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ANALYSIS OF THE ENERGY VALUE OF SOW COLOSTRUM

ANALÝZA ENERGETICKEJ HODNOTY KOLOSTRA PRASNÍC

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The aim of this study was to determine the gross energy (GE) of sow colostrum in different sampling times and find out how time affects the GE of sow colostrum. Colostrum samples were collected at every hour from the beginning of farrowing to the 12th hour. Then, the samples were analyzed for GE, dry matter, crude protein, fat and lactose. We detected the highest GE of colostrum soon after the beginning of farrowing: 5.30 MJ.kg^{-1} in the 1st hour, 5.48 MJ.kg^{-1} in the 2nd hour and 5.38 MJ.kg^{-1} in the 3rd hour. The lowest GE of colostrum was detected in the 11th hour (4.90 MJ.kg^{-1}) and the 12th hour (4.88 MJ.kg^{-1}) after the beginning of farrowing. We did not find a statistically significant relationship between the times of sampling and the gross energy concentration in sow colostrum.

Keywords: sow, colostrum, nutrients, gross energy

A newborn pig is susceptible to hypoglycaemia until the milk energy intake from the dam is adequate (Seerley et al., 1974). The extra energy available to pigs may be metabolized by increased activity of behaviour (Coffey et al., 1982). According to Seerley et al. (1974), changes in milk composition and yield caused by fat treatment may be important in regard to improved survival. Increased levels of lipids and energy at day three may be particularly important because piglet glycogen stores are depleted by 72 hours after birth in fed and fasted pigs. Colostrum has proved to be an efficient route for acquisition of immunoglobulins (Rolinec et al., 2012; Rolinec et al., 2010; Kanka, 2010) and especially of fat and hence they create a supply of energy to the pig during the 1st day after birth (Le Dividich et al., 1991; Herpin et al., 1992). Le Dividich et al. (1994) have studied energy utilization of colostrum by a newborn pig. However, sow colostrum production often varies 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). However, little information is to be found about the exact energy concentration of sow colostrum in time near to the parturition. This study was therefore designed to evaluate the energy value of sow colostrum in the first 12 hours from the beginning of parturition.

Material and methods

In this study, a total of 18 clinically healthy sows were monitored. These Large White sows from The Sheep and Pig Farm Žirany (VPP Kolíňany, Slovak University of Agriculture in Nitra) were between the 3rd and the 6th farrows. All sows received the same mixture of food twice a day, 1.3 kg per 100 kg of live weight. Their diet contained 13.88% of crude protein, 3.96% of fat, 3.33% of crude fibre, 58.79% of nitrogen-free extract and 12.0 MJ.kg^{-1} of ME. At the parturition day, the sows were not fed. Their water intake was *ad libitum*. The parturition process was free from help of observers. One sample of the colostrum was collected from each sow every hour since the birth of the first piglet (0. hour) to the twelfth hour. Approximately 25 ml of colostrum were collected from different mammary glands without the injection of oxytocin – milking by hand. Before lyophilisation, ten ml of samples were weighed in a frozen flask (Freeze Dryer Series, ilShin Europe, Netherlands) and then they were frozen at -40 °C in a deep-freeze cabinet (EVERmed, Italy). After drying, the gross energy content of the colostrum samples was determined by Automatic Calorimeter AC500 (LECO Corporation, USA). Fat, crude protein and lactose were analyzed by MilkoScan FT 120 (Foss, Denmark). Primary calibration of MikoScan FT 120 comes from the manufacturer and it is valid for all kinds of milk. The determined GE values were in normal distribution, which is necessary for the following statistical analysis (Schubertová and Candrák, 2012). The concentration of gross energy (GE) in sow colostrum was statistically analyzed by a one-way ANOVA, the differences in average GE concentration of colostrum between different sampling times were tested with Duncan test ($P < 0.05$) and correlation analysis (Pearson's correlation) and evaluated using a SAS system V.8.02. and the SAS system 9.1. (SAS Institute Inc.).

Results and discussion

The survival of pigs during the critical 1st day after birth is known to depend mainly on a sufficient supply of energy from body reserves and ingested colostrum to meet the pig's requirements for heat production (Close, 1992; de Passillé et al., 1993). Mechanisms of thermoregulations are for pig's major energy losses (Debrecéni et al., 2012). The efficiency of 91% observed for the utilization of colostral ME (Le Dividich et al., 1994) is close to the 95% found for human milk (Whyte et al. 1985). Table 1 shows the gross energy concentration and the dry matter concentration in sow colostrum from the beginning of farrowing (0.hour) to the 12th hour from the beginning of farrowing. The GE of colostrum was highest soon after the beginning of farrowing: 5.30 MJ.kg^{-1} in the 1st hour, 5.48 MJ.kg^{-1} in the 2nd hour and 5.38 MJ.kg^{-1} in the 3rd hour. The GE of colostrum was lowest in the 11th hour (4.90 MJ.kg^{-1}) and in the 12th hour (4.88 MJ.kg^{-1}).

When experimenting with the utilization of colostral energy by a newborn pig, Le Dividich et al. (1994) determined the gross energy in colostrum during parturition as 5.95 MJ.kg^{-1} (the dry matter was 23.4%) and 24 hour after parturition, the

Table 1 Gross energy (GE in MJ.kg^{-1} of original dry matter) and dry matter (DM) content in sow colostrum during the first 12 hours from the beginning of farrowing

Hour from the birth of the first piglet (1)		Average Mean (2)	Standard Deviation (3)	Standard Error (4)	Variance (5)
0. hour (n 18)	GE in MJ.kg^{-1}	5.18	0.63	0.26	0.39
	DM in g.100 g^{-1}	23.15	2.87	1.17	8.26
1. hour (n 18)	GE in MJ.kg^{-1}	5.30	0.68	0.28	0.46
	DM in g.100 g^{-1}	22.43	2.03	0.82	4.12
2. hour (n 18)	GE in MJ.kg^{-1}	5.48	0.69	0.28	0.48
	DM in g.100 g^{-1}	21.68	3.94	1.61	15.53
3. hour (n 18)	GE in MJ.kg^{-1}	5.38	0.82	0.33	0.67
	DM in g.100 g^{-1}	22.28	3.06	1.25	9.37
4. hour (n 18)	GE in MJ.kg^{-1}	5.04	0.74	0.30	0.54
	DM in g.100 g^{-1}	20.17	0.20	0.08	0.03
5. hour (n 18)	GE in MJ.kg^{-1}	5.13	0.69	0.28	0.48
	DM in g.100 g^{-1}	23.00	6.02	2.46	36.20
6. hour (n 18)	GE in MJ.kg^{-1}	5.18	0.84	0.34	0.71
	DM in g.100 g^{-1}	21.27	3.11	1.27	9.65
7. hour (n 18)	GE in MJ.kg^{-1}	5.24	0.52	0.21	0.27
	DM in g.100 g^{-1}	21.47	2.81	1.15	7.92
8. hour (n 18)	GE in MJ.kg^{-1}	5.10	0.59	0.24	0.34
	DM in g.100 g^{-1}	19.86	1.40	0.57	1.95
9. hour (n 18)	GE in MJ.kg^{-1}	4.92	0.45	0.18	0.20
	DM in g.100 g^{-1}	21.11	3.49	1.42	12.20
10. hour (n 18)	GE in MJ.kg^{-1}	5.14	0.72	0.30	0.52
	DM in g.100 g^{-1}	18.06	0.43	0.17	0.18
11. hour (n 18)	GE in MJ.kg^{-1}	4.90	0.59	0.24	0.34
	DM in g.100 g^{-1}	19.09	1.79	0.73	3.21
12. hour (n 18)	GE in MJ.kg^{-1}	4.88	0.49	0.20	0.24
	DM in g.100 g^{-1}	18.33	0.59	0.24	0.35

$P > 0.05$ – there was no significant difference in the mean value of GE between different sampling times variancia
$P > 0.05$ – nebol zaznamenaný štatisticky významný rozdiel v priemernej hodnote BE medzi rôznymi časmi odberu vzoriek

Tabuľka 1 Obsah brutto energie (BE) a sušiny v kolostre prasníc počas prvých 12 hodín od začiatku pôrodu
(1) hodina od začiatku pôrodu, (2) priemerná hodnota, (3) smerodajná odchylka, (4) chyba strednej hodnoty, (5) variancia

value decreased to 5.90 MJ.kg^{-1} (the dry matter was 22.0%). This was caused by a higher fat concentration in the dry matter of colostrum observed by Le Dividich et al. (1994). In another experiment where sows were fed different protein diets and provided with different exposure to high ambient temperature, Renaudeau and Noblet (2001) determined the value of gross energy of sow milk collected at day 14 between 4.67 and 5.03 MJ.kg^{-1} (the dry matter was between 17.8 and 18.8%). From the energy aspect of colostrum and milk it is clear that decrease in crude protein energy ratio is compensated by the increased proportion of fat. Le Dividich et al. (1997) determined the GE content in colostrum that contained 2.5, 5.0, 7.5 or 10.0% of colostral fat. The results were as follows: the colostrum with 2.5% of fat contained 4.35 MJ.kg^{-1} (the dry matter was 19.50%), the colostrum with 5.0% of fat contained 5.02 MJ.kg^{-1} (the dry matter was 21.09%), the colostrum with 7.5% of fat contained 5.99 MJ.kg^{-1} (the dry matter was 23.46%), the colostrum with 10.0% of fat contained 6.78 MJ.kg^{-1} (the dry matter was 25.16%).

Our colostrum samples contained 3.30 to 5.24% of colostrum fat; 15.05 to 9.07% of crude proteins; 2.57 to 3.68% of lactose. The concentration of GE in our colostrum samples is like the GE in colostrum in the experiment done by Le Dividich et al. (1997).

Table 2 shows how strong the relationship is between the content of GE and the content of nutrients at different sampling times. The correlation coefficients vary to a great degree, which is caused by the low numbers of observations.

Milk energy reached the highest level during the farrowing in all treatment groups due to high protein, whereas milk fat was low at this sampling time (Coffey et al., 1982; Rolinec et al., 2011). Coffey et al. (1982) found that the energy content of milk showed the same tendencies over time and treatments as the fat content. A high protein content of colostrum is contributed to the increased energy content of colostrum (Coffey et al., 1982). Le Dividich et al. (1997) found out that the increase in colostrum fat level is associated with an increase in GE concentration and a decrease in moisture and crude

Table 2 Correlation analysis of the gross energy (GE) of colostrum and the nutrients in colostrum at different times of sampling (*n* = 18)

Gross energy (GE) (1)	Colostrum fat content at different times of sampling (2)												
	0 h	1^{st} h	2^{nd} h	3^{rd} h	4^{th} h	5^{th} h	6^{th} h	7^{th} h	8^{th} h	9^{th} h	10^{th} h	11^{th} h	12^{th} h
	-0.65	-0.38	0.48	0.80	-0.64	-0.14	0.80	-0.20	-0.69	-0.08	-0.82	-0.61	-0.62
Gross energy (GE) (1)	Content of crude protein in colostrum at different times of sampling (3)												
	0 h	1^{st} h	2^{nd} h	3^{rd} h	4^{th} h	5^{th} h	6^{th} h	7^{th} h	8^{th} h	9^{th} h	10^{th} h	11^{th} h	12^{th} h
	0.25	-0.43	-0.20	0.93	-0.39	-0.36	-0.34	0.33	-0.65	-.043	-0.88	-0.32	-0.57
Gross energy (GE) (1)	Content of lactose in colostrum at different times of sampling (4)												
	0 h	1^{st} h	2^{nd} h	3^{rd} h	4^{th} h	5^{th} h	6^{th} h	7^{th} h	8^{th} h	9^{th} h	10^{th} h	11^{th} h	12^{th} h
	-0.76	0.70	0.31	-0.71	0.52	-0.12	0.65	-0.34	0.92	0.71	0.83	0.89	-0.63
Gross energy (GE) (1)	Content of dry matter in colostrum at different times of sampling (5)												
	0 h	1^{st} h	2^{nd} h	3^{rd} h	4^{th} h	5^{th} h	6^{th} h	7^{th} h	8^{th} h	9^{th} h	10^{th} h	11^{th} h	12^{th} h
	0.27	0.27	-0.64	0.22	-0.60	-0.01	-0.31	0.01	-0.93	-0.22	-0.77	-0.54	-0.74

Tabuľka 2 Korelačná analýza medzi brutto energiou kolostra a obsahom jednotlivých živín v kolostre podľa rozličných časov odberu vzorky (*n* = 18)
(1) brutto energia (BE), (2) obsah tuku v kolostre podľa rozličných časov odberu vzorky, (3) obsah bielkovín v kolostre podľa rozličných časov odberu vzorky, (4) obsah laktózy v kolostre podľa rozličných časov odberu vzorky, (5) obsah sušiny v kolostre podľa rozličných časov odberu vzorky

Table 3 Analysis of variance of the gross energy concentration in sow colostrum depending on the time of sampling

	F Value	Pr > F	R-Square
GE (1)	0.47	0.9278	0.079

Tabuľka 3 Analýza variancie obsahu brutto energie kolostra prasníc v závislosti od času odberu vzorky
(1) BE

protein contents. The results in Table 3 suggest that the time of sampling did not have a statistically significant effect on the gross energy concentration in sow colostrum.

Conclusions

Insufficient supply of energy during the first hours of life is the greatest cause of mortality and poor growth in neonatal pigs. We detected the highest GE of colostrum soon after the beginning of farrowing: 5.30 MJ.kg^{-1} in the 1^{st} hour, 5.48 MJ.kg^{-1} in the 2^{nd} hour and 5.38 MJ.kg^{-1} in the 3^{rd} hour. The lowest GE of colostrum was found in the 11^{th} hour (4.90 MJ.kg^{-1}) and the 12^{th} hour (4.88 MJ.kg^{-1}) after the beginning of farrowing. We did not find a statistically significant relationship between the times of sampling and gross energy concentration in sow colostrum during the first 12 hours. From energy aspect of colostrum and milk it is clear that the decrease in crude protein energy ratio is compensated by the increase in the proportion of fat. The growth of energy concentration in colostrum is a method for increasing the energy intake of newborn pigs.

Súhrn

Cieľom tejto štúdie bolo stanoviť obsah brutto energie (BE) v kolostre prasníc v rôznych časoch odberu vzoriek a zistiť, vplyv času odberu vzorky na obsah BE v kolostre prasníc. Vzorky kolostra osemnástich prasníc boli odobraté v hodinových intervaloch od začiatku pôrodu až do dvanástej hodiny od začiatku pôrodu, následne boli v odobratých vzorkách kolostra stanovené BE, sušina, bielkoviny, tuk a laktóza. Najvyšší obsah BE v kolostre prasníc sme zistili vo vzorkách odobratých krátko po začatí pôrodu: v prvej hodine 5,30 MJ.kg^{-1}; v druhej hodine 5,48 MJ.kg^{-1} a v tretej hodine od začiatku pôrodu 5,38 MJ.kg^{-1}. Najnižší obsah BE v kolostre prasníc sme zaznamenali na jedenástu 4,90 MJ.kg^{-1} a dvanástu 4,88 MJ.kg^{-1} hodinu od začiatku pôrodu. Nezaznamenali sme štatisticky preukazný vplyv času odberu vzorky k obsahu brutto energie v kolostre prasníc.

Kľúčové slová: prasnica, kolostrum, živiny, brutto energia

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VPLYV POMALY PÔSOBIACICH HNOJÍV NA ÚRODU A KVALITU ZRELÝCH PLODOV JAHÔD

THE EFFECT OF SLOW RELEASE FERTILIZERS ON THE YIELD AND QUALITY OF MATURE STRAWBERRY FRUIT

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The effect of slow release fertilizers on the formation of yield and quality of mature fruit was investigated in a pot experiment with strawberries (the 'Darselect variety'). The experiment was established in 2011 within the area of Slovak Agricultural University in Nitra and consisted of six treatments with the same rate of nitrogen (1.65 g per pot) applied through different fertilizers. The first treatment: unfertilized control, the second treatment: quickly soluble fertilizer (DE), the third treatment: slowly acting fertilizer (DC), the fourth treatment: slowl release fertilizer with microelements (DCm), the fifth treatment: a mixture of DE + DC, the sixth treatment: application of urea-formaldehyde condensate. The highest yield of mature strawberry fruit (643.35 g/pot) was harvested from the fourth treatment fertilized by the slow release fertilizer with microelements. The nitrate content in fruits fluctuated from 56 to 65 $mg.kg^{-1}$ of fresh matter. A significantly lower content of NO_3^- (37.5 $mg.kg^{-1}$) was found in the treatment fertilized by urea-formaldehyde condensate. With vitamin C as well as with sugar content, the best results were achieved in the treatment fertilized by the mixture DE + DC; and they were statistically significant in comparison to the other fertilizer treatments.

Keywords: yield, vitamin C, sugar content, nitrate content, fertilizers

Jahody patria medzi najskôr dozrievajúce druhy ovocia a sú jednou z najúrodnejších ovocnín. Sú obľúbeným ovocím pre vynikajúcu chuť a arómu. Obsahujú však aj veľa dôležitých látok, ktoré sú nepostrádateľné pre ľudské zdravie (Pevná et al., 1989). Zásady aplikácie hnojív musia vychádzať zo skutočnosti, že jahody sú viacročné rastliny a zostávajú na stanovišti 2 – 3 roky, plytko korenia a majú slabšiu schopnosť osvojovať si živiny. Výživárske opatrenia by mali byť sústredené do dvoch období: hnojenie pred výsadbou a hnojenie založenej plantáže (Vaněk et al., 2013). Príjem živín jahodami začína na začiatku vegetačného obdobia, kedy rastú nové listy a regeneruje sa koreňová sústava. V tomto období je vysoký príjem dusíka a draslíka. Zvýšený príjem živín je opäť v čase tvorby generatívnych orgánov a regenerácie starších trsov po zbere, kedy sa tvorí veľké množstvo fytomasy a diferencujú sa kvetné púčiky pre ďalšie vegetačné obdobie (Vaněk et al., 2007). Pri určovaní dávok