation was made from beer yeast cake and sweet whey by specific hydrothermal treatment methods.	
Production technology prevented the occurrence of reactions that can inactivate the action of active substances in the raw material.	
Physico-chemical properties of the yeast-whey preparation:	
Colour – light cream	
Taste: sweet and sour	
Physical form: finely ground flour	

The experiment involved the determination of the growth rate of the piglets and feed intake during rearing, the number of diarrhea cases and losses, as well as their causes. In addition, blood was collected from the jugular vein of six 55-day-old piglets to determine some hematological (hematocrit - Ht, hemoglobin content - Hb, erythrocyte - RBC and leukocyte - WBC) and biochemical parameters (urea - UREA).

All the obtained results were subjected to statistical analysis using a one-way analysis of variance using Stastica 13.1 software package (Statsoft Inc.). Differences between the groups were analyzed with Duncan test.

RESULTS

The nutritional value of the prestarter mixture (Table 2) conformed to the standards defined by nutritional recommendations [17].

Table 2. Nutritional value of the prestarter mixture

Specification, %	Treatment		
	I	II – 4%	III – 7%
	Control	Yeast-whey preparation	
Barley	38.50	37.50	37.00
Wheat	37.00	36.00	35.00
Soybean meal (46% CP)	13.00	11.00	9.50
Yeast-whey preparation	-	4.00	7.00
Soya bean oil – 1.50; Complementary feed – 4.00; Preparation – source of energy and protein– 6.00			
Metabolizable energy (MJ · kg ⁻¹)	13.23	13.20	13.24
Crude protein	16.63	16.75	16.68
Crude fat	3.55	3.49	3.45
Crude fibre	3.70	3.53	3.41
Lysine	1.22	1.22	1.22
Methionine	0.40	0.39	0.39
Methionine+Cysteine	0.72	0.71	0.71
Threonine	0.77	0.78	0.79
Tryptophan	0.23	0.22	0.22
Ca	0.75	0.77	0.78
P _{total}	0.55	0.56	0.57
Vitamin A – 14 000 IU; Vitamin D – 2 000 IU; Vitamin E – 140 IU			

The production performance indices of the piglets obtained during the experiment are presented in Table 3. On the day of weaning, the body weight (BW) of the piglets differed only slightly between the groups and ranged from 7.2 kg to 7.7 kg. The mean body weight of the piglets from group II and III was insignificantly higher than in the control group.

At 55 days of life, the body weight of the piglets from group II and III was higher, while the piglets from the control group at that time weighted less by 1 kg and 2 kg, respectively. The obtained results indicate that diet supplementation of 7% yeast-whey preparation induced the most beneficial effect on the growth rate of the animals during rearing ($p < 0.05$). Group II and III piglets also showed significantly higher weight gains, by 15% and 26% respectively, compared with group I (control).

Table 3. Production performance indices of the piglets

Specification	Treatment			SEM	p-value
	I	II – 4%	III – 7%		
	Control	Yeast-whey preparation			
Number of piglets (head)					
day 28	80	80	80	-	-
day 55	73	78	79		
Mortality (head)	7	2	1	-	-
Average body weight(kg)					
day 28	7.7	7.2	7.5	0.142	0.40
day 55	16.8 a	17.7 ab	18.9 b	0.296	0.01
Average daily body weight gains (g)	337 A	389 B	422 C	7.436	0.00
Feed intake from 28 th to 55 th day of life (kg/head)	17.20 a	18.29 b	18.94 b	0.372	0.02
Feed conversion ratio (kg/kg)	1.89 a	1.74 b	1.66 b	0.033	0.01
Diarrhea (number of days when diarrhea was determined in piglets)	16	0	0	-	-

A, B – $p < 0.01$; a, b – $p < 0.05$

The piglets showed a greater preference for the prestarter mixtures supplemented with the yeast-whey preparation compared to group I (control). Feed conversion per 1 kg of body weight gain measured 1.89 kg/kg in the control group, whereas it was significantly lower ($p < 0.05$) in groups II and III (1.74 kg/kg and 1.66 kg/kg, respectively).

The losses and culling rate of the piglets during rearing averaged 9% in the control group and fluctuated from 1% to 2% in groups receiving the test preparation. The highest number of diarrhea cases was noted in the control group (16 piglets during the whole experiment). In contrast, no diarrhea cases were observed in the experimental groups. The obtained production data (including body weight and losses during rearing) indicate a beneficial effect of the yeast-whey preparation on the production performance of piglets and weaners.

Hematological parameters remained within the physiological range confirming the good health status of the animals [18] (Table 4). In our experiment, we did not notice statistically significant ($p > 0.05$) differences in RBC measurements (Ht, Hb, RBC).

Plasma urea content was reduced in animals fed the mixture with the yeast-whey preparation; it is a beneficial reaction of the body to the supplement under the study. The significantly reduced ($p < 0.05$) urea level (noted in the groups receiving the yeast-whey preparation in the diet) can be indicative of better protein utilization probably due to lactoglobulins contained in the preparation.

Table 4. Biochemical parameters determined in the blood serum (55th day of life)

Specification	Treatment			SEM	p-value
	I	II – 4%	III – 7%		
	Control	Yeast-whey preparation			
Hematocrit (%)	34.11	35.20	34.90	0.337	0.40
Hemoglobin (mmol · l ⁻¹)	10.10	11.12	11.30	0.289	0.19
Erythrocytes x 10 ¹² · l ⁻¹	5.70	5.60	5.65	0.110	0.94
Leukocytes x 10 ⁹ · l ⁻¹	18.40	18.44	18.56	0.368	0.98
Urea (mmol/l)	6.12 a	5.16 b	5.02 b	0.105	0.01

A, B – $p < 0.01$; a, b – $p < 0.05$

DISCUSSION

After the withdrawal of antibiotic growth promoters from animal feeds (in 2006), studies were launched to search for bioactive substances limiting the negative impact of the so-called immune gap (occurring after the separation of piglets from the sow) and supporting digestion (mostly during transition from milk to solid feed). They include spray dried plasma, yeast preparations containing beta-glucans and mannans composing the yeast cell wall or active substances of milk occurring in the colostrum or whey [6,19-20]. All of them show multidirectional effects beginning with the mobilization of the immune system in piglets (e.g. by binding pathogenic bacteria as in the case of mannans). Therefore, they show a similar activity profile as antibiotic growth promoters, but do not increase the drug resistance of pathogenic bacterial strains [16,21]. Mukhopadhyaya *et al.* [22] emphasized also that milk hydrolysates, depending on the source and chemical composition, have antimicrobial and anti-inflammatory properties. Additionally, Cross and Gil [23] confirmed in their review paper that it was possible to transfer active substances present in cow's milk to other animal species.

The present study was based on a combination of components of bacterial cell wall (mannans and beta-glucans) and whey-derived active substances. The yeast-whey preparation increased the body weight of piglets compared with piglets from the control group, resulting in a more than 10% rise in daily body weight gains obtained in group II receiving dietary supplementation with the 4% yeast-whey preparation. On the other hand, the addition of 7% preparation to the diet increased weight gain by 26%. Evidence to confirm this hypothesis was also provided by the studies of Pluske *et al.* [2] and Le Huëron-Luron *et al.* [24], demonstrating a beneficial effect of cow colostrum supplemented at 40 - 100 g/kg of the diet on body weight gains and feed intake during weaning. In particular, a direct stimulation of the intestines by dietary components was one of the factors exerting a positive effect on these results [3]. Active substances isolated from yeast cell walls, i.e. mannans and beta 3/1-6- glucans also continue to be of great interest [25-27]. The obtained results of the research indicate beneficial outcomes after application of these preparations, including a faster

growth rate of piglets and reduced risk of post-weaning diarrhea [28-29]. In the present study, apart from the increased daily body weight gains, the piglets from the groups receiving dietary supplementation with the test preparation showed a greater preference for the feed, whereas incorporation of the preparation in the diet at the level of 7% improved feed conversion per kg of weight gain by 230 g compared with piglets from the control group.

An immunomodulating action was also observed for milk whey both in ruminants and monogastric animals. Cross and Gil [23] reported, based on *in vivo* studies that cow's milk proteins influenced lymphocyte action and antibody response in other animal species. In the present study, the addition of the yeast-whey preparation to the diet reduced the culling rate from 9% in the control group to 2% in piglets fed the test preparation. It was also reflected by the level of the observed incidence of diarrhea. No cases of diarrhea were noted in piglets receiving the yeast-whey preparation, while in the control group 16 piglets with diarrhea were noted. However, the hematological studies did not confirm a greater frequency of inflammation in the control animals, while haptoglobin level remained at a similar level in all groups of piglets.

The impulse to undertake this type of research was a small number of previous articles regarding the use of dried yeast-whey preparations in piglet nutrition. The main advantage of this type of preparation is the combination of the beneficial effects of both of these ingredients in the period from weaning piglets on the 28th to the 55th day of their life. Dried brewer's yeast has a beneficial effect on the reduction of the number of pathogenic bacteria in the gastrointestinal tract of piglets due to the presence of mannan-oligosaccharides in the cell wall. However, the use of dried whey, as a by-product of the dairy industry, in combination with dried brewer's yeast resulted in a more efficient use of feed proteins confirmed by the lower level of urea in the blood of piglets receiving this supplement in the diet.

CONCLUSIONS

Dietary supplementation of the yeast-whey preparation at the level of 4% and 7% improved the growth rate and feed conversion in piglets (including proteins, as was evidenced by significantly reduced plasma urea concentration). The addition of the test preparation also efficiently suppressed post-weaning diarrhea.

Authors' contributions

AST coordinated experiment performances and has been involved in manuscript writing. TH performed the statistical analysis and participated in manuscript writing. MK performed the chemical analysis and participated in manuscript writing. BF conceived and designed the study, coordinated experiment performance and has been involved in manuscript writing. All authors read and approved the final manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. Brooks PH, Moran CA, Beal J, Demeckova V, Campbell A: Liquid feeding for the young piglets. In: MA Varley, JR Wiseman (eds), *The Weaner Pig Nutrition and Management* CAB International Wallingford Oxon 2001, 153.
2. Pluske JR, Hampson DJ, Williams IH: Factors influencing the structure and function of small intestine in weaned piglets: A review. *Livest Prod Sci* 1997, 52: 215-236.
3. Boundry C, Dehoux JP, Wavrielle J, Portetelle D, Thewis A, Buldgen A: Effect a bovine colostrum whey supplementation on growth performance, faecal *E.coli* population and systemic immune response of piglets at weaning. *Animal* 2008, 2(5): 730- 737.
4. Che L, Xu Q, Wu C, Luo Y, Huang X, Zhang B, Auclair E, Kiros T, Fang Z, Lin Y, Xu S, Feng B, Li J, Wu D: Effects of dietary live yeast supplementation on growth performance, diarrhea severity, intestinal permeability and immunological parameters of weaned piglets challenged with enterotoxigenic *Escherichia coli* K88. *Br J Nutr* 2017, 118: 949-958.
5. Melin L, Mattson S, Katouli M, Wallgren P: Development of postweaning diarrhea in piglets. Relation to presence of *E.coli* strains and Rotavirus. *J Vet Med B* 2004, 51: 12-22.
6. Heo JM, Opapeju FO, Pluske JR, Kim JC, Hampson DJ, Nyachoti CM: Gastrointestinal health and function in weaned pigs: a review of feeding strategies to control post-weaning diarrhea without using in-feed antimicrobial compounds. *J Anim Physiol Anim Nutr* 2013, 97: 207-237.
7. Lalles JP, Boundry G, Favier C, Le Floch N, Montagne I, Oswald IP, Pie S, Piel C, Seve B: Gut function and dysfunction in young pigs. *Gut function and dysfunction in young pigs' physiology.* *Anim Res* 2004, 53: 301-316.
8. Lalles J, Bosi P, Smidt H, Stokes CR: Weaning – A challenge to gut physiologists. *Livest Sci* 2007, 108: 82-93.
9. Held S, Mendl M: Behaviour of the young weaner piglets, Chapter 14. In: *The Weaner Pig: Nutrition and Management.* CABI Publishing, New York. 2001.
10. Liu Y, Espinosa CD, Abelilla JJ, Casas GA, Lagos LV, Lee SA, Kwon WB, Mathai JK, Navarro DMDL, Jaworski NW, Stein HH: Non-antibiotic feed additives in diets for pigs: A review. *Anim Nutr* 2018, 4: 113-125.
11. Wu X, Xie C, Li B, Zhou H, Yao J, Li K, Zhang B, Zhou L, Yin Y: Effect of replacement of SDPP with yeast extracts in piglets on plasma amino acid and intestinal mucosa morphology. *J Anim Plant Sci* 2016, 26(6): 1568-1575.
12. Yang HS, Wu F, Long LN, Li TJ, Xiong X, Liao P, Liu HN, Yin YL: Effects of yeast products on the intestinal morphology, barrier function, cytokine response, and antioxidant system of weaned piglets. *J Zhejiang Univ–Sc B* 2016, 17(10): 752-762.
13. Li J, Xing J, Li D, Wang X, Zhao L, Lv S, Huang D: Effects of β -glucan extracted from *Saccharomyces cerevisiae* on humoral and cellular immunity in weaned piglets. *Arch Anim Nutr* 2005, 59(5): 303-312.

14. Pakkanen R, Aalto J: Growth factors and antimicrobial factors of bovine colostrum. *Int Dairy J* 1997, 7: 285-297.
15. Vrese M, Marteau PR: Probiotics and prebiotics: Effects on diarrhea. *J Nutr* 2007, 137: 803-811.
16. Waititu SM, Heo JM, Patterson R, Nyachoti CM: Dietary yeast-based nucleotides as an alternative to in-fed antibiotics in promoting growth performance and nutrient utilization in weaned pigs. *Can J Anim Sci* 2016, 96: 289-293.
17. Nutrient Requirements and Nutritional Value of Feed for Swine (in Polish). The Kielanowski Institute of Animal Physiology and Nutrition PAN, Jablonna, Poland. 1993.
18. Winnicka A: Wartości referencyjne w weterynarii (in Polish). SGGW, Warszawa, Poland. 2004.
19. Bosi P, Han IK, Jung HJ, Heo KN, Perini S, Castellazzi AM, Casini L, Creston D, Gremokolini C: Effect of different spray dried plasmas on growth, ileal digestibility, nutrient deposition, immunity and health of early-weaned pigs challenged with *E.coli* K88. *Asian-Austral J Anim Sci* 2001, 14(8): 1138-1143.
20. Miguel JC, Rodriguez-Zas SL, Pettigrew JE: Efficacy of mannan- oligosaccharides (Bio-Mos) for improving nursery pig performance. *J Swine Health Prod* 2004, 12(6): 296-307.
21. Vondruskova H, Slamova R, Trckova M, Zraly Z, Pavlik I: Alternatives to antibiotic growth promoters in prevention of diarrhea in weaned piglets. *Vet Med* 2010, 55: 199-224.
22. Mukhopadhyaya A, O'Doherty JV, Sweeney T: A combination of yeast beta-glucan and milk hydrolysate is a suitable alternative to zinc oxide in the race to alternative postweaning diarrhea in piglets. *Sci Rep* 2019, 9: 616-626.
23. Cross ML, Gill HS: Immunomodulatory properties of milk. *Brit J Nutr* 2000, 84: S81-S89.
24. Le Huërou-Luron I, Huguet A, Callarec J, Leroux T, Le Dividich J: La supplementation de l'aliment de sevrage en colostrum bovin améliore l'ingestion et les performances zootechniques chez les porcelets au sevrage (in French). *Journ Rech Porc Fr* 2004, 36: 33-38.
25. Fuchs B, Frericks J, Szuba-Trznadel A, Ragaller V, Lira R: The influence of products contained mannans and β -D-1,3/1-6-glucans on the production and physiology results of piglets during weaning period (in Polish). *Zesz Nauk UP Wroc, Biol i Hod Zw* 2010, 580: 131-141.
26. Hahn TW, Lohakare JD, Lee SL, Moon WK, Chae BJ: Effects of supplementation of β -glucans on growth performance, nutrient digestibility, and immunity in weanling pigs. *J Anim Sci* 2006, 84: 1422-1428.
27. Liu G, Yu L, Martínez Y, Ren W, Ni H, Al-Dhabi NA, Duraipandiyan V, Yin Y: Dietary *Saccharomyces cerevisiae* cell wall extract supplementation alleviates oxidative stress and modulates serum amino acids profiles in weaned piglets. *Oxid Med Cell Longev* 2017, Article ID 3967439 7 pages.
28. Decuyper N, Dierick N, Boddez S: The potentials for immunostimulatory substances (α -1,3/1,6 glucans) in pig nutrition. *J Anim Feed Sci* 1998, 7: 259.
29. Kim JD, Hyun Y, Sohn KS, Woo HJ, Kim TJ, Han In K: Effects of immunostimulators on growth performance and immune response in pigs weaned at 21 days of age. *J Anim Feed Sci* 2000, 9: 2.

PREPARATI SURUTKE SA KVASCEM KAO SUPLEMENTI U ISHRANI ZALUČENE PRASADI

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Kod svinja, period zalučenja predstavlja stres kako za prasiće tako i za krmaču. Stres u tom periodu je povezan sa promenom ishrane koja može da utiče na fiziologiju gastrointestinalnog trakta kao i mikrobiološki i imunski status životinja. U eksperimentu, preparat surutke je korišćen da bi se smanjilo zaostajanje u rastu koje je povezano sa smanjenjem unosa hraniva kod prasadi. Prasići su podeljeni u tri grupe u odnosu na tretman. U kontrolnoj grupi (I), životinje su dobijale standardnu smešu hraniva koja se rutinski koristila na farmi. U slučaju druge i treće grupe, odnosno tretmana II i III, dodati su preparati surutke tretirane kvascem u količini od 4 odnosno 7%.

Dodavanje preparata surutke u hranivo u koncentraciji od 7%, značajno je povećala težinu telesne mase prasadi ($p < 0,05$), a kao posledica uočeno je povećanje prosečnog prirasta ($p < 0,01$) u poređenju sa kontrolnom grupom. Pored toga, prasad hranjena preparatom surutke tretirane kvascem, imali su veći unos hraniva ($p < 0,05$) kao i bolji odnos konverzije hraniva ($p < 0,05$) u poređenju sa životinjama koje su bile u kontrolnoj grupi, bez dodavanja preparata surutke. U studiji, nisu uočene razlike u odnosu na većinu bioloških parametara ($p < 0,05$), sa izuzetkom koncentracije ureje u krvi koja je bila značajno manja ($p < 0,05$) u grupama koje su primale preparat surutke. Ovi rezultati ukazuju da preparati surutke mogu efikasno da suprimiraju dijareju koja je prisutna kod prasadi posle zalučenja kao i da poboljša ukupne performanse kod životinja.