动物营养学报 2011,23(1):25-33
Chinese Journal of Animal Nutrition

doi:10.3969/j.issn.1006-267x.2011.01.006

饲粮纤维水平对妊娠母猪繁殖性能、激素分泌及仔猪器官发育的影响

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摘 要: 本试验旨在研究饲粮纤维水平对妊娠母猪繁殖性能、激素分泌及仔猪器官发育的影响。选用399头日龄、体况相近的长白×约克杂交的后备母猪,随机分为3组,妊娠1~90 d分别饲喂含10.8%(n=132)、15.8%(n=132)和20.8%(n=135)中性洗涤纤维(NDF)的饲粮,妊娠91 d至分娩及泌乳期各处理饲喂相同饲粮。结果表明:1)第1胎时,10.8% NDF组母猪平均每窝产仔数比15.8% NDF组和20.8% NDF组分别高0.74(P<0.05)和1.05头(P<0.01),平均每窝产活仔数比20.8% NDF组高1.01头(P<0.01),哺乳仔猪第22天个体均重和窝均重较20.8% NDF组分别高0.36和3.31 kg (P<0.05);第2胎时,15.8% NDF组母猪平均每窝产仔数比10.8% NDF组、20.8% NDF组分别高0.91和1.03头(P<0.05),平均每窝产活仔数分别高0.92和0.95头(P<0.05),仔猪出生窝均重比10.8% NDF组高1.86 kg (P<0.01);2)饲粮纤维水平对第1胎母猪妊娠期血浆雌二醇和孕酮含量无显著影响(P>0.05);第2胎时,15.8% NDF组和20.8% NDF组妊娠各阶段雌二醇和妊娠25 d孕酮含量显著或极显著低于10.8% NDF组(P<0.05或P<0.01),但20.8% NDF组显著增加母猪新生仔猪肝脏、心脏及肾脏的指数(P<0.05);3)第1胎和第2胎母猪的产程、泌乳期平均采食量及断奶后发情间隔时间均未受饲粮纤维水平的影响。结果提示,第1胎妊娠母猪饲粮NDF水平为10.8%,每日摄入NDF 222 g,第2胎妊娠母猪饲粮NDF水平为15.8%,每日摄入NDF 365 g可显著改善母猪的繁殖性能。

关键词: 纤维水平;妊娠母猪;繁殖性能;激素水平

中图分类号:S816.7 **文献标识码:**A **文章编号:**1006-267X(2011)01-0025-09

妊娠母猪的饲养目标是提高产活仔数,降低仔猪的生产成本,改善养猪生产的整体效益。研究表明,妊娠饲粮中适宜的纤维水平可提高妊娠早期胚胎存活[1]、改善规癖行为和肠道健康[2]、降低母猪分娩应激[3]等,从而显著改善母猪的繁殖性能。然而,由于不同胎次母猪在生理和营养需求上有较大差异,现代母猪已普遍采用分胎次饲养,饲粮纤维对妊娠母猪是否具有胎次效应有待进一步研究。由此,本试验旨在通过研究妊娠饲粮不同纤维水平对第1胎及第2胎母猪繁殖性能、激素分泌及新生仔猪器官发育的影响,为实际生产中不同胎次妊娠母猪纤维的应用提供参考。

1 材料与方法

1.1 试验材料

L-赖氨酸:纯度≥78.0%(ADM),*L*-苏氨酸:纯度≥98.5%(广东肇庆星湖生物科技股份有限公司),*L*-色氨酸:纯度≥98.5%(浙江升华拜克有限公司),*DL*-蛋氨酸:纯度≥98%(Evonik Degussa Antwerpen N. V. Company)。

1.2 试验设计及饲粮

本试验共设计3个处理,饲粮中性洗涤纤维

收稿日期:2010-06-14

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(neutral detergen fiber,NDF)水平分别为 10.8%、15.8%、20.8%。试验饲粮主要参照 NRC(1998)配制而成;纤维来源选择小麦麸和脱脂米糠,配制 3 个不同营养浓度的饲粮,饲粮组成及营养水平见表 1。通过采食量调控(表 2),使各处理间除每日纤维摄入量不同外,其他营养成分摄入量均相同。

表 1 饲粮组成及营养水平(风干基础)

Table 1 Composition and nutrient levels of diets (air-dry basis) %

项目 Items	10.8% NDF	15.8% NDF	20.8% NDF
原料 Ingredients			
玉米 Corn	68.94	57.05	45.22
豆粕 Soybean meal	15.95	10.30	4.60
小麦麸 Wheat bran (43% CP)	6.00	24.00	42.00
脱脂米糠 Defatted rice bran	4.00	4.00	4.00
氨基酸复合添加剂 Amino acid compound additive[1)]	0.25	0.35	0.45
石粉 Limestone	1.35	1.52	1.68
磷酸氢钙 $CaHPO_4$	1.51	1.03	0.56
食盐 NaCl	0.40	0.38	0.35
小苏打 $NaHCO_3$	0.18	0.15	0.10
元明粉 Na_2SO_4	0.48	0.34	0.22
预混料 Premix[2)]	0.94	0.88	0.82
合计 Total	100.00	100.00	100.00
营养水平 Nutrient levels[3)]			
消化能 DE/(MJ/kg)	13.00	12.22	11.44
粗蛋白质 CP	14.08(14.14)	13.58(13.74)	13.08(13.38)
中性洗涤纤维 NDF	10.80(10.84)	15.80(15.44)	20.80(20.39)
酸性洗涤纤维 ADF	4.60	6.10	7.60
粗纤维 CF	3.00	4.07	5.14
钙 Ca	0.89(0.91)	0.84(0.85)	0.79(0.80)
总磷 TP	0.68(0.66)	0.69(0.69)	0.71(0.71)
有效磷 AP	0.40	0.38	0.36
可消化赖氨酸 DLys	0.70	0.66	0.62
可消化蛋氨酸+可消化胱氨酸 DMet+DCys	0.45	0.43	0.40
可消化色氨酸 DTrp	0.14	0.13	0.12
可消化苏氨酸 DThr	0.50	0.47	0.44

[1)] 氨基酸复合添加剂包含赖氨酸、苏氨酸、蛋氨酸和色氨酸,各处理每千克饲粮提供赖氨酸、苏氨酸、蛋氨酸和色氨酸分别为:10.8% NDF 组,1.715、0.590、0.215 和 0.020 g;15.8% NDF 组,2.235、0.864、0.370 和 0.050 g;20.8% NDF 组,2.771、1.145、0.540 和 0.085 g。

Amino acid compound additive includes lysine, threonine, methionine and tryptophan, which are provided per kg of diet as follows: 10.8% NDF group, 1.715, 0.590, 0.215 and 0.020 g; 15.8% NDF group, 2.235, 0.864, 0.375 and 0.050 g; 20.8% NDF group, 2.771, 1.145, 0.540 and 0.085 g.

[2)] 预混料为每千克饲粮提供 Premix provides per kg of diet: Zn 100 mg, Cu 30 mg, Fe 100 mg, Mn 40 mg, I 0.25 mg, Se 0.25 mg, VD_3 0.07 mg, VA 2 mg, VB_6 14 mg, VE 30 mg, VC 100 mg, 生物素 biotin 0.1 mg, 叶酸 folic acid 2.5 mg, 肉毒碱 carnitine 46 mg, 有机铬 organic chromium 0.3 mg。

[3)] 括号内为实测值,其他为计算值。

The values in the brackets are determined, while the others are calculated.

表 2　第 1 胎和第 2 胎母猪妊娠期饲料给料量

Table 2　Designed feed intakes during gestation in parities 1 and 2　　kg/d

项目 Items		低纤维 LF		中纤维 MF		高纤维 HF	
		第 1 胎 Parity 1	第 2 胎 Parity 2	第 1 胎 Parity 1	第 2 胎 Parity 2	第 1 胎 Parity 1	第 2 胎 Parity 2
妊娠天数 Days of pregnancy/d	1 ~ 20	1.70	1.70	1.80	1.80	1.90	1.90
	21 ~ 50	1.90	2.20	2.00	2.34	2.28	2.50
	51 ~ 75	2.20	2.30	2.35	2.45	2.55	2.61
	76 ~ 90	2.35	2.50	2.50	2.66	2.70	2.84
1 ~ 90 d 平均采食量 Average feed intake from 1 to 90 d		2.05	2.17	2.18	2.31	2.33	2.47

1.3　试验动物分组及饲养管理

选用399 头日龄、体况相近的长白 × 约克杂交后备母猪,随机分为 3 组,分别为 10.8% NDF 组(n = 132)、15.8% NDF 组(n = 132)和 20.8% NDF 组(n = 135)。试验在 3 个连续的批次中进行,每批所选母猪均按背膘厚结合体况评分随机分为3 组。试验连续进行2 个繁殖周期,因繁殖失败(返情、流产、空怀)、肢蹄问题、疾病问题或较差的产仔性能而被淘汰的母猪除外,其他母猪始终保持分组不变,直到试验结束。妊娠母猪单栏饲喂,日喂 2 次,时间分别为 08:00 和 17:00,自由饮水,妊娠舍室温夏季为 22 ~ 25 ℃、冬季为 15 ~ 22 ℃。母猪在分娩前 1 周转至分娩舍,泌乳母猪单栏饲喂,自由饮水,日喂 3 次,时间分别为 08:00、11:30 和 17:30,分娩舍室温夏季为 22 ~ 27 ℃、冬季为 20 ~ 23 ℃。严格保证仔猪在处理内调栏(平均每头母猪带仔 9 ~ 12 头),所有仔猪 24 日龄断奶。其他饲养管理按规模化猪场统一进行。

1.4　测定指标

1.4.1　母猪繁殖性能

母猪配种时、妊娠 109 d 和分娩后第 20 天,用超声波背膘仪(SFK-Technology, Piglog 105)测量母猪 P_2 点(左侧距最后肋背中线 6 cm)背膘厚度;记录母猪 2 胎的产仔数(包括总仔、弱仔、死胎、木乃伊、畸形)、妊娠天数、产程、配种分娩率、返情率、泌乳期平均采食量、断奶后 10 d 内发情率及断奶后发情间隔时间;称量并记录 2 胎试验仔猪出生重和哺乳第 22 天体重。

1.4.2　妊娠母猪血浆雌二醇、孕酮含量

在第 1 胎母猪妊娠 13、54、85、109 d,第 2 胎母猪妊娠 25、54、85 d 时,每处理随机选取 5 头母猪早餐后 1 h 前腔静脉采血 5 mL,注入肝素钠离心管中,静置后 4 000 r/min 离心 15 min 收集血浆,样品 -20 ℃保存。测定血浆雌二醇和孕酮含量,试剂盒购自美国 RD 公司,具体操作步骤按说明书进行。

1.4.3　新生仔猪器官指数

2 胎母猪分娩后,每个处理选择 15 头新生仔猪,不允许吃初乳,出生后即刻将仔猪屠宰,称取心、肝、胃、肾、肠、肺的重量,计算脏器指数:脏器指数(%) = (脏器重/体重) × 100。

1.5　数据处理

所有数据均采用平均值 ± 标准差表示,采用 SPSS 11.5 单因素方差分析,并采用 Duncan 氏检验进行多重比较和显著分析。显著性水平为 $P < 0.05$,极显著水平为 $P < 0.01$。

2　结　果

2.1　饲粮纤维水平对母猪繁殖性能的影响

2.1.1　饲粮纤维水平对第 1 胎母猪繁殖性能的影响

由表 2 可知,10.8% NDF 组母猪平均每窝产仔数(出生窝均总仔数)比 15.8% NDF 组和 20.8% NDF 组分别高 0.74($P < 0.05$)和 1.05 头($P < 0.01$),母猪平均每窝产活仔数[出生窝均活仔数(健仔 + 弱仔)]比 20.8% NDF 组高 1.01 头($P < 0.01$),仔猪出生个体均重比 15.8% NDF 组低 0.05 kg($P < 0.05$),但仔猪哺乳第 22 天窝均重和个体均重比 20.8% NDF 组分别高 3.31 和 0.36 kg($P < 0.05$),母猪分娩后 20 天的背膘厚显著低于 20.8% NDF 组($P < 0.05$);饲粮纤维水平对母猪泌乳期平均采食量、断奶后发情间隔时间、妊娠天数、产程及仔猪出生窝均重影响均不显著($P > 0.05$)。

表 3 饲粮纤维水平对第 1 胎母猪繁殖性能的影响

Table 3 Effects of dietary fiber levels on reproductive performance of sows in parity 1

项目 Items	10.8% NDF	15.8% NDF	20.8% NDF
配种母猪数量 Number of breeding sows/头	132	132	135
配种分娩率 Breeding birth rate/%	89.39	87.12	87.41
返情率 Rate of return to estrus/%	3.79	4.55	7.41
1~90 d 平均采食量 Average feed intake from 1 to 90 d/(kg/d)	2.05	2.18	2.33
1~90 d 平均 NDF 摄入量 Average NDF intake from 1 to 90 d/(kg/d)	222	345	485
泌乳期平均采食量 Average feed intake during lactation/(kg/d)	4.61±0.52	4.51±0.41	4.51±0.30
母猪背膘厚 Sow backfat thickness/mm			
配种时 Day of breeding	17.62±1.34	17.67±1.48	17.78±1.46
妊娠 109 d 109 days after gestation	20.12±2.48	19.67±2.48	19.56±2.45
分娩后 20 天 20 days after farrowing/mm	17.14±1.95^{b}	17.57±2.35^{ab}	18.20±2.67^{a}
断奶后 10 d 内发情率 Percentage of sows displaying estrus during 10 days postweaning/%	93.52	89.42	88.68
断奶后发情间隔时间 WEI/d	4.15±1.11	4.35±1.65	4.43±1.63
妊娠天数 Days of pregnancy/d	114.49±1.05	114.35±0.94	114.48±1.00
产程 Duration of farrowing/h	4.77±1.92	4.50±2.21	4.63±1.20
窝产仔性能 Litter farrowing performance			
出生窝均总仔数 Average total piglets born per litter/头	12.09±2.16^{Aa}	11.35±2.66^{ABb}	11.04±2.59^{Bb}
出生窝均活仔(健仔+弱仔)数 Average piglets born alive (healthy and weak) per litter/头	10.92±2.46^{Aa}	10.57±2.56^{ABab}	9.91±3.08^{Bb}
哺乳第 22 天窝均活仔数 Average piglets born alive per litter on 22 d of lactation/头	9.10±1.16	9.20±0.82	9.04±0.91
出生窝均重 Average litter weight at birth/kg	14.91±3.51	14.93±3.80	13.88±4.29
出生个体均重 Average live piglet weight at birth/kg	1.35±0.50^{b}	1.40±0.30^{a}	1.39±0.31^{ab}
哺乳第 22 天窝均重 Average litter weight on 22 d of lactation/kg	55.84±10.99^{a}	55.80±11.71^{a}	52.53±9.51^{b}
哺乳第 22 天个体均重 Average live piglet weight on 22 d of lactation/kg	6.19±1.33^{a}	6.07±1.37^{ab}	5.83±1.15^{b}

同行数据肩标不同小写字母表示差异显著($P<0.05$),不同大写字母表示差异极显著($P<0.01$)。表 4 和表 7 同。

Values in the same row with different small letter superscripts mean significant difference ($P<0.05$), and with different capital letter superscripts mean significant difference ($P<0.01$). The same as Table 4 and Table 7.

弱仔指出生体重≤0.8 kg 的仔猪。表 4 同。

Weak piglets mean whose weight at birth are ≤0.8 kg. The same as Table 4.

2.1.2　饲粮纤维水平对第 2 胎母猪繁殖性能的影响

由表 4 可知,15.8% NDF 组母猪平均每窝产仔数比 10.8% NDF 组和 20.8% NDF 组分别高 0.91 和 1.03 头($P<0.05$),母猪平均每窝产活仔数比 10.8% NDF 组和 20.8% NDF 组分别高 0.92和 0.95 头($P<0.05$),仔猪出生窝均重比 10.8% NDF 组高 1.86 kg($P<0.01$);饲粮纤维水平对母猪泌乳期平均采食量、断奶后发情间隔时间、仔猪出生个体均重、哺乳第 22 天窝均重及个体均重的影响均不显著($P>0.05$)。

表 4　饲粮纤维水平对第 2 胎母猪繁殖性能的影响

Table 4　Effects of dietary fiber levels on reproductive performance of sows in parity 2

项目 Items	10.8% NDF	15.8% NDF	20.8% NDF
配种母猪数量 Number of breeding sows/头	101	93	94
配种分娩率 Breeding birth rate/%	82.18	89.25	87.23
返情率 Rate of return to estrus/%	10.89	4.3	10.64
1 ~ 90 d 平均采食量 Average feed intake from 1 to 90 d /(kg/d)	2.17	2.31	2.47
1 ~ 90 d 平均 NDF 摄入量 Average NDF intake from 1 to 90 d /(kg/d)	234	365	514
泌乳期平均采食量 Average feed intake during lactation/(kg/d)	5.66 ± 0.15	5.71 ± 0.18	5.79 ± 0.29
母猪背膘 Sow backfat thickness/mm			
配种时 Day of breeding	18.73 ± 3.41	18.12 ± 2.86	17.84 ± 3.27
妊娠 109 d 109 days after gestation	16.91 ± 4.12	16.60 ± 2.09	16.29 ± 3.71
分娩后 20 天 20 days after farrowing/mm	91.43	95.45	94.12
断奶后 10 d 内发情率 Percentage of sows displaying estrus during 10 days postweaning/%	4.29 ± 0.85	4.57 ± 0.99	4.29 ± 1.13
断奶后发情间隔时间 WEI/d	114.23 ± 1.22	114.58 ± 1.37	114.48 ± 1.07
妊娠天数 Days of pregnancy/d	6.11 ± 1.56^{b}	7.74 ± 1.29^{a}	6.12 ± 1.45^{b}
窝产仔性能 Litter farrowing performance			
出生窝均总仔数 Average total piglets born per litter/头	11.25 ± 2.21^{b}	12.16 ± 2.34^{a}	11.13 ± 2.66^{b}
出生窝均活仔(健仔 + 弱仔)数 Average piglets born alive (healthy and weak) per litter/头	10.72 ± 2.15^{b}	11.64 ± 2.32^{a}	10.69 ± 2.91^{b}
哺乳第 22 天窝均活仔数 Average piglets born alive per litter on 22 d of lactation/头	10.27 ± 0.57	10.48 ± 0.59	10.38 ± 0.61
出生窝均重 Average litter weight at birth/kg	15.96 ± 3.85^{Bb}	17.82 ± 4.15^{Aa}	16.45 ± 3.75^{ABab}
出生个体均重 Average live piglet weight at birth/kg	1.51 ± 0.35	1.50 ± 0.37	1.53 ± 0.33
哺乳第 22 天窝均重 Average litter weight on 22 d of lactation/kg	58.88 ± 8.57	60.03 ± 9.66	63.08 ± 9.83
哺乳第 22 天个体均重 Average live piglet weight on 22 d of lactation/kg	5.74 ± 0.92	5.96 ± 1.01	6.08 ± 1.02

2.2 饲粮纤维水平对母猪血浆雌二醇和孕酮含量的影响

从表5可知,第1胎母猪妊娠各阶段血浆雌二醇含量差异不显著($P>0.05$)。第2胎母猪妊娠各阶段20.8% NDF组和15.8% NDF组血浆雌二醇含量显著或极显著低于10.8% NDF组($P<0.05$或$P<0.01$),15.8% NDF组与20.8% NDF组差异不显著($P>0.05$)。

从表6可知,第1胎母猪妊娠各阶段血浆孕酮含量差异不显著($P>0.05$)。第2胎母猪妊娠25 d,20.8% NDF组和15.8% NDF组血浆孕酮含量极显著低于10.8% NDF组($P<0.01$),15.8% NDF组与20.8% NDF组差异不显著($P>0.05$);妊娠54和85 d,各处理血浆孕酮含量差异不显著($P>0.05$)。

表5 饲粮纤维水平对母猪血浆雌二醇含量的影响

Table 5 Effects of dietary fiber levels on plasma estradiol content of sows ($n=5$) pmol/L

项目 Items	第1胎 Parity 1				第2胎 Parity 2		
	d 13	d 54	d 85	d 109	d 25	d 54	d 85
10.8% NDF	34.65±2.74	47.90±3.82	47.14±3.93	51.34±4.43	81.49±6.79^{a}	96.37±8.49^{Aa}	75.37±5.23^{a}
15.8% NDF	36.07±3.11	52.48±4.24	48.66±4.33	50.97±4.91	57.06±4.95^{b}	55.53±5.37^{Bb}	57.44±7.07^{b}
20.8% NDF	32.63±2.69	51.34±3.96	48.61±3.29	56.30±5.66	60.50±5.23^{b}	60.88±6.22^{Bb}	60.38±3.18^{b}

同列数据肩标不同小写字母表示差异显著($P<0.05$),不同大写字母表示差异极显著($P<0.01$)。表6同。

Values in the same column with different small letter superscripts mean significant difference ($P<0.05$), and with different capital letter superscripts mean significant difference ($P<0.01$). The same as Table 6.

表6 饲粮纤维水平对母猪血浆孕酮含量的影响

Table 6 Effects of dietary fiber levels on plasma progesterone content of sows ($n=5$) pmol/L

项目 Items	第1胎 Parity 1				第2胎 Parity 2		
	d 13	d 54	d 85	d 109	d 25	d 54	d 85
10.8% NDF	630.63±56.57	762.38±62.93	682.54±48.43	756.31±60.11	912.20±84.05^{Aa}	674.08±62.37	623.50±54.27
15.8% NDF	655.63±45.50	709.18±68.02	701.37±70.42	723.75±46.75	728.33±61.09^{Bb}	630.52±60.66	578.55±51.16
20.8% NDF	649.38±63.64	743.45±71.16	693.40±58.34	708.88±40.43	708.50±64.17^{Bb}	668.50±59.22	513.50±47.20

2.3 饲粮纤维水平对第2胎母猪的新生仔猪器官指数的影响

由表7可知,20.8% NDF组肝脏指数极显著高于15.8% NDF组($P<0.01$),显著高于10.8% NDF组($P<0.05$);20.8% NDF组心脏指数显著高于10.8% NDF组($P<0.05$);20.8% NDF组肾脏指数显著高于10.8% NDF组和15.8% NDF组($P<0.05$)。

表7 饲粮纤维水平对新生仔猪脏器指数的影响

Table 7 Effects of dietary fiber levels on viscera indices in newborn piglets ($n=15$) g/kg

项目 Items	10.8% NDF	15.8% NDF	20.8% NDF
肝脏 Liver	2.44±0.23^{ABb}	2.32±0.19^{Bb}	2.77±0.17^{Aa}
心脏 Heart	0.76±0.09^{b}	0.83±0.12^{ab}	0.84±0.08^{a}
肾脏 Kidney	0.72±0.11^{b}	0.74±0.19^{b}	0.89±0.23^{a}
胃 Stomach	0.54±0.11	0.55±0.08	0.61±0.10
肠 Intestine	2.72±0.07	2.52±0.08	3.18±0.09
肺 Lung	1.60±0.35	1.70±0.43	1.61±0.39

3 讨　论

本试验表明,饲粮纤维水平影响第 1 胎和第 2 胎母猪的繁殖性能,第 1 胎时 10.8% NDF 组母猪平均每窝产仔数最高,第 2 胎时 15.8% NDF 组母猪平均每窝产仔数最高。Reese 等[4]研究表明,纤维饲粮作用时间的长短对母猪产仔性能有显著影响,第 1 个繁殖周期使用高纤维(26.5% NDF)饲粮较使用低纤维(13.5% NDF)饲粮母猪平均每窝产活仔数下降 1.01 头,而第 2 个繁殖周期使用高纤维饲粮可提高母猪平均每窝产活仔数 0.4 头;Veum 等[5]报道,高纤维(19.76% 和 9.71% NDF)饲粮在第 1 个繁殖周期和第 2 个繁殖周期可分别提高窝产活仔数 0.31 和 0.61 头;Matte 等[6]发现,高纤维(20.41% 粗纤维)饲粮可提高第 1 个繁殖周期母猪窝产活仔数,但对第 2 个繁殖周期母猪窝产仔数却没有影响;然而 Peet 等[7]报道,高纤维(15.9% 和 12.6% 粗纤维)饲粮对连续 3 个繁殖周期母猪的窝产仔数未产生影响。其原因可能在于:1)饲粮纤维来源不同。研究表明,要获得最佳的窝产仔数和断奶仔猪数,当用苜蓿干草饲喂母猪时应约为 450 g NDF/d,用玉米芯时应为 380 g NDF/d,用麦秸时应为 368 g NDF/d[8]。本试验所用的纤维来源是小麦麸和脱脂米糠,而 Veum 等[5]用的是小麦秸秆,Matte 等[6]用的是小麦麸和燕麦皮,Peet 等[7]用的主要是甜菜渣。不同的纤维来源所含纤维的结构不同,可能造成母猪对其消化利用率不同而对其繁殖性能产生不同的效果。2)母猪胎次不同。研究发现,成熟母猪较生长期母猪对纤维的消化系数高[9],且成熟母猪大肠纤维分解菌的数量是生长猪的 6 倍[10]。由于现代母猪配种日龄的不断提前,使得第 1 胎母猪虽已达到性成熟,但未达到体成熟,而第 2 胎母猪在生理上更接近成熟母猪,这使得第 1 胎母猪和第 2 胎母猪对纤维饲粮的消化能力存在较大的差别。由于第 1 胎母猪处于生长期[11],在本试验中可能导致 15.8% NDF 组和 20.8% NDF 组摄入能量不足,从而没有足够的能量满足胎儿的生长发育,从而导致 15.8% NDF 组和 20.8% NDF 组母猪较 10.8% NDF 组母猪的繁殖性能下降。而第 2 胎母猪对纤维消化能力增强,单位体重能量需要降低[12],此时适当提高纤维水平(15.8% NDF)可显著改善母猪的繁殖性能。

雌性动物在孕激素与雌激素共同作用下通过协同和拮抗 2 种途径调节生殖活动。本试验结果表明,饲粮纤维水平对第 1 胎母猪妊娠期血浆雌二醇及孕酮含量无显著影响,而第 2 胎时,15.8% 和 20.8% NDF 组显著低于 10.8% NDF 组,表明高纤维(15.8% 和 20.8% NDF)饲粮降低妊娠母猪血浆雌二醇、孕酮含量,这与在人[13]和鼠[14]上的研究一致。由于纤维具有吸附类固醇激素、改变肠道分解纤维酶活性和阻断类固醇激素肠肝循环的作用,所以其能够促进循环类固醇激素的清除。循环类固醇浓度降低,会减少其对下丘脑-垂体轴的负反馈,增加促黄体生成激素脉冲频率,促进卵母细胞的成熟,增加胚胎存活率[1]。不同饲粮纤维水平可以影响妊娠期母猪雌二醇和孕酮的分泌,可能与纤维发酵产生的短链脂肪酸抑制胆固醇合成有关[15],胆固醇是动物体内生成类固醇激素的主要成分,但不同饲粮纤维水平对母猪繁殖性能的影响是如何通过繁殖代谢激素的介导调控的尚需进一步研究。

本试验结果表明,妊娠母猪饲粮纤维水平可显著影响仔猪心脏、肝脏和肾脏的脏器指数,20.8% NDF 组第 2 胎母猪仔猪脏器指数显著提高。越来越多的研究显示,母体营养状况可以改变胎儿基因表达及内分泌情况,从而永久性地改变胎儿的结构、生理学形态和新陈代谢,并对后代的生长发育及健康状况产生长远的影响[16]。仔猪脏器指数的高低可在一定程度上反映其功能的强弱。高纤维饲粮可能延缓养分(如葡萄糖和氨基酸)的吸收[17],稳定体内胰岛素的水平[18],使母体—胎盘—胎儿营养分配向更有利于胎儿生长发育的方向进行。同时,饲粮纤维对过氧化氢、超氧阴离子自由基和过氧亚硝基有清除作用,并对脂质的过氧化有较强的抑制作用[19]。此外,纤维的持水能力能有效防止母猪便秘,减少母猪肠道代谢紊乱,增强肠道活性,减少分娩应激[2]。因此,纤维对母体的有利作用可能程序化地影响胎儿出生后的生长表现,有效提高后代的存活率。

4 结　论

第 1 胎妊娠母猪饲粮 NDF 水平为 10.8%,每日摄入 NDF 222 g,第 2 胎妊娠母猪 NDF 水平为 15.8%,每日摄入 NDF 365 g 可显著改善母猪的繁殖性能。

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Effects of Dietary Fiber Levels on Reproductive Performance and Hormone Levels of Gestating Sows and Organ Development of the Piglets

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Abstract: The study was conducted to investigate the effects of dietary fiber levels on reproductive performance and hormone levels of gestating sows and organ development of piglets. Three hundred and ninety-nine cross-bred (Landrace × Yorkshine) gilts with similar age and body condition were randomly allocated to three groups which were fed with the diets including 10.8% (n=132), 15.8% (n=132), and 20.8% NDF (n=135) during 1 to 90 days of gestation. Sows during last pregnancy (from d 91 to farrowing) and lactation period (from farrowing to d 24 of lactation) were fed with the same diets among all groups. The results indicated as follows: 1) in parity 1, the total average number of piglets born per litter in 10.8% NDF group was increased by 0.74 (P<0.05) and 1.05 piglets (P<0.01) than that in 15.8% NDF group and 20.8% NDF group, respectively; the average number of piglets born alive (healthy and weak) per litter was also increased by 1.01 piglets than that in 20.8% NDF group (P<0.01); average weight of live piglet and average litter weight on 22 d of lactation were increased by 0.36 and 3.31 kg than those in 15.8% NDF group (P<0.05). In parity 2, the average total number of piglets born per litter in 15.8% NDF group was increased by 0.91 and 1.03 piglets than that in 10.8% NDF group and 20.8% NDF group (P<0.05), respectively; the average number of piglets born alive (healthy and weak) per litter was also increased by 0.92 and 0.95 piglets than that in 10.8% NDF group and 20.8% NDF group (P<0.05), respectively; the average litter weight at birth of piglets was increased by 1.86 kg than that in 10.8% NDF group (P<0.01). 2) The plasma contents of estradiol and progesterone of gestating sows in parity 1 were no significant difference (P>0.05), while those in every stage of gestation and plasma progesterone content on 25 d of gestation in parity 2 in 15.8% NDF group and 20.8% NDF group were significantly lower than those in 10.8% NDF group (P<0.05); meanwhile the liver, heart and kidney indices of newborn piglets from parity 2 sows in 20.8% NDF group were higher than those in 10.8% NDF group and 15.8% NDF group (P<0.05). 3) No effects of dietary fiber levels on the interval from weaning to estrus, duration of farrowing and average feed intake during lactation period were observed during their first and second parities (P>0.05). In conclusion, the reproductive performance of sows during their first and second parities is significantly affected by increasing dietary fiber levels. Daily intake of 222 g NDF (10.8% NDF in a diet) is beneficial to reproductive performance of primiparous sows, and daily intake of 365 g NDF (15.8% NDF in a diet) is suitable for sows in parity 2 to play the best reproductive performance. [***Chinese Journal of Animal Nutrition*, 2011, 23(1): 25-33**]

Key words: fiber levels; gestating sow; reproductive performance; hormone levels

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(编辑　何丽霞)