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The Effect of Two Combinations of Direct Fed Microbials on Growth Performance of Nursery Pigs Weaned from Sows Fed Diets with or without Yeast Additives

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Abstract

A total of 330 weaned pigs (Line 241 × 600, DNA; initially 12.7 lb BW) were used in a 38-d nursery study to evaluate previous sow treatment (control vs. yeast additives) and nursery diets with different combinations of direct fed microbials (DFMs; Phileo by Lesaffre, Milwaukee, WI) on nursery pig growth performance. Pigs were placed in pens across two nursery rooms at weaning then pens were assigned to 1 of 3 dietary treatments with 6 pigs per pen and 8 to 10 replications per treatment. Treatments were arranged in a 2 × 3 factorial with main effects of sow treatment (control vs. yeast additives; 0.10% ActiSaf Sc 47 HR+ and 0.025% SafMannan) and nursery treatment (control; DFM 1, 0.05% of SafMannan from d 0 to 38 and NucleoSaf at 0.05% from d 0 to 10 and 0.025% from d 10 to 24; or DFM 2, 0.10% MicroSaf from d 0 to 38 and NucleoSaf at 0.05% from d 0 to 10 and 0.025% from d 10 to 24). Data were analyzed using linear mixed models using the nlme package of R with fixed effects of sow treatment, nursery treatment, and their interaction, and nursery room serving as the random effect. During the first ten days post-weaning, progeny of sows fed yeast additives had improved ($P < 0.05$) ADG, ADFI, and G:F. In fact, while pigs weaned from sows fed yeast additives entered the nursery at a lighter ($P < 0.001$) BW compared to pigs weaned from sows fed the control diet, by d 10 there was no difference ($P > 0.10$) in BW between the two groups. Offspring from sows fed yeast additives tended to have improved (P = 0.069) overall F/G. Pigs fed DFM 2 had increased ($P < 0.05$) ADG from d 24 to 38, and improved end of nursery BW compared to pigs fed the control diet. In conclusion, feeding yeast additives to sows had a positive impact on progeny growth in the early nursery, while the addition of DFMs in nursery diets had more impact on growth later in the nursery period.

Keywords

lactation, nursery pigs, probiotics, live yeast, yeast extracts

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K-STATE Research and Extension

SWINE DAY 2021

The Effect of Two Combinations of Direct Fed Microbials on Growth Performance of Nursery Pigs Weaned from Sows Fed Diets with or without Yeast Additives

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Summary

A total of 330 weaned pigs (Line 241 × 600, DNA; initially 12.7 lb BW) were used in a 38-d nursery study to evaluate previous sow treatment (control vs. yeast additives) and nursery diets with different combinations of direct fed microbials (DFMs; Phileo by Lesaffre, Milwaukee, WI) on nursery pig growth performance. Pigs were placed in pens across two nursery rooms at weaning then pens were assigned to 1 of 3 dietary treatments with 6 pigs per pen and 8 to 10 replications per treatment. Treatments were arranged in a 2 × 3 factorial with main effects of sow treatment (control vs. yeast additives; 0.10% ActiSaf Sc 47 HR+ and 0.025% SafMannan) and nursery treatment (control; DFM 1, 0.05% of SafMannan from d 0 to 38 and NucleoSaf at 0.05% from d 0 to 10 and 0.025% from d 10 to 24; or DFM 2, 0.10% MicroSaf from d 0 to 38 and NucleoSaf at 0.05% from d 0 to 10 and 0.025% from d 10 to 24). Data were analyzed using linear mixed models using the nlme package of R with fixed effects of sow treatment, nursery treatment, and their interaction, and nursery room serving as the random effect. During the first ten days post-weaning, progeny of sows fed yeast additives had improved ($P < 0.05$) ADG, ADFI, and G:F. In fact, while pigs weaned from sows fed yeast additives entered the nursery at a lighter ($P < 0.001$) BW compared to pigs weaned from sows fed the control diet, by d 10 there was no difference ($P > 0.10$) in BW between the two groups. Offspring from sows fed yeast additives tended to have improved ($P = 0.069$) overall F/G. Pigs fed DFM 2 had increased ($P < 0.05$) ADG from d 24 to 38, and improved end of nursery BW compared to pigs fed the control diet. In conclusion, feeding yeast additives to sows had a positive impact on progeny growth in the early nursery, while the addition of DFMs in nursery diets had more impact on growth later in the nursery period.

Introduction

The post-weaning period is a time of physiological, nutritional, and environmental changes that increases the likelihood of diminished growth, post-weaning diarrhea

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[2] Phileo by Lesaffre, Milwaukee, WI.

(PWD), and mortality.[3] Traditionally, the inclusion of subtherapeutic levels of antibiotics and/or the inclusion of pharmacological levels of Zn have been included in early nursery pig diets to combat the lag in growth and the occurrences of PWD. However, alternative feeding strategies are being explored due to the EU's ban of growth-promoting levels of antibiotics (2006) and restrictions regarding pharmacological levels of Zn (June 2022) as well as the implementation of the veterinary feed directive in the US (2017).

Direct fed microbials (DFM) have been considered an alternative of interest because of their potential to positively modulate gut microflora which may lead to improved immunity, nutrient digestion and absorption, and growth performance.[4] These beneficial attributes may be heightened during a stressful stage of life, such as weaning. Lu et al. (2019) recently reported that feeding *Saccharomyces cerevisiae* through gestation and lactation improved ADG, increased BW, and improved gross energy digestibility of offspring in the nursery.[5] There is limited data exploring the impacts of feeding live yeast and yeast extracts in late gestation through lactation and its impact on subsequent offspring growth performance when feeding varying combinations of DFM. Thus, the objective of this study was to evaluate feeding diets with two different combinations of *Bacillus* spp. and yeast extracts derived from *Saccharomyces cerevisiae* on nursery pigs weaned from sows fed a diet with or without yeast additives on nursery pig growth performance.

Materials and Methods

General

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS, in two nursery rooms. Each room is completely enclosed, environmentally controlled, and mechanically ventilated. Each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide *ad libitum* access to feed and water. Pens (4 × 4 ft) had metal tri-bar floors and allowed approximately 2.7 ft^2/pig.

Animals and treatment structure

A total of 330 weaned pigs (Line DNA 241 × 600, DNA; initially 12.7 ± 0.07 lb BW), progeny of sows fed either a control diet or a diet containing yeast additives from d 110 of gestation through weaning, were used in a 38-d nursery study. Only twelve weaned pigs (6 pigs from each sow treatment) were not included in the nursery study due to being either a "fall behind" needing extra care, or pigs that were well above the average weight at weaning. Pigs within the same sow treatment were randomly allotted to pens, pens were then allotted to treatment with 6 pigs per pen and 8 to 10 replications per treatment.

[3] Pluske, J. R. 2013. Feed- and feed additives-related aspects of gut health and development in weanling pigs. J. Anim. Sci .Biotech. 4:1. doi: 10.1186/2049-1891-4-1.

[4] Liao, S. F., and M. Nyachoti. 2017. Using probiotics to improve swine gut health and nutrient utilization. Animal Nutrition. 3:331-343. doi:10.1016/j.aninu.2017.06.007.

[5] Lu, H., P. Wilcock, O. Adeola, and K. M. Ajuwon. 2019. Effect of live yeast supplementation to gestating sows and nursery piglets on postweaning growth performance and nutrient digestibility. J. Anim. Sci. 97:2534-2540. doi:10.1093/jas/skz150.

Dietary treatments were fed in 3 phases and arranged in a 2 × 3 factorial with main effects of sow treatment (control vs. yeast additives; 0.10% ActiSaf Sc 47 HR+ and 0.025% SafMannan; Phileo by Lesaffre, Milwaukee, WI) and nursery treatment (control; DFM 1, 0.05% of SafMannan from d 0-38 and NucleoSaf at 0.05% from d 0 to 10 and 0.025% from d 10 to 24; or DFM 2, 0.10% MicroSaf from d 0 to 38 and NucleoSaf at 0.05% from d 0 to 10 and 0.025% from d 10 to 24; NucleoSaf, SafMannan, NucleoSaf, and MicroSaf; Phileo by Lesaffre, Milwaukee, WI; Table 1). Thus, a third of the pigs from each sow group were fed either a control diet, a diet with the DFM 1 additives, or a diet with the DFM 2 additives. The DFM 1 additives included a yeast cell wall fraction with concentrated mannan-oligosaccharides and β-glucans from *Saccharomyces cerevisiae* (SafMannan), and DFM 2 included a blend of *Bacillus* spp. and yeast extracts (MicroSaf). Both DFM 1 and DFM 2 included a yeast extract containing ≥6% unbound nucleotides from *Saccharomyces cerevisiae* (NucleoSaf). A respiratory disease outbreak occurred from approximately d 8 to 20 of the study; thus, removals were recorded and analyzed (Tables 3 and 4).

Diet preparation

Pigs were fed phase 1 diets from placement until d 10, phase 2 diets were fed from d 10 to 24, and phase 3 diets were fed from d 24 to 38 (Table 2). Phase 1 diets were formulated to 1.40% standardized ileal digestible (SID) Lys and phase 2 and 3 diets were formulated to 1.35% SID Lys. All other nutrients were formulated to meet or exceed NRC (2012)[6] requirement estimates. The phase 1 control diet was manufactured by a commercial feed mill (Hubbard Feeds; Beloit, KS) then DFM 1 and DFM 2 were added at their respective amounts for phase 1 and mixed at the O.H. Kruse Feed Technology Innovation Center (Manhattan, KS). All phase 2 and 3 diets were manufactured by the same commercial feed mill with the DFMs added at the expense of corn. Feed samples were collected from every fourth, 50-lb bag using a feed probe to obtain a representative sample for each respective diet and phase. All three phases were fed in meal form. Pens of pigs were weighed, and feed disappearance recorded weekly to determine ADG, ADFI, and F/G. Feed efficiency was expressed as G:F from d 0 to 10 due to the high number of removals and pigs that lost weight, which inflated F/G.

Statistical analysis

Growth performance data were analyzed using the nlme package of R (Version 4.0.0, R Foundation for Statistical Computing, Vienna, Austria) with pen serving as the experimental unit. Fixed effects included sow treatment, nursery treatment, and their interaction with nursery room serving as the random effect. The proportion of pigs removed from test pens was analyzed using binomial distribution. The main effects of sow treatment and nursery treatment, as well as their interactions, were tested. Differences between treatments were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

There were no interactions observed between previous sow treatment and nursery treatment (Table 3). Thus, the main effects of sow and nursery treatment are reported (Table 4).

[6] National Research Council. 2012. Nutrient Requirements of Swine: Eleventh Revised Edition. Washington, DC: The National Academies Press. doi:10.17226/13298.

In phase 1 (d 0 to 10), pigs weaned from sows fed yeast additives had increased ($P < 0.05$) ADG, ADFI, and G:F. Offspring from the sows fed yeast additives had lighter BW at weaning ($P < 0.001$) compared to the control sows' progeny; however, by d 10 there was no difference ($P = 0.753$) in nursery pig BW between the two sow treatments. There was no evidence for difference ($P > 0.10$) for nursery dietary treatment on any growth criteria from d 0 to 10. In phase 2 (d 10 to 24), there was no evidence ($P > 0.10$) for difference for either sow or nursery treatments on any of the response criteria.

In phase 3 (d 24 to 38), there was a tendency ($P = 0.090$) for increased ADFI for progeny of sows that were fed the control diet. Interestingly, pigs fed the DFM 2 treatment in the nursery had increased ($P < 0.05$) ADG and greater ($P < 0.05$) d 38 BW compared to the control treatment, with pigs fed DFM 1 being intermediate. There was no difference ($P > 0.05$) for previous sow treatment or nursery treatment on F/G.

For the overall period (d 0 to 38), a tendency ($P = 0.069$) was observed for improved F/G of offspring from sows fed yeast additives from d 110 of gestation through weaning. As mentioned previously, pigs fed the DFM 2 treatment in the nursery had greater ($P < 0.05$) ending BW compared to the control treatment with pigs fed DFM 1 intermediate. Regardless of dietary treatment, there was no difference ($P > 0.05$) in ADG or ADFI for the overall period. There was no evidence for statistical difference ($P > 0.10$) for the percentage of removals between treatments in this study.

In conclusion, feeding yeast additives from d 110 of gestation through lactation improved progeny nursery growth performance from d 0 to 10 post-weaning and improved overall F/G. Additionally, feeding DFM 2 in nursery diets improved final BW compared to pigs not fed a DFM. Thus, the addition of yeast additives in sow diets had more impact on offsprings' growth performance in the early nursery phase, while the inclusion of DFMs in the nursery phase had more influence on growth later in the nursery phase.

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Table 1. Nursery direct fed microbials (DFM) inclusion[1]

		DFM 1, %		DFM 2, %	
	Control	SafMannnan	NucleoSaf	MicroSaf	NucleoSaf
Phase 1 (d 0-10)	---	0.05	0.05	0.10	0.05
Phase 2 (d 10-24)	---	0.05	0.025	0.10	0.025
Phase 3 (d 24-38)	---	0.05	---	0.10	---

[1]Nursery treatment is explained regardless of sow treatment. Pigs were weaned from sows fed either a control diet or a diet that contained yeast extracts then fed one of the three nursery treatments.

Table 2. Diet composition (as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3
Ingredients, %			
Corn	44.15	56.75	64.75
Soybean meal (46.5% CP)	18.20	25.85	31.30
Whey powder	25.00	10.00	---
Fish meal	4.50	2.00	---
Enzymatically-treated soybean meal[2]	3.75	---	---
Corn oil	1.50	1.50	---
Calcium carbonate	0.30	0.63	0.85
Monocalcium phosphate (21% P)	0.48	0.85	1.00
Salt	0.30	0.55	0.60
L-Lys-HCl	0.43	0.51	0.52
DL-Met	0.22	0.22	0.21
L-Thr	0.18	0.22	0.22
L-Trp	0.07	0.06	0.06
L-Val	0.13	0.15	0.13
L-Ile	---	0.02	---
Vitamin premix with phytase[3]	0.25	0.25	0.25
Trace mineral premix[4]	0.15	0.15	0.15
Zinc oxide	0.40	0.27	---
DFM[5]	±	±	±
Total	100	100	100

continued

Table 2. Diet composition (as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3
Calculated analysis			
SID amino acids, %			
Lys	1.40	1.35	1.35
Ile:Lys	56	55	55
Leu:Lys	109	110	114
Met:Lys	38	37	36
Met and Cys:Lys	57	57	57
Thr:Lys	63	63	63
Trp:Lys	20.6	20.0	20.3
Val:Lys	69	69	69
His:Lys	32	34	36
Total Lys, %	1.54	1.49	1.49
ME, kcal/lb	1,551	1,530	1,488
NE, kcal/lb	1,169	1,147	1,099
SID Lys:NE, g/Mcal	5.43	5.34	5.57
CP, %	20.9	20.3	21.2
Ca, %	0.69	0.70	0.69
P, %	0.68	0.64	0.61
STTD P, %	0.63	0.57	0.50

[1] Phase 1 diets were fed from d 0 to 10 (approximately 12.7 to 13.6 lb BW), phase 2 diets were fed from d 10 to 24 (approximately 13.6 to 29.2 lb BW), and phase 3 diets were fed from d 24 to 38 (approximately 29.2 to 47.5 lb BW). All diets were manufactured by Hubbard Feeds (Beloit, KS).

[2] HP 300, Hamlet Protein, Findlay, OH.

[3] Ronozyme HiPhos GT 2700 (DSM Nutritional Products, Parsippany, NJ) provided 918 FTU/lb and an expected STTD P release of 0.16% STTD P in phases 1 and 2, and 566 FTU/lb with an estimated P release 0.14% STTD P in phase 3. Provided per lb of premix: 750,000 IU vitamin A; 300,000 IU vitamin D; 8,000 IU vitamin E; 600 mg vitamin K; 6 mg vitamin B_{12}; 9,000 mg niacin; 5,000 mg pantothenic acid; and 1,500 mg riboflavin.

[4] Provided per lb of premix: 73 g Zn from zinc sulfate; 73 g Fe from iron sulfate; 22 g Mn from manganese oxide; 11 g Cu from copper sulfate; 0.2 g I from calcium iodate; and 0.2 g Se from sodium selenite.

[5] The direct fed microbials (DFM) 1 additive included a yeast-extract blend with SafMannan (0.05% in phases 1, 2, and 3) and NucleoSaf (0.05% in phase 1, 0.025% in phase 2, and 0% in phase 3). The DFM 2 additive included a *Bacillus* spp. and yeast-extract blend with MicroSaf (0.10% in phases 1, 2, and 3), and NucleoSaf (0.05% in phase 1, 0.025% in phase 2 and 0% in phase 3). SafMannan, NucleoSaf, and MicroSaf; Phileo by Lesaffre, Milwaukee, WI.

Table 3. Interactive effects of sow and nursery pig dietary treatment on growth performance of nursery pigs[1]

Sow treatment:[2]	Control			Yeast				*P* =		
Nursery treatment:	Control	DFM 1[3]	DFM 2[4]	Control	DFM 1	DFM 2	SEM	Sow	Nursery	Sow × nursery
BW, lb										
d 0	13.0	13.0	13.0	12.4	12.5	12.4	0.07	< 0.001	0.738	0.722
d 10	14.4	14.9	14.8	14.7	14.7	14.6	0.25	0.753	0.498	0.399
d 24	28.4	29.4	29.5	28.9	29.5	29.6	0.56	0.591	0.206	0.930
d 38	46.3	47.7	48.3	46.3	48.0	48.4	0.82	0.800	0.028	0.969
Phase 1 (d 0 to 10)										
ADG, lb	0.13	0.18	0.18	0.22	0.22	0.22	0.024	0.003	0.508	0.428
ADFI, lb	0.25	0.30	0.29	0.31	0.34	0.34	0.021	0.002	0.103	0.850
F/G[5]	1.88	1.67	1.57	1.40	1.59	1.53	---	---	---	---
G:F	0.49	0.60	0.62	0.70	0.62	0.64	0.048	0.023	0.680	0.081
Phase 2 (d 10 to 24)										
ADG, lb	0.97	1.03	1.02	1.00	1.01	1.04	0.028	0.815	0.235	0.559
ADFI, lb	1.23	1.35	1.32	1.29	1.30	1.34	0.038	0.738	0.117	0.333
F/G	1.27	1.30	1.29	1.29	1.29	1.30	0.018	0.750	0.548	0.530
Phase 3 (d 24 to 38)										
ADG, lb	1.27	1.30	1.34	1.24	1.32	1.32	0.030	0.553	0.033	0.685
ADFI, lb	1.97	1.98	2.00	1.89	1.96	1.94	0.041	0.090	0.533	0.613
F/G	1.55	1.52	1.50	1.53	1.49	1.47	0.026	0.179	0.064	0.992
Overall (d 0 to 38)										
ADG, lb	0.84	0.91	0.91	0.88	0.90	0.91	0.023	0.596	0.094	0.599
ADFI, lb	1.22	1.30	1.28	1.25	1.27	1.27	0.030	0.811	0.730	0.632
F/G	1.45	1.43	1.42	1.42	1.41	1.40	0.017	0.069	0.307	0.809
Removals, %	7.4	1.7	5.6	2.1	7.4	10.0	3.87	0.625	0.402	0.179

[1] A total of 330 pigs (initially 12.7 ± 0.07 lb BW) were used in a 38-d nursery trial with 6 pigs per pen and 8 to 10 pens per treatment. Pigs were weaned at approximately 19 d of age and allotted to treatment in completely randomized design. Dietary treatments were arranged in a 2 × 3 factorial with main effects of sow treatment (control or yeast additives) and nursery pig treatment (control, DFM 1, or DFM 2).

[2] Sow treatment consisted of providing a control diet or a yeast-based pre- and probiotic diet supplemented with Actisaf Sc 47 HR+ at 0.10% and SafMannan at 0.03% (Phileo by Lesaffre, Milwaukee, WI) from d 110 of gestation until weaning.

[3] The direct fed microbials (DFM) 1 additive included a yeast-extract blend with SafMannan (0.05% in phases 1, 2, and 3) and NucleoSaf (0.05% in phase 1, 0.025% in phase 2, and 0% in phase 3); Phileo by Lesaffre, Milwaukee, WI.

[4] The DFM 2 additive included a *Bacillus* spp. and yeast-extract blend with MicroSaf (0.10% in phases 1, 2, and 3) and NucleoSaf (0.05% in phase 1, 0.025% in phase 2, and 0% in phase 3); Phileo by Lesaffre, Milwaukee, WI.

[5] Feed-to-gain was calculated from ADFI and ADG treatment LS Means. Therefore, statistical analysis was not conducted for F/G. For the statistical outcome of feed efficiency, refer to G:F.

Table 4. Main effects of sow and nursery pig dietary treatment on growth performance of nursery pigs[1]

	Sow treatment[2]				Nursery treatment				
Item	**Control**	**Yeast**	**SEM**	***P* =**	**Control**	**DFM 1[3]**	**DFM 2[4]**	**SEM**	***P* =**
BW, lb									
d 0	13.0	12.4	0.04	< 0.001	12.7	12.7	12.7	0.05	0.738
d 10	14.7	14.6	0.13	0.753	14.5	14.8	14.7	0.17	0.498
d 24	29.1	29.3	0.31	0.591	28.7	29.5	29.5	0.85	0.206
d 38	47.4	47.6	0.45	0.800	46.3[b]	47.9[ab]	48.3[a]	0.56	0.028
Phase 1 (d 0 to 10)									
ADG, lb	0.17	0.22	0.013	0.003	0.18	0.20	0.20	0.016	0.508
ADFI, lb	0.28	0.33	0.012	0.002	0.28	0.32	0.31	0.015	0.103
F/G[5]	1.70	1.51	---	---	1.58	1.63	1.55	---	---
G:F	0.57	0.66	0.026	0.023	0.59	0.61	0.63	0.033	0.680
Phase 2 (d 10 to 24)									
ADG, lb	1.01	1.01	0.015	0.815	0.99	1.02	1.03	0.019	0.235
ADFI, lb	1.30	1.31	0.021	0.738	1.26	1.32	1.33	0.026	0.117
F/G	1.29	1.29	0.010	0.750	1.28	1.30	1.29	0.012	0.548
Phase 3 (d 24 to 38)									
ADG, lb	1.31	1.29	0.016	0.553	1.26[b]	1.31[ab]	1.33[a]	0.021	0.033
ADFI, lb	1.98	1.93	0.022	0.090	1.93	1.97	1.97	0.028	0.533
F/G	1.52	1.49	0.014	0.179	1.54	1.50	1.48	0.018	0.064
Overall (d 0 to 38)									
ADG, lb	0.89	0.90	0.013	0.596	0.86	0.90	0.91	0.016	0.094
ADFI, lb	1.27	1.26	0.016	0.811	1.23	1.29	1.28	0.021	0.173
F/G	1.43	1.41	0.009	0.069	1.43	1.42	1.41	0.012	0.307
Removals, %	4.1	5.4	2.08	0.625	4.0	3.6	7.5	2.54	0.402

[a,b] Superscripts signify a statistical difference of $P < 0.05$.

[1] A total of 330 pigs (initially 12.7 ± 0.07 lb BW) were used in a 38-d nursery trial with 6 pigs per pen and 8 to 10 pens per treatment. Pigs were weaned at approximately 19 d of age and allotted to treatment in completely randomized design. Dietary treatments were arranged in a 2 × 3 factorial with main effects of sow treatment (control or yeast additives) and nursery pig treatment (control, DFM 1, or DFM 2).

[2] Sow treatment consisted of providing a control diet or a yeast-based pre- and probiotic diet supplemented with Actisaf Sc 47 HR+ at 0.10% and SafMannan at 0.03% (Phileo by Lesaffre, Milwaukee, WI) from d 110 of gestation until weaning.

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