EFFECT OF DIETARY SUPPLEMENTATIONS ON BODY CONDITION SCORE, OCCURRENCE OF POST PARTURIENT DYSGALACTIA SYNDROME, LITTER PERFORMANCE AND SERUM BIOCHEMICAL PROFILE IN TRANSITION SOWS

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ABSTRACT

The aim of the present study was to investigate the effect of different dietary supplementations in periparturient sow diet on the occurrence of post parturient dysgalactia syndrome (PDS), body condition score (BCS), litter performance and serum biochemical profile. Forty-eight pregnant multiparous crossbred sows (Hampshire × Ghungroo) were randomly divided into four groups (12 sows per group) 30 days before expected date of farrowing as control (Basal diet); probiotics (Basal diet + Probiotics); Vitamin E-selenium and aminoacids (Basal diet + VES-AA) and calcium-vitamin (Basal diet + Cal-Vit). The results of the study revealed that the occurrence of PDS was lowest ($p<0.05$) in VES-AA than the Probiotic and Cal-Vit mix groups. The incidence of still birth and piglet scour were significantly lower ($p<0.05$) in VES-AA and Cal-Vit mix groups as compared to probiotic and control groups. A significantly lower ($p<0.05$) incidence of piglet mortality was noted in VES-AA group than and probiotic, Cal-Vit mix and control groups. The mean BCS was significantly decreased ($p<0.05$) on day 15 and 45 after farrowing than the value of day -15 in all the groups and the mean BCS was significantly higher ($p<0.05$) on day 45 in probiotic, VES-AA, Cal-Vit mix than control group. The piglet performance and weaning to estrus interval sows were not affected across the groups. Similarly, mean serum biochemical parameters did not alter throughout the study period in all the groups. From the findings of the present study, it is concluded that the dietary vitamin E- selenium along with amino acid supplementations from late gestation to throughout lactation could contribute, at least in part, to decrease the occurrence of PDS of sow, incidence of still birth, piglet scour and mortality.

Key words: sows; dysgalactia; supplementation; litter performance; body condition score.

INTRODUCTION

Successful farrowing, a critical event in any swine production farm, is essential for good health and welfare of the sow and is reflected in her ability to produce a healthy litter of piglets. Any farrowing difficulties or reduced milk production impedes the profitability of farm due to higher pre-weaning piglet losses (Peltoniemi and Oliviero 2015, Ison *et al.* 2018). Now a days, postparturient dysgalactia syndrome (PDS) has emerged as prominent reproductive barriers due to increased intensiveness of sow breeding practices (Niemi *et al.* 2017) and deprives the newborn piglet suckling adequate milk leading to mortality of piglets. Among the various risk factors, nutrition is a significant factor in the development of PDS. Therefore, strategic manipulation of diet in periparturient sows could be a valid approach to prevent the post parturient health disorder of sows and improve productivity of sows after farrowing (Papadopoulos *et al.* 2010).

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Much has been learnt about the beneficial effects of probiotics supplementation in gestational sows to improve health and productivity of lactaional sows (Hayakawa *et al.* 2016, Link *et al.* 2016). Recently, it has been documented that probiotics supplementation in sow diet during late pregnancy and lactation partially alleviated the adverse effects of stress and improved the lactation performance of sows without influencing reproductive performance, and colostrum and milk composition (Chen *et al.* 2020). However, less is known about the effects of feeding of pre and probiotics, vitamins and calcium along with functional amino acids to sows from late gestation to lactation on body condition score, occurrence of PDS, litter performance and certain serum biochemical profile in sows.

Therefore, it was hypothesized that supplementations of probiotics, vitamins and calcium, along with functional amino acids to sow diet during transition period from late gestation to lactation till weaning can reduce the occurrence of PDS and alleviate the negative impact of post farrowing health disorders, an indicator of occurrence of PDS, low BCS and poor litter performance of sows in a subtropical climate.

MATERIALS AND METHODS

The crossbred sows (Hampshire × Ghungroo) maintained at Pig Production Unit, ICAR- Research complex for North Eastern Hill region, Nagaland Centre, Jharnapani, Nagaland as per the mandate of Mega Seed Project on Pig were selected for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), India.

The probiotic mixture (Tonakind) was procured from Vet Mankind pharmaceuticals, New Delhi, India. The Selenium and vitamin E (Sel-e-vera powder) and Calcium-vitamin mixture (Calcicare gold) was purchased from Brihans Laboratories Pvt. Ltd., Mumbai, India.

The basal diet was formulated according to NRC (2012) to meet the nutrient requirements of pregnant sows weighing 168.16 ± 10.54 kg with CP and ME maintained at 13.5% and 3100 Kcal/Kg.

In total, 48 clinically healthy crossbred (Hampshire × Indigenous Ghungroo) pregnant sows of last trimester, 2-4 parity and mean body weight 168.16 ± 10.54 kg were enrolled in the study and randomly divided into four groups, each group was consisted of 12 sows. The sows of Group I received basal diet and was additionally supplemented with 5.0 gm probiotics mixture/sow/day. The sows of Group II were supplemented with 5.0 gm vitamin E-Selenium-amino acid (VES-AA) mixture/sow/ day in the basal diet whereas; 20 mL calcium- vitamin (Cal-vit) mixture/sow/day was supplemented in basal diet to sows of group III. Twelve sows of Group IV received only basal diet without any additional supplementation and served as control (Table 1). Sows were moved to individual farrowing pen two weeks before expected date of farrowing offered gestation ration @1.5 kg/day/sow up to farrowing and 2.0 kg/day/sow up to 4 days post-farrowing followed by 3.5 kg/day/sow up to weaning. Diets were provided in meal form. Sows and piglets had free access to water throughout the experimental period. Sows in all groups additionally received 150g of jaggery daily in the basal diet during post-farrowing period. The sows were clinically examined daily for their health status by veterinary clinician of the institute. The sows remained in the farm were kept according to common management practices after completion of the study.

Approximately, 6.0 mL blood was collected at early morning from each participant sow by venipuncture of ear vein into vacutainer tubes containing clot activator for separation of serum. Blood samples were collected on day 30 and 15 before expected date of farrowing and thereafter on day 3, 15 and 45 of farrowing. After blood collection, the samples were allowed to clot and centrifuged at 200g for 10 min at 4°C, to separate the serum and stored at -20°C until analysis.

Sows were scored for their body condition according to the technique described by Kaiser *et al.* (2018) on day 30 before expected day of farrowing and on day 15 and 45 after farrowing. Clinically, PDS was defined according to standard method (Martineau *et al.* 2012) and sows was considered PDS+ if at least two of the following clinical criteria were fulfilled within 72 hours of farrowing: a) low feed intake, defined as 'trough not empty within 30 min after feeding', b) evidence of inflammation of the udder, characterized by a subjective assessment of redness, swelling and increased skin temperature, c) rectal temperature e" 39.5 °C. No prematurely farrowing of any sows was present during the study.

The health performance of sows was assessed by recording the data on number of sows showed PDS and days taken by sows to show estrous cycle after weaning. The incidence of still birth (%), piglet scour and mortality were calculated using following formulas:

$$\text{Incidence of still birth (\%)} = \frac{\text{Number of stillborn fetus} \times 100}{\text{Total number of piglet born}}$$

$$\text{Incidence of scour (\%)} = \frac{\text{Number of piglets showed diarrhea} \times 100}{\text{Total number of piglet born}}$$

$$\text{Incidence of mortality (\%)} = \frac{\text{Number of piglets died} \times 100}{\text{Total number of piglet born}}$$

The performance of piglets was evaluated by recording the data on litter size, litter weight, individual piglet weight at birth and on the day of weaning. Liter wise pre-weaning mortality and average daily weight gain was calculated using following formula:

$$\text{Liter wise pre-weaning mortality} = \frac{\text{(No. of piglet died per litter from birth to weaning)}}{\text{No. of litters}}$$

$$\text{Average daily weight gain} = \frac{\text{(Piglet weight at weaning - Piglet weight at birth)}}{\text{Number of days from birth to weaning}}$$

The concentrations of total protein, albumin, total cholesterol (Tc), HDL-total cholesterol (HDL-c), triglyceride (Tg), calcium (Ca) and phosphorus (P) in serum were measured by spectrophotometric method using standard kits (Crest Biosystem, Coral clinical systems, Goa, India).

The significance of the difference between the proportion of still birth, scour and piglet mortality was compared in treatment groups against the control using z-ratio calculated in online VassarStats. The effect of treatment on body condition score, litter traits and serum biochemical parameters was compared using one way ANOVA in SPSS 16.0. All data were presented as mean ±SEM. The difference of mean values for all data analyzed with P<0.05 was set as significant.

RESULTS AND DISCUSSION

The clinical diagnosis and treatment of postpartum dysgalactia syndrome (PDS) in sows are often difficult because the pathogenesis is not fully understood owing to its multiple etiological factors and complex risk factors. Nutrition is a significant factor in the development of PDS, and feeding strategies to sows from gestation to throughout lactation affects the incidence of PDS. The primary objective of this study was to investigate the effects of different dietary supplementations from 30 days prior farrowing to 45 days post farrowing on occurrence of PDS, BCS, sow productivity and serum biochemistry. In the current study, although the occurrence of PDS was lower in supplemented groups as compared to control group but, the occurrence of PDS was lowest (p<0.05) in VES-AA (8.33%) than the probiotic and Cal-Vit mix groups (Table 2). The incidence of still birth and piglet scour was significantly lower (p<0.05) in VES-AA and Cal-Vit mix groups as compared to Pre+pro-biotic and control groups. The incidence of piglet mortality was significantly lower (p<0.05) in VES-AA group than probiotic, Cal-Vit mix and control groups. The incidence of piglet mortality from crushing did not differ significantly across the four groups.

It is reported that dietary supplementation of non-nutritive feed additives improved productive and physiological parameters of livestock (Attia *et al.* 2013, 2016). Mahan (1994) reported that dietary supplementation of vitamin E and selenium in gestating and lactating sows diet significantly reduce the incidence of PDS. They further opined that litter birth and weaning weights were not affected by dietary vitamin E levels provided to the sow but, there was an increased number of pigs born when dietary vitamin E was increased. In earlier studies, reduction of pre-weaning piglet mortality has been reported from dietary vitamin E supplementation during gestation (Pinelli-Saavedra 2003). Similarly, increased dietary aminoacid supplementation during late gestation significantly influences the reproductive performances of sows (Miao *et al.* 2019, Wei *et al.* 2019, Seoane *et al.* 2020). However, dietary supplementation of probiotics did not affect reproductive performance of sows as reported earlier (Chen *et al.* 2020). Earlier researchers have demonstrated that vitamin D and dietary yeast culture supplementation has no significant effect on reproductive performance, and their results are consistent (Kim *et al.* 2010, Lauridsen *et al.* 2010, Shen *et al.* 2017).

The mean BCS was significantly decreased (p<0.05) on day 15 and 45 after farrowing than the value of day -15 in all the groups (Table 3). It might be due to excessive utilization of reserve body fat during lactation-induced negative energy balance (Young *et al.* 2004). During lactation sow feed intake is not sufficient to meet the nutrient requirements for lactation, which leads to mobilization of protein and fat reserves and drop in BCS (Aherne *et al.* 1999; Kim *et al.* 2016). However, no reports are available on the effects of supplementations of probiotics and calcium preparations on BCS. The dietary intake of calcium and phosphorus is of great importance for primiparous sows to support their growth and development of bone and muscle tissues (NRC, 2012).

The mean litter size at birth and weaning, pre-weaning mortality/litter, individual weight at birth and weaning, litter weight at birth and weaning and average daily weight gain of piglets and weaning to estrus interval of sows did not differ significantly in sows of across the groups (Table 4). Similar findings were also recorded in our previous work where, dietary vitamin E and Se supplementations had no influence on average number of piglets/sow at weaning, mean weight of piglet at birth and weaning (Chen *et al.* 2016; Gaykwad *et al.* 2019). The effect of probiotics in sow diet on reproductive performance is widely variable and influenced by duration of supplementation. For example, the *Bacillus* and *Saccharomyces cerevisiae* based probiotics diet to periparturient sows did not influence the reproductive performance of sows (Menegat *et al.* 2019, Chen *et al.* 2020). In contrast, bacillary probiotics supplementations significantly improved the reproductive performance of sows, when the trial was conducted for two full, sequential reproductive cycles from service of the first cycle to weaning of the second cycle (Kritas et al., 2015). Further, it is believed that probiotics are generally host-species specific and more effective if it is naturally occurring in the target species (Dunne *et al.* 1999; Kailasapathy and Chin 2000). In the current study, the dietary supplementations did not affect the serum biochemical profile significantly (Table 5). However, mean albumin concentration was significantly (p<0.05) significantly decreased in VES-AA supplemented group and cholesterol concentrations was significantly (p<0.05) increased on day 45 of farrowing in probiotic supplemented group. It might be due to difference in management and environmental conditions of swine herd or non target species specific probiotics or it warrants longer duration of supplementation in gestational period of sows. Alkhalf et al (2010) reported that total protein, lipids and albumin concentrations were not affected by probiotic supplementation in broiler chickens.

From this study it is concluded that dietary vitamin E- selenium along with amino acid supplementations from late gestation to throughout lactation could contribute, at least in part, to decrease the occurrence of PDS of sow, incidence of still birth, piglet scour and mortality. However, further investigation should focus on dietary supplementations of Vitamin E- selenium along with amino acid to whole gestational period to obtain full benefits for improving sow's reproductive performance and reducing pre-weaning piglet mortality.

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Table 1. Dietary supplementation protocols in periparturient sows during one month pre-farrowing till weaning

Groups (n=12/Gr.)	Treatment	Composition	Dose rate
Gr. I	Pre+ probiotic (Tonakind powder, Vet mankind pharma)	Each gm contains : Saccharomyces cerevisiae 8 billion CFU; Lactobacillus acidophilus 240 million CFU; Lactobacillus sporogenes 240 million CFU; Bacillus subtilis 480 million CFU; Bacillus licheniformis 480 million CFU; Fructo Oligo Saccharide 40 mg; Mannan Oligo Saccharide 40 mg	5 g/ day
Gr. II	Selenium + Vit. E (Sel-e-vera powder, (Brihans Laboratories Pvt. Ltd.)	Each gram contains: Vitamin E 100 mg; Selenium 200 mcg; L-Lysine 8 mg; DL-Methionine 5 mg; L-Tryptophan 200 mcg; Aloe Vera 200 mcg	5 g/day
Gr. III	Calcium (Calcicare gold, Brihans Laboratories Pvt. Ltd)	Each mL contains: Calcium 35 mg; Phosphorous 17.5 mg; Vitamin D3 150 IU; Vitamin B_{12} 2 mcg; Carbohydrates 400 mg	20 ml/day
Gr. IV	Control	No supplementation	-

Proximate composition of basal diet consists of CP: 13.5%; ME: 3100 Kcal/Kg; EE: 6%; NDF: 28.5%; ADF: 7.1% and Ash:4.5%.

Table 2. Seasonal influence and impact of dietary supplementation on occurrence of post farrowing disorders in sows (n=12/Gr.).

Attributes	Gr. I	Gr. II	Gr. III	Gr. IV
Incidence of PDS (%)	41.67^{a}	8.33^{b}	25.00^{a}	50.00^{a}
Incidence of still birth (%)	11.40^{a}	5.56^{b}	5.74^{b}	12.82^{a}
Incidence of piglet diarrhoea (%)	4.39^{a}	12.96^{b}	13.11^{b}	42.74^{c}
Piglet mortality (%)	28.95^{a}	13.89^{b}	22.95^{a}	30.77^{a}
Incidence of piglet mortality due to crushing (%)	10.53	8.33	13.93	13.68

The proportion data of each treatment was compared against the control using Z test. Level of significance was set at P<0.05.

Table 3. Effect of dietary supplementation on body condition score in periparturient sows (n=12/Gr.)

Treatment groups	Day -30	Day +15	Day +45
Gr. I	$3.38{\pm}0.13^{A}$	$3.04{\pm}0.10^{B}$	$2.71{\pm}0.07^{Cab}$
Gr. II	$3.21{\pm}0.14^{A}$	$2.88{\pm}0.11^{B}$	$2.58{\pm}0.08^{Bab}$
Gr. III	$3.29{\pm}0.13^{A}$	$3.04{\pm}0.10^{AB}$	$2.75{\pm}0.08^{Ba}$
Gr. IV	$3.41{\pm}0.13^{A}$	$3.05{\pm}0.11^{B}$	$2.45{\pm}0.11^{Cb}$

Treatment effect and days effect was compared using one way ANOVA. Values with different superscript in a row (A,B, C) and column (a,b) differ significantly (p<0.05). Data presented as mean ±SEM.

Table 4. Impact of dietary supplementation during periparturient period on piglet performance and weaning to estrus interval in sows (n=12/Gr.).

Attributes	Gr. I	Gr. II	Gr. III	Gr. IV
Litter size at birth	9.50±0.99	9.00±1.02	10.17±0.72	9.75±0.1.01
Litter size at weaning	6.75±1.12	7.75±0.72	7.83±0.60	6.75±1.02
Pre-weaning mortality/litter	2.75±0.67	1.25±0.52	2.33±0.47	3.00±0.71
Individual weight at birth (kg)	1.31 ±0.11	1.15±0.07	1.19±0.04	1.12±0.08
Individual weight at weaning (kg)	7.48±0.62	6.95±0.64	7.05±0.36	6.41±0.29
Litter weight at birth (kg)	11.93±0.79	9.87±0.92	12.09±0.93	10.36±0.96
Litter wt at weaning (kg)	45.65±6.25	54.65±5.50	52.02±3.45	43.03±6.17
Average daily weight gain (g)	136.47±13.05	129.63±13.40	130.48±7.92	119.45±5.99
Weaning to estrus interval (days)	7.18±2.19	8.73±2.79	6.45±2.28	9.83±2.58

Treatment effect and days effect was compared using one way ANOVA. Data presented as mean ±SEM.

Table 5. Effect of dietary supplementation on serum biochemical profile in sows during periparturient period

Serum biochemical	Treatments	Day -30	Day -15	Day +3	Day +15	Day +45
Total proteins	Gr. I	6.12±0.44	6.95±0.62	6.99±0.60	7.14±0.45	6.57±0.52
	Gr. II	6.27±1.06	6.73±0.52	6.07±0.20	6.90±0.49	5.65±0.77
	Gr. III	5.69±0.41	6.69±0.56	6.74±0.70	7.39±0.42	5.58±0.72
	Gr. IV	6.98±0.50	6.22±0.49	7.13±0.86	6.39±0.65	5.66±0.56
Glucose	Gr. I	71.83±8.09	65.39±6.36	81.46±7.54	60.45±4.67	73.91±6.44
	Gr. II	76.77±6.95^{ABC}	60.60±5.83^{A}	80.04±2.21^{BC}	67.36±5.70^{AB}	87.34±6.35^{C}
	Gr. III	51.35±7.05^{A}	62.66±11.50^{AB}	76.49±5.53^{AB}	67.70±6.42^{AB}	85.58±8.37^{B}
	Gr. IV	63.29±7.17	62.87±3.44	63.88±7.39	67.83±7.29	77.29±7.24
Albumin	Gr. I	3.91±0.40	3.76±0.48	3.97±0.49	4.03±0.38	2.64±0.17
	Gr. II	4.51±0.26^{A}	3.82±0.42^{AB}	4.05±0.33^{AB}	3.71±0.22^{AB}	3.06±0.39^{B}
	Gr. III	3.49±0.40	3.38±0.26	3.60±0.40	4.02±0.42	2.94±0.21
	Gr. IV	3.59±0.28^{AB}	3.65±0.41^{AB}	3.60±0.21^{AB}	4.32±0.42^{A}	3.00±0.39^{B}
Cholesterol	Gr. I	53.47±7.36^{A}	98.22±15.66^{aAB}	63.85±14.34^{A}	78.77±15.64^{AB}	124.40±21.72^{B}
	Gr. II	78.12±7.91	57.87±9.31^{b}	61.68±11.48	77.87±13.59	68.20±13.65
	Gr. III	67.76±15.96	63.72±10.43^{b}	61.60±10.53	89.28±13.51	101.02±18.54
	Gr. IV	60.35±5.95	46.59±8.44^{b}	56.46±6.95	93.19±28.94	78.10±10.42
HDL-Cholesterol	Gr. I	23.36±1.40^{A}	37.42±9.16^{B}	16.27±2.30^{A}	22.48±3.70^{A}	29.99±2.82^{AB}
	Gr. II	28.70±2.89	32.28±0.69	32.64±9.76	25.14±4.35	22.18±5.64
	Gr. III	33.95±10.14	23.58±3.82	20.28±2.72	26.42±7.42	25.85±3.65
	Gr. IV	27.45±5.91	25.74±2.94	19.31±4.21	22.44±4.94	27.09±3.84
Triglyceride	Gr. I	33.58±3.63	46.22±11.56	24.97±5.44	27.65±8.74	35.27±8.32
	Gr. II	32.93±6.13	56.79±14.58	26.76±4.54	34.33±6.45	39.57±7.49
	Gr. III	51.60±14.15	53.59±13.82	42.20±15.94	27.93±4.93	20.51±7.16
	Gr. IV	33.95±9.20	47.18±6.51	35.87±10.07	49.48±14.31	29.15±7.29
Calcium	Gr. I	8.82±1.01	9.16±0.49	9.23±0.73	9.01±0.87	7.87±0.92
	Gr. II	7.91±0.52	8.50±0.65	9.83±1.09	8.35±0.55	9.00±0.55
	Gr. III	8.30±0.52	8.46±0.76	8.77±0.84	9.39±0.71	8.19±0.49
	Gr. IV	7.90±0.38	9.27±0.21	8.88±0.35	8.79±0.70	8.41±0.79
Phosphorus	Gr. I	6.79±0.58	6.69±0.77	9.12±1.41	9.15±1.47	8.95±1.09
	Gr. II	5.29±0.51^{A}	6.23±0.47^{AB}	8.11±0.88^{B}	8.30±0.63^{B}	8.06±0.85^{B}
	Gr. III	7.04±1.04	7.80±0.69	7.62±1.47	7.25±1.06	8.93±0.92
	Gr. IV	6.28±0.39	7.49±0.40	6.38±1.65	6.94±0.38	7.05±0.57

Treatment effect and days effect was compared using one way ANOVA. Values with different superscript in a row (A,B, C) and column (a,b) differ significantly ($p<0.05$). Data presented as mean ±SEM.