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Effect of supplementing multiparous sows with xylanase, L-Carnitine and their combination during maternity on litter performance and survivability of piglets#

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Abstract

A nutritional study was conducted using 24 multiparous Large White Yorkshire (LWY) sows maintained at the Centre for Pig Production and Research (CPPR), Mannuthy from 75th day of gestation till weaning (42nd day of farrowing) to evaluate the effect of supplementing feed additives during maternity on litter performance and survivability of piglets. Experimental animals were grouped into four dietary treatments of six animals each, following the completely randomised design. Control diet (C) was formulated as per NRC, 2012 (3300 kcal ME/kg feed and 18 per cent crude protein). The other three dietary treatments were prepared by fortification of C with additives viz., L-Carnitine at 50 mg/kg diet (C+c), xylanase at 0.01 per cent level (C+x) and a combination of both L-Carnitine at 50 mg/kg diet and xylanase at 0.01 per cent level (C+c+x). All sows received experimental diets from the 75th day of gestation to four weeks after farrowing. The experimental animals were maintained on farm rations until weaning, thereafter. Litter size and litter weight were recorded at birth and weekly intervals until weaning. All observed indices on litter performance did not differ among the four treatment groups. Average piglet weight and survivability did not differ among the four dietary treatment groups during the first recording during the experiment, as well as during the last recording at the weaning stage. From the overall results of the experiment, it could be inferred that supplementation of maternal diets with L- L-Carnitine at 50 mg/kg diet or xylanase at 0.01 per cent level or the combination of both could not improve the overall litter performance and survivability of LWY piglets.

Keywords: *Xylanase, L-Carnitine, multiparous sows, survivability, litter performance, LWY*

An improvement in swine population from 51,000 in 2012 to 1,01,000 in 2019 (DAHD, 2019) reveals the amplified preference for pork as a meat source in Kerala, and swine farming has gained momentum to transform into an industry (Keyho *et al*., 2018). Commercial pig farming provides better economic returns due to its unique characteristics like better-feed conversion efficiency, early maturity, short generation interval and high fecundity (Ambily *et al*., 2021). Swine

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farming could be economically viable only if sows are hyper-prolific and farrow twice a year to yield at least twenty piglets per sow per year at weaning. A swine reproductive cycle spreads through estrus, breeding, gestation, farrowing, lactation and weaning before switching to the subsequent reproductive cycle. A smooth transition needs to be ensured between different stages of an existing reproductive cycle as well as between subsequent reproductive cycles. Adequacy of dietary energy is a key factor that could ensure transitions during maternity (van den Brand, 2000). Carbohydrates and fats are widely used in swine diets as sources of energy. Utilization of these energy sources are enhanced by addition of specific feed additives *viz*., xylanase (enzyme) that were known to enhance availability of carbohydrates from cereals (Valli *et al*., 2011) and L–Carnitine (lipotrophic factor) that improves utilisation of fatty acids from fat rich diets (Owen *et al*., 2001) or their combinations in feed. Consequently, the effect of supplementing high-energy maternal diets of sows with feed additives, *viz*., xylanase, L-Carnitine and their combinations, warranted an investigation in the farm scenario that exists in Kerala. The present study, therefore, aimed to assess the effect of supplementing the maternal diets of sows with xylanase, L-Carnitine, or their combinations used as feed additives and the effect on litter performance and survivability.

Materials and methods

Twenty-four Large White Yorkshire (LWY) sows (parity between two to five) that screened positive for pregnancy using an ultrasonic pregnancy detector (Draminski, Poland) were selected after 70 days of breeding from the Centre for Pig Production and Research (CPPR), Mannuthy and were grouped into four dietary treatments, having six animals each *viz.,* Control diet (C), C+c, C+x, C+c+x using completely randomised design. Diet C was formulated as per NRC, 2012 (3300 kcal ME/kg feed and 18 per cent crude protein). Other three experimental diets were formulated by fortification of control diet with additives *viz.,* L-Carnitine at 50 mg/kg diet (C+c), xylanase at 0.01 per cent level (C+x) and combination of both L-Carnitine at 50 mg/kg diet and xylanase at 0.01 per cent level (C+c+x) as shown in Table 1. All sows included in the present study received experimental diets from the 75th day of gestation until four weeks after farrowing and later maintained on farm rations until weaning of piglets away from the respective sows on the 42nd day after farrowing. Litter performance and survivability of piglets were recorded on a weekly basis as part of the present study up to weaning. Litter size at birth was measured by counting the number of piglets that were born alive and found viable within an hour after the farrowing of the last piglet by the sow, and it was recorded once during every subsequent week until weaning. Litter weight at birth was measured by totalling the weights of all individual piglets in a litter, and it was recorded once every week until weaning subsequently. Average piglet weight was recorded from birth until weaning in all litters. Survivability was considered as a proportion of piglets that survived during each progressive week and was calculated as a fraction of the number of piglets born to the number of piglets that survived from the first to sixth week.

Statistical analysis of data collected on various parameters of the study was done using One Way Analysis of Variance (ANOVA). Means were compared with Duncan's Multiple Range Test. Comparisons were done as per Snecdecor and Cochran (1994) and using Statistical Product and Service Solutions (SPSS) (Version 24.0).

Results and discussion

The litter size observed in the present study is presented in Table 2. The litter size recorded in four dietary treatment groups, *viz.,* C, C+c, C+x and C+c+x was 10.33, 10.50, 10.67 and 10.50, respectively, on the day of farrowing. It had reduced to 9.33, 9.67, 9.67 and 9.67, respectively, during weaning on the 42nd day of farrowing. There was no variation ($p>0.05$) among the four dietary treatment groups with regard to litter size at birth as well as during subsequent weeks. Dietary supplementation of xylanase and L-Carnitine did not influence litter size of sows (Eder *et al.*, 2001; Zhou *et al.*, 2018), and the results of the present study were in agreement with the same. However, Rooney *et al.* (2020) had observed that L-Carnitine supplementation during gestation could increase litter size at birth, and the same was not observed during the present study. Additives were expected to provide more available energy, but the results of the present study contradicted the findings of Long *et al.* (2010), who had observed increased litter size with an increase in energy availability in diets of sows. Litter size at birth and at 42nd day of farrowing ranged from 9.60 to 10.00 and 7.38 to 7.75 (Thiruveni, 2003), 9.60 to 11.20 and 7.00 to 9.00 (Tripura, 2018) and 10 to 10.83 and 6.17 to 8.17 (Lokhande, 2020), respectively. The present study had documented a litter size that ranged from 9.50 to 9.67 on the 28th day of farrowing, as against 9.21 to 10.64 recorded in multiparous sows earlier (Zang *et al*., 2014).

Table 1. Dietary treatments of experimental animals

Group	Experimental Treatments
C	Gestational and lactation diet (NRC, 2012) with 3300 kcal ME/kg diet and 18 % CP - (Control)
C+c	Control + 50 mg L-Carnitine/ kg diet
C+x	Control + 0.01 % xylanase [containing 16000 BXU per kg]
C+c+x	Control + 50 mg L-Carnitine/ kg diet + 0.01 % xylanase

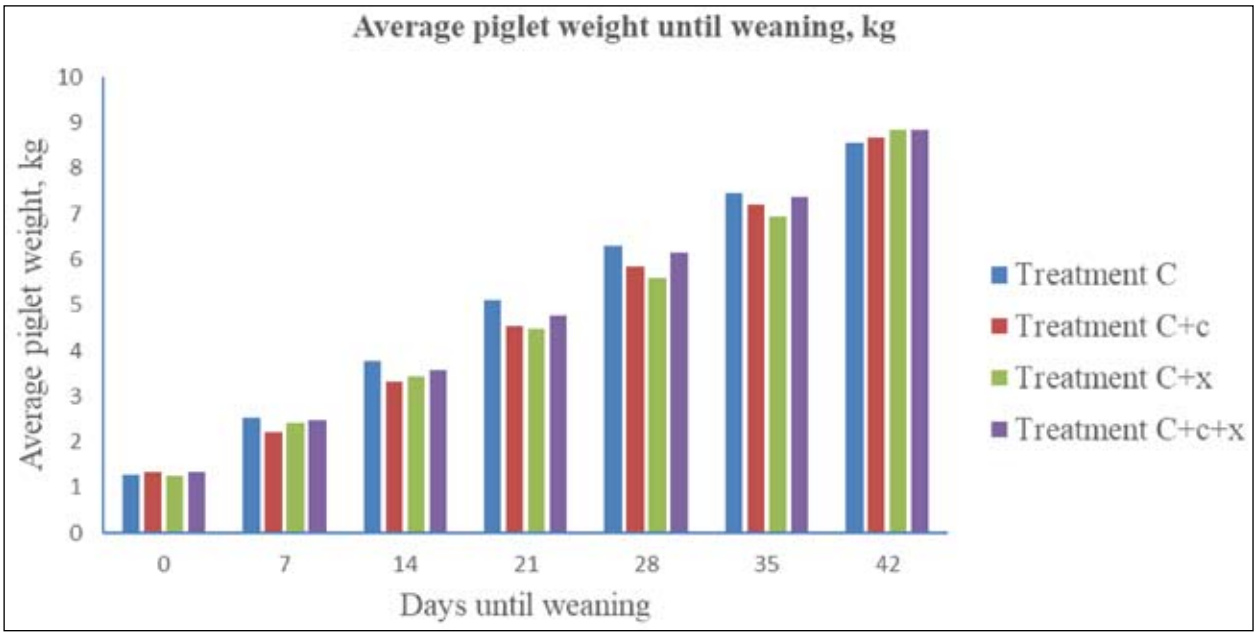

Fig. 1. Average piglet weight among litters of sows maintained on four dietary treatments, kg

Table 2. Litter size of sows maintained on four dietary treatments

Days	Treatments[1]				p value
	C	C+c	C+x	C+c+x	
0	10.33 ± 0.88	10.50 ± 0.56	10.67 ± 0.56	10.50 ± 0.22	0.984
7	9.83 ± 0.70	9.83 ± 0.54	9.67 ± 0.42	9.83 ± 0.17	0.993
14	9.50 ± 0.67	9.67 ± 0.49	9.67 ± 0.42	9.67 ± 0.21	0.993
21	9.50 ± 0.67	9.67 ± 0.49	9.67 ± 0.42	9.67 ± 0.21	0.993
28	9.50 ± 0.67	9.67 ± 0.49	9.67 ± 0.42	9.67 ± 0.21	0.993
35	9.33 ± 0.67	9.67 ± 0.49	9.67 ± 0.42	9.67 ± 0.21	0.946
42	9.33 ± 0.67	9.67 ± 0.49	9.67 ± 0.42	9.67 ± 0.21	0.946

[1]Mean of six values with SE

Table 3. Litter weight of sows maintained on four dietary treatments, kg

Days	Treatments[1]				p value
	C	C+c	C+x	C+c+x	
0	13.08 ± 0.98	13.87 ± 0.78	13.45 ± 0.67	13.91 ± 0.45	0.840
7	24.84 ± 2.18	21.73 ± 1.08	23.18 ± 0.95	24.29 ± 1.01	0.426
14	35.47 ± 2.04	32.12 ± 1.66	33.06 ± 0.81	34.56 ± 1.33	0.432
21	47.82 ± 1.95	43.95 ± 2.49	42.89 ± 1.28	46.01 ± 1.33	0.262
28	59.44 ± 3.60	56.16 ± 2.57	53.61 ± 2.26	59.45 ± 2.11	0.372
35	69.22 ± 4.50	69.43 ± 3.21	66.40 ± 3.50	71.43 ± 3.43	0.815
42	79.65 ± 5.10	83.57 ± 4.04	84.79 ± 4.23	85.78 ± 4.97	0.796

[1]Mean of six values with SE

The litter weight observed in the current study is presented in Table 3. The mean litter weight of piglets increased linearly from birth to the sixth week. The litter weight recorded in the four dietary treatment groups, *viz.,* C, C+c, C+x and C+c+x, were 13.08, 13.87, 13.45 and 13.91 kg, respectively, immediately after farrowing. It increased linearly to 79.65, 83.57, 84.79 and 85.78 kg, respectively, during weaning. There was no variation ($p>0.05$) noted among treatment groups with regard to litter weight at birth and during any subsequent week where it was recorded. Lokhande (2020) had reported a litter weight at birth that ranged from 13.03 to 14.66 kg and litter weight at weaning that ranged from 49.98 to 62.15 kg earlier. Results of the present study were in agreement with previous studies where supplementation of sow diets with L-Carnitine and xylanase had not brought forth any changes in litter weight of sows (Eder *et al.,* 2001; Zhou *et al.,* 2018; Rooney *et al*., 2020).

Table 4. Average piglet weight among sows maintained on four dietary treatments, kg

Days	Treatments[1]				p value
	C	C+c	C+x	C+c+x	
0	1.27 ± 0.03	1.32 ± 0.01	1.26 ± 0.02	1.33 ± 0.05	0.334
7	2.53 ± 0.13	2.22 ± 0.09	2.40 ± 0.07	2.47 ± 0.11	0.198
14	3.76^{a} ± 0.12	3.33^{b} ± 0.06	3.44^{b} ± 0.10	3.58^{ab} ± 0.12	0.040*
21	5.10 ± 0.24	4.54 ± 0.08	4.47 ± 0.21	4.76 ± 0.10	0.068
28	6.30 ± 0.20	5.83 ± 0.16	5.60 ± 0.34	6.15 ± 0.18	0.165
35	7.45 ± 0.18	7.21 ± 0.24	6.94 ± 0.50	7.38 ± 0.28	0.687
42	8.56 ± 0.12	8.67 ± 0.25	8.84 ± 0.55	8.86 ± 0.41	0.929

[1]Mean of six values with SE,

*[a-b] Means with different superscript within row differ significantly ($p<0.05$)

Table 5. Survivability of piglets of sows maintained on four dietary treatments

Days	Treatments[1]				p value
	C	C+c	C+x	C+c+x	
7	0.96 ± 0.02	0.94 ± 0.02	0.91 ± 0.02	0.94 ± 0.02	0.425
14	0.93 ± 0.04	0.92 ± 0.02	0.91 ± 0.02	0.92 ± 0.02	0.951
21	0.93 ± 0.04	0.92 ± 0.02	0.91 ± 0.02	0.92 ± 0.02	0.951
28	0.93 ± 0.04	0.92 ± 0.02	0.91 ± 0.02	0.92 ± 0.02	0.951
35	0.91 ± 0.04	0.92 ± 0.02	0.91 ± 0.02	0.92 ± 0.02	0.980
42	0.91 ± 0.04	0.92 ± 0.02	0.91 ± 0.02	0.92 ± 0.02	0.980

[1]Mean of six values with SE

The average piglet weight that was calculated during the present study is shown in Table 4 and represented as Fig. 1. Average piglet birth weight recorded in the four dietary treatment groups, *viz.,* C, C+c, C+x and C+c+x, were 1.27, 1.32, 1.26 and 1.33 kg, respectively, and average piglet weight recorded at weaning (42nd day after farrowing) was 8.56, 8.67, 8.84 and 8.86 kg, respectively. The present study did not record any changes in the average birth weight of piglets from birth to weaning among the four treatment groups, except during the second week. Average piglet weight during the second week of recording was higher ($p<0.05$) among sows receiving dietary treatment C than those receiving C+c and C+x, while it was similar to all other dietary treatment groups in sows receiving C+c+x diets. Results of present study were in agreement with findings of Liu *et al.* (2020) as they too had reported feeding of energy rich diets not to result in a corresponding increase in birth weight of piglets but contradicted the findings of Ramanau *et al*. (2002) as they had observed that L-Carnitine supplementation significantly increased average piglet birth weight compared to control. Thiruveni (2003) had reported piglet weight at birth to range between 1.38 to 1.54 kg and piglet weight at weaning to range from 7.96 to 8.95 kg. Tripura (2018) had reported piglet weight at birth to range between 1.35 to 1.46 kg and piglet weight at weaning to range from 8.25 to 8.88 kg. Lokhande (2020) had reported an average piglet weight at birth that ranged from 1.31 to 1.44 kg and piglet weight at weaning that ranged from 6.07 to 6.89 kg during previous studies.

Survivability observed in the present study is given in Table 5. Survivability recorded in four dietary treatment groups *viz.,* C, C+c, C+x and C+c+x was 0.96, 0.94, 0.91 and 0.94, respectively, in the first week and 0.91, 0.92, 0.91 and 0.92 during the seventh week that coincided with the date of weaning. There was no difference ($p>0.05$) in survivability among dietary treatment groups from the first to the seventh week of recording. Average mortality of piglets per sow ranged from 16.72 to 21.74 per cent (Thiruveni, 2003), and the survival rate that was observed ranged from 63.14 to 76.27 per cent (Lokhande, 2020). Gokuldas *et al*. (2015) listed diarrhoea, pneumonia, crushing under sow and chills as major reasons of pre-weaning mortality. Piglet survivability depended on factors, *viz.,* placental size (Roehe and Kalm, 2000), birth weight (Walkr *et al*., 1981) and colostrum yield (Foisnet *et al*., 2010; Decaluwe *et al*., 2013; Devillers *et al*., 2011). It could be concluded that the decent survivability recorded during the present study among all treatment diets that were comparable to those reported by Ramanau *et al*. (2004) and Xin *et al.* (2020) could be attributed to the improved health status of sows included in the experiment on account of superior maternal diets.

Conclusion

From the overall results, it could be concluded that supplementation of maternal diets with xylanase, L-Carnitine or their combination could not improve the litter performance and survivability of LWY piglets.

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Conflict of interest

The authors declare that they have no conflict of interest.

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