CHANGES IN THE NUTRIENT CONTENT OF COLOSTRUM OF SOWS DURING PARTURITION

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Abstract

The pig is born with low body energy stores and devoid of serum immunoglobulins. Colostrum provides the piglet with both energy and maternal antibodies but its fat and protein composition is very variable. The composition and quantity of colostrum and milk produced by sows is an important factor in successful piglet production. The aim of this study was to determine the changes in the concentration of the nutrients of colostrum of sows during parturition. The concentrations of dry matter, crude protein, fat and lactose of sow colostrum was determined in 20 sows (Large White with various lactation numbers and various litter sizes) at 7 time points throughout first 11 hours from beginning of farrowing. Colostrum nutrients were analyzed with MilkoScan FT 120, Foss A/S. During the first 11 hours from beginning of farrowing increased the concentration of fat by 57.15% and concentration of lactose by 0.28%. At the same time decreased the concentration of crude protein by 28.76% and the concentration of dry matter by 11.78%. We found the impact of sampling time on the concentration of crude protein (P<0,0001). For the fat, lactose and dry matter concentration was the effect non significant.

Key Words: Sow, colostrum, nutrients, farrowing, time

At present, the (really) assumed potential of fecundity is 15.0 piglets born alive, 2.4 litters/year, < 10% losses and 32.5 piglet per sow/year (WÄHNER and BRÜSSOW, 2009). Very important factors determining the level of sows reproduction are: the influence of the outer environment including stress (OPLETAL et al., 2008; PETRÁK et al., 2011) and the course of some diseases (ALEXA et al., 2011; MIRKO and BILKEI, 2004; TEŠIĆ et al., 2005). One indicator of the sow performance is the piglet weight at the birth and at the weaning (STUPKA et al., 2009). Nutritional quality of the sows colostrum is one of the factors influencing the performance of the piglets up to weaning (GÁLIK et al., 2011). With the additional knowledge that piglets are born with as little as 2% of body weight as fat (SEERLEY et al. 1981) and that reserves of stored glycogen also are limited (BOYD et al. 1978), the importance of rapid and adequate colostrum intake by the newborn pig is clear. Colostrum also has essential roles for the developing piglet, most importantly, it provides passive immunity and nutrients to the piglet and permits thermoregulation. It also stimulates gastrointestinal development, muscle protein synthesis (PETRÁK et al., 2012) and the development of active immunity (ROLINEC et al., 2012). The production of colostrum, however, is very variable between sows and the factors affecting this variability are not well known (FARMER et al., 2006). These factors are divided into genetic and non-genetic (TRAKOVICKÁ et al., 2005; TRAKOVICKÁ et al., 2006; GÁBOR et al., 2008). LINK et al. (2007) studied the composition of the milk of sows. The aim of this experiment was to examine the changes in dry matter, crude protein, fat and lactose concentration of sows colostrum from beginning of farrowing to 11. hour of lactation.

Material and Methods

Colostrum samples was collected from 10 Large White sows (with various lactation numbers and various litter sizes) maintained at the Sheep and pig farm Žirany (VPP Kolíňany, Slovak University of Agriculture in Nitra). All sows farrowed between March 8 and May 6. Sows were inseminated with semen from Large White boars and were housed with their litters in individual farrowing boxes with straw bedding. All sows received the same mixture of food twice a day. Diet containing 13.88% crude protein, 3.96% fat, 3.33% crude fibre, 58.79% nitrogen-free extract and 12.0 $MJ.kg^{-1}$ ME. In the day of parturition sows were not to feed. Water was supplied *ad libitum*. Seven colostrum samples were collected from each sow at this time points, the first sample on birth of the first piglet (0. hour) and than 1., 3., 5., 7., 9. and 11. hour from birth of the first piglet. Colostrum (10 mL) was collected from the right second (5 mL) and the sixth (5 mL) gland – these two samples were then mixed. Colostrum samples were collected without injection of oxytocin. Samples were stored at -20°C (freezing box PDF370S, Evermed) until they were analyzed for dry matter, crude protein, fat and lactose (MilkoScan FT 120, Foss A/S). Colostrum composition data were statistically analyzed by one-way ANOVA, testing differences in average nutrient concentration of colostrum between different sampling times, were performed with Duncan-test (P<0.05), using a the SAS system V.8.02. and the SAS system 9.1. (SAS Institute Inc.).

Results and Discussion

Here we report on the composition of colostrum throughout first 11 hours of lactation in 10 Large White sows maintained in a controlled environment with each receiving the same nutrients. Data show the amounts of dry matter, crude protein, fat and lactose throughout first 11 hours of lactation (Tab. 1 - 4).

Dry matter was the highest at beginning of farrowing (Tab. 1) and its concentration decreased approximately 5.7% during the first 5 h from beginning of farrowing and approximately 11.8% during the first 11 h from beginning of farrowing. This decrease in the percentage of dry matter in colostrum is attributed to a high decrease in the percentage of crude protein. KLOBASA et al. (1987) evaluated dry matter concentration in sows colostrum in 6 h 22.7% and in 12 h 18.4%. In the dry matter concentration differences between the average means at the time of sampling 0., 3., 5., and 7. hours were significant ($P<0.05$). Coefficient of variation is in colostrum highest in first and in 5th h. That corresponded with KLOBASA et al. (1987) they say, that the coefficient of variation was highest during the colostral period (10 to 14%).

Crude protein concentration (Tab. 2) during the first 5 h of lactation declined by nearly 18.5% and during the first 11 h by nearly 28.8%. Concentration of crude protein decreased from 0 to 11 h from beginning of farrowing. This pattern is similar to that found by KLOBASA et al. (1987), JACKSON et al. (1995), ROLINEC et al. (2009). Colostrum is characterized by a sharp drop (about 50%) in crude protein concentration occurs during the first 48 h (KLOBASA et al. 1987). 60% of sows showed a drop in colostral crude protein greater than 50% within 24 h *post partum* and the mean overall decrease for all sows was 52% (DEVILLERS et al. 2007). In the crude protein concentration differences between the average means were non significant ($P>0.05$). The coefficient of variation remained on low value. KLOBASA et al. (1987) say, that the coefficients of variation in total protein concentration were highest during early stages of lactation (5 to 26%).

Colostrum fat concentrations were relatively low and not constant (Tab. 3). Milk fat percentage values are in agreement with average milk fat values reported by KLOBASA et al. (1987) and ČANAKYOVÁ et al. (2009). Fat content in colostrum on day 1 of lactation of Meishan gilts was 10.9% and in the Yorkshire gilts 6.6% (ZOU et al., 1992). AVERETTE et al. (1999) published that, milk fat concentration of sows was elevated by supplemental fat regardless of whether they were induced or farrowed naturally, whereas dietary fat had no effect on naturally farrowing gilts and tended to reduce milk fat percentage in induced gilts. In the fat concentration differences between the average means at the time of sampling 1., 3., 7. and 11. hour were significant ($P<0.05$). The coefficient of variation remained constant throughout lactation at a level of about 18 % (KLOBASA et al., 1987).

Average lactose concentrations (Tab. 4) in samples collected from the 0. to 11th h of the lactation were in interval from 2.42% to 2.98%. DEVILLERS et al. (2007) published that, least proportional representation nutrient in sows colostrum is lactose. Concentration of lactose in second hour of lactation is 3.04% respectively 3.26% (JACKSON et al., 1995). KLOBASA et al. (1987); JACKSON et al. (1995) and ROLINEC et al. (2008) evaluated lactose concentration in sows colostrum at 6. h in interval from 3.16% to 3.40% with increasing to 12. h in interval from 3.16% to 4.1%. In the lactose concentration differences between the average means at the time of sampling 1., 3., 7. and 9. hour were significant ($P<0.05$). The lowest coefficients of variation between surveyed nutrients were observed in the concentrations of lactose.

We found the impact of sampling time on the crude protein concentration ($P<0.0001$). For the dry matter, fat and lactose concentration the effect was non significant (Tab. 5). JACKSON et al. (1995) found, that concentrations of fat, protein and lactose in colostrum and milk changed over time ($P<0.01$). Percentage of fat in colostrum of sows increased from 0 to 11 hours of lactation. Concentration of crude protein and dry matter decreased from 0 to 11 hours of lactation. The concentration of lactose in the colostrum of sows during the first 11 hours of lactation has the value between 2.42% to 2.98%.

Table 1. Concentration of dry matter (%) in sows colostrum in the first 11 hours

Hour from birth of the first piglet	Average Mean	Standard Deviation	Standard Error	Minimum	Maximum	Coefficient of variation
0. hour	**23.43***	2.21	0.70	20.42	27.78	4.91
1. hour	**24.60**	3.93	1.24	20.25	33.49	15.46
3. hour	**23.32***	2.28	0.72	20.16	26.72	5.22
5. hour	**22.09***	3.54	1.12	19.24	31.32	12.56
7. hour	**22.65***	1.88	0.59	19.56	26.30	3.52
9. hour	**20.91**	3.14	0.99	15.66	26.97	9.83
11. hour	**20.67**	2.46	0.78	17.24	24.18	6.04

* ($P<0.05$) significant difference in the mean value between different sampling times

Table 2. Concentration of crude protein (%) in sows colostrum in the first 11 hours

Hour from birth of the first piglet	Average Mean	Standard Deviation	Standard Error	Minimum	Maximum	Coefficient of variation
0. hour	**14.73**	1.84	0.58	12.20	18.30	3.38
1. hour	**14.85**	1.70	0.54	11.87	17.72	2.90
3. hour	**13.91**	1.70	0.53	11.40	16.34	2,89
5. hour	**12.00**	1.66	0.52	8.19	14.41	2.75
7. hour	**12.21**	0.94	0.30	10.29	13.28	0.89
9. hour	**9.94**	1.73	0.55	6.56	12.14	2.98
11. hour	**10.49**	1.14	0.36	8.34	12.06	1.30

* (P<0.05) significant difference in the mean value between different sampling times

Table 3. Concentration of fat (%) in sows colostrum in the first 11 hours

Hour from birth of the first piglet	Average Mean	Standard Deviation	Standard Error	Minimum	Maximum	Coefficient of variation
0. hour	**3.31**	0.66	0.21	2.35	4.72	0.43
1. hour	**5.07***	3.17	1.00	2.50	13.59	10.04
3. hour	**4.66***	1.82	0.58	1.78	9.00	3.33
5. hour	**5.63**	3.23	1.02	1.28	12.74	10.43
7. hour	**5.16***	1.68	0.53	3.50	9.01	2.82
9. hour	**6.60**	1.60	0.51	4.73	10.22	2.56
11. hour	**5.19***	2.20	0.70	2.48	9.61	4.85

* (P<0.05) significant difference in the mean value between different sampling times

Table 4. Concentration of lactose (%) in sows colostrum in the first 11 hours

Hour from birth of the first piglet	Average Mean	Standard Deviation	Standard Error	Minimum	Maximum	Coefficient of variation
0. hour	**2.98**	0.29	0.09	2.54	3.36	0.08
1. hour	**2.73***	0.58	0.18	1.91	3.96	0.34
3. hour	**2.71***	0.44	0.14	1.66	3.34	0.20
5. hour	**2.42**	0.54	0.17	1.02	3.06	0.29
7. hour	**2.83***	0.33	0.10	2.24	3.34	0.11
9. hour	**2.80***	0.57	0.18	1.75	3.39	0.33
11. hour	**2.98**	0.30	0.09	2.52	3.52	0.09

* (P<0.05) significant difference in the mean value between different sampling times

Table 5. Analysis of variance of the nutrient concentration of colostrum, depending on the time of sampling

Nutrient	F Value	Pr > F	R-Square
Dry matter	2.00	0.078	0.160
Crude protein	15.84	<.0001	0.601
Fat	2.02	0.076	0.161
Lactose	1.73	0.129	0.141

Conclusions

The aim of this experiment was to examine the changes in dry matter, crude protein, fat and lactose concentration of sows colostrum from beginning of farrowing to 11. hour of lactation. During the first 11 hours from beginning of farrowing increased the concentration of fat by 57.15% and concentration of lactose by 0.28%. At the same time decreased the concentration of crude protein by 28.76% and the concentration of dry matter by 11.78%. We found the impact of sampling time on the concentration of crude protein. For the fat, lactose and dry matter concentration was the effect non significant. Pigs that are born later or they begin to suck later, do not have so quality colostrum than pigs born sooner, especially in crude protein concentration. The quality of the colostrum of sows, especially concentration of fat is very different. Difference in fat concentration in colostrum is between sows more than 10%.

References

ALEXA, P., HAMŘÍK, J., KONSTANTINOVÁ, L., ŠRÁMKOVÁ-ZAJACOVÁ, Z., Experimental infection of weaned piglets with enterotoxigenic *Escherichia coli* O149:F4. In Acta Veter. /Brno/, vol. 80, 2011, p. 337-341.

AVERETTE, L.A., ODLE, J., MONACO, M.H., DONOVAN, S.M. Dietary fat during pregnancy and lactation increases milk fat and insulin-like growth factor | Concentrations and improves neonatal growth rates in swine. In J. Nutr., vol. 129, 1999, p. 2123-2129.

BOYD, R.D., MOSER, B.D., PEO, E.R.Jr., CUNNINGHAM, P.J. Effect of energy source prior to parturition and during lactation on piglet survival and growth and on milk lipids. In J. Anim. Sci., vol. 47, 1987, p. 883–892.

ČANAKYOVÁ, Z., ROLINEC, M., KANKA, T., DANKOVÁ, Z. Influence of oxytocin on farrowing process and on quality of sows colostrum. In IV. Vedecká konferencia doktorandov. Nitra : SPU, 2009, p. 100-102.

DEVILLERS, N., FARMER, C., LEDIVIDICH, J., PRUNIER, A. Variability of colostrum yield and colostrum intake in pigs. In Animal, vol. 1:7, 2007, 1033-1041.

FARMER, C., DEVILLERS, N., ROOKE, J.N., LEDIVIDICH, J. Colostrum production in swine: from the mammary glands to the piglets. In Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources. CAB Reviews 1, 2006, 16.

GÁBOR, M., TRAKOVICKÁ, A., MILUCHOVÁ, M. Identification of polymorphism of candidate genes RYR1 and ESR by wild boar (Sus Scrofa Scrofa) and domestic pigs with multiplex PCR-FRLP method. In Biotechnology 2008, České Budějovice : University of South Bohemia, 2008, p. 117-119.

GÁLIK, B., BÍRO, D., ŠIMKO, M., JURÁČEK, M., HORNIAKOVÁ, E., ROLINEC, M. Nutritional characteristic of feed (Nutričná charakteristika krmív), Nitra : SUA, 2011, 101 p.

JACKSON, J.R., HURLEY, W.L., EASTER, R.A., JENSEN, A.H., ODLE, J. Effect of induced or delayed parturition and supplemental dietary fat on colostrum and milk composition in sows. In J. Anim. Sci., vol. 73, 1995, p. 1906-1913.

KLOBASA, F., WERHAHN, E., BUTLER, J.E. Composition of Sow Milk During Lactation. In J. Anim. Sci., vol. 64, 1987, p. 1458-1466.

LINK, R., KOVÁČ, G., FOLTYS, V., KIRCHNEROVÁ, K. Composition of sow´s milk and selected metabolic indices after administration of probiotics. In Res. Pig Breed., vol. 1, 2007, p. 40-42.

MIRKO, C.P., BILKEI, G., Acute phase proteins, serum cortisol and preweaning litter perfotmance in sow suffering from periparturient disease. In Acta Veter. / Beograd/, vol. 54, 2004, p. 153-161.

OPLETAL, L., ROZKOT, M., LUSTYKOVÁ, A., FRYDRYCHOVÁ, S., DANĚK, P., VÁCLAVKOVÁ, E. Natural compounds potentially influencing pig reproduction – review. In Res. Pig Breed., vol. 2, 2008, p. 50-54.

PETRÁK, J., DEBRECÉNI, O., BUČKO, O. Vplyv transportnej záťaže na zmeny IGF-1 a kortizolu v sére ošípaných. In 18. odborná konference s mezinárodní účastí "Ochrana zvířat a welfare 2011, Brno : VFU, 2011, p. 126-129.

PETRÁK, J., BUČKO, O., DEBRECÉNI, O., VAVRIŠÍNOVÁ, K. Efekt selénu na koncentráciu IGF-I v sére ošípaných na vybrané svalové a tukové tkanivá. In Lazarové dni výživy a veterinárnej dietetiky X., Košice : UVL, 2012, p. 184-187.

ROLINEC, M., BÍRO, D., ŠŤASTNÝ, P., GÁLIK, B., ŠIMKO, M., JURÁČEK, M. Immunoglobulins in colostrum of sows with porcine reproductive and respiratory syndrome – PRRS. In *J Central European Agriculture*, vol. 13, 2012, p. 303-311.

ROLINEC, M., MINDEK, S., KANKA, T., ČANAKYOVÁ, Z., DANKOVÁ, Z., SCHUBERTOVÁ, Z. Effect of farowing fortification on the content of proteins in sows colostrum. In XI. Konference mladých vědeckých pracvoníků s mezinárodní účasťí. Brno : VFU, 2009, p. 72-74.

ROLINEC, M., ŠŤASTNÝ, P., KANKA, T. Influence of nutrition on health of neonatal pigs. In: Days of animal nutrition, Nitra : SPU, 2008, p. 190-193.

SAS Institute Inc. (THE SAS SYSTEM V.8.02 and THE SAS SYSTEM 9.1.)

SEERLEY, R.W., SNYDER, R.A., MCCAMPBELL, H.C. The influence of sow dietary lipids and choline on piglet survival, milk and carcass composition. In J. Anim. Sci., vol. 52, 1981, p. 542–550.

STUPKA, R., ČÍTEK, J., ŠPRYSL, M., KUREŠ, D., KRATOCHVÍLOVÁ, H., DVOŘÁKOVÁ, V. The effect of attained live weight on an affective stock introduction and reproduction potential of subsequent litters in gilts. In Res. Pig Breed., vol. 3, 2009, p. 65-71.

TEŠIĆ, M., ŽUGIĆ, G., KLJAJIĆ, R., TAJDIĆ, N., STOJILKOVIĆ, L.J., BLAGOJEVIĆ, M., ROGOŽARSKI, D. Leptospirosis control on an intensive raising pig farm. In Acta Veter. /Beograd/, vol. 55, 2005, p. 335-344.

TRAKOVICKÁ, A., BUJKO, J., ŽITNÝ, J., STRAPÁKOVÁ, E., BOBČEK, B. Analýza genetických a negenetických faktorov na produkciu mäsa ošípaných. In 4th International Congress on Ethology in Animal Production, Nitra : SPU, 2005, p. 212-217.

TRAKOVICKÁ, A., MILUCHOVÁ, M., GÁBOR, M. Analysis of polymorphism of ESR (Pvull) gene of pig by method PCR-RFLP. In Acta fytotechn. zootechn., vol. 9, mimoriadne číslo 2006, p. 18-19.

WÄHNER, M.,BRÜSSOW, K.-P. Biological potential of fecundity of sows. In Res. Pig Breed., vol. 3, 2009, p. 22-27.

ZOU, S., MCLAREN, D.G., HURLEY, W.L. Pig colostrum and milk composition: comparisons between Chinese Meishan and US breeds. In Livestock Prod. Sci., vol. 30, 1992, p. 115-127.

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