Original scientific paper
DOI: /10.5513/JCEA01/19.1.2028
Journal of Central European Agriculture, 2018, 19(1), p.95-101

Essential amino acid index of sow's colostrum
Index esenciálnych aminokyselín v mledzive prasníc

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Abstract

The aim of this study was to determine the protein quality of sow's colostrum. For this purpose, the essential amino acid index (EAAI) of sow's colostrum was calculated. The study was carried out on 12 Large white sows, which were on the 2.9 farrowing on average. Colostrum samples were collected by milking per hand without application of oxytocin. First sample were milked at time of birth of first piglet, and then every hour till 12th hour. Essential amino acids were determined using Amino Acid Analyser AAA400 (Ingos, Prague). For calculation of EAAI, the egg protein ($EAAI_{egg}$) and protein of sow's milk ($EAAI_{sow's\ milk}$) were used as standard. The highest value of EAAI was calculated for both at 4th h, $EAAI_{egg}$ 97.1%, $EAAI_{sow's\ milk}$ 120.2%. The lowest values of EAAI were calculated at 12th h $EAAI_{egg}$ 78.3% and $EAAI_{sow's\ milk}$ 96.9%. During the first 12 hours, protein of sow's colostrum had not reached the quality of egg protein. Except sample collected at 12th hour after birth of first piglet, all colostrum samples had better quality of protein in comparison to sow's milk. No significant (P>0.05) differences of EAAI between colostrum samples collected at different times from the birth of the first piglet till 12th h were observed.

Keywords: amino acids, colostrum, index of essential amino acid, sow

Abstrakt

Cieľom tejto práce bolo stanoviť kvalitu bielkovín v mledzive prasníc. Pre dosiahnutie vytýčených cieľov bol pre mledzivo prasníc vypočítaný index esenciálnych aminokyselín (EAAI). Štúdia bola realizovaná na 12 prasniciach plemena Biela ušľachtilá, ktoré boli v priemere na 2,9 vrhu. Vzorky mledziva boli odoberané ručným oddojením, bez aplikácie oxytocínu. Prvá vzorka bola odobraná v čase narodenia prvého prasiatka vo vrhu, následné vzorky boli odoberané každú hodinu až do dvanástej hodiny po narodení prvého prasiatka. Obsah esenciálnych aminokyselín bol stanovený na prístroji Amino Acid Analyser AAA400 (Ingos, Praha). Ako štandardná bielkovina pre výpočet EAAI bola použitá bielkovina vajca ($EAAI_{egg}$) a bielkovina mlieka prasníc ($EAAI_{sow's\ milk}$). Najvyššie hodnoty EAAI boli stanovené pri oboch na 4 hodinu od narodenia prvého prasiatka, $EAAI_{egg}$ 97,1%, $EAAI_{sow's\ milk}$

120,2%. Najnižšie hodnoty EAAI boli stanovené na dvanástu hodinu od narodenia prvého prasiatka, $EAAI_{egg}$ 78,3% and $EAAI_{sow's\ milk}$ 96,9%. Počas sledovaných prvých dvanástich hodín mledzivo prasníc nedosiahlo kvalitu bielkovín, ktorá je vo vaječnej bielkovine. Okrem vzorky mledziva odobranej na dvanástu hodinu po narodení prvého prasiatka, mali všetky vzorky mledziva lepšiu kvalitu bielkovín ako je kvalita bielkovín v mlieku prasníc. Rozdiely hodnôt $EAAI_{egg}$ a aj $EAAI_{sow's\ milk}$ zistené medzi jednotlivými časmi odberu vzorky boli štatisticky nepreukazné (P>0.05).

Kľúčové slová: aminokyseliny, index esenciálnych aminokyselín, mledzivo, prasnica

Introduction

Colostrum are mammary secretions from the sow within a few hours after parturition. Sow's colostrum has been studied several times for the concentration of all nutrients, as well as for amino acids. For the determination of amino acids concentration, the samples called colostrum were sampled by researchers in different sampling times. For example Elliott et al. (1971) obtained colostrum samples within 12 h after farrowing, without the injecting of oxytocin. Csapó et al. (1996) took the first colostrum sample immediately after parturition (before the piglets could suckle) and then after 12 and 24 h, without injecting of oxytocin. Hurley (2015) wrote, that colostrum used for amino acids determination was from within 12 h of parturition, together with information published by Jackson et al. (1995) about necessary administration of oxytocin to collect colostrum samples by about 6 h after birth of the first piglet. Other publications shown amino acids concentration only in sow's milk. For example, Dourmad et al. (1998) took milk samples for amino acids determination after injecting of oxytocin at day 3, 7, 15 and 22 of lactation. Daza et al. (2004) milked functional glands of sows after injecting of oxytocin on day 5, 12, 19 and 26 of lactation. Dunshea et al. (2005) collected milk samples from sows in the mid and late lactations stage, without the injection of oxytocin. All above mentioned authors published changes in amino acids concentration between colostrum and milk of sows, where as a colostrum only one or two samples are considered. A closer look on changes of amino acids in sow's colostrum is needed. Therefore, the aim of this study was to define the protein quality (EAAI essential amino acid index) of sow's colostrum through comparison to standard egg protein and protein of sow's milk.

Materials and methods

The experiment was realized at a pig and sheep farm in Žirany (Slovakia) under Slovak University of Agriculture in Nitra (48°22'43" N, 18°10'58" E). For this study, twelve Large white sows were used. Sows were on the 2.9 farrowing on average. One week before farrowing sows were moved to individual farrowing crates within the pens. During the later part of pregnancy, the sows were fed approximately 3 $kg*day^{-1}$ of a standard lactation diet containing 86.09% dry matter, 14.63% crude protein, 3.74% crude fat, 3.2% crude fibre, 58.89% nitrogen free extract, 5.63% ash and 13.1 $MJ*kg^{-1}$ ME. Concentration of amino acids in lactation diet in kg of feed was as follows aspartic acid 11.1 g, threonine 5.8 g, serine 6.1 g, glutamic acid 22.4 g,

proline 9.7 g, glycine 5.1 g, alanine 5.5 g, valine 5.4 g, isoleucine 4.5 g, leucine 9.8 g, tyrosine 4.6 g, phenylalanine 6.2 g, histidine 3.1 g, lysine 8.7 g, arginine 8.7 g, cystine 3.1 g and methionine 2.7 g. At the day of parturition sows received 1.25 kg*day^{-1} of a diet. Feed analysis, as well as the determination of amino acids in feed and colostrum samples were realized at Department of Animal Nutrition (SUA in Nitra) in Laboratory of Quality and Nutritive Value of Feeds.

Colostrum samples were collected from the first, second and third pair of mammary glands, similar as published Šamanc et al. (2013). Colostrum samples were always collected from the same three glands. Every colostrum sample consisted from colostrum mix of these three glands. The schedule for collection of colostrum by hand milking was immediately after birth of the first piglet (0 h) and then every hour for the next 12 hours. During parturition piglets were remained by the mammary gland and colostrum samples were collected at the stated times. Afterwards piglets were separated from their dams and were held in the supplemental heating area in a corner of the farrowing crate. Every hour, approximately 5 minutes before stated time of colostrum sampling, piglets were removed from the heating area to mammary gland and colostrum samples were collected during a suckling bout initiated by the piglets (i.e. without injecting of oxytocin). After suckling, piglets were again removed to the heating area. This procedure was repeated until the last colostrum sampling at 12th h. In some cases, the ejection of colostrum was not initiated by the piglets. In that case, piglets were removed back to the heating area without getting a colostrum sample. This is the reason why the number of colostrum samples is not identical in each sampling time. The number of gained samples in stated sampling times is as follows: 0 h, 1st h and 2nd h 12 samples; 3rd h, 4th h and 5th h 9 samples; 6th h and 8th h 8 samples; 7th h, 10th h and 12th h 7 samples; 9th h and 11th h 6 samples.

Gained colostrum samples were frozen and stored at -20 °C and before analysis were lyophilized. Dry matter by oven drying to constant weight at 103 ± 2 °C and crude protein by Kjeldahl method, N x 6.38 (AOAC, 1995) were determined. Amino acids concentration was determined using amino acid analyser AAA 400 (Ingos, Prague). Freeze-dried colostrum samples for amino acid determination were adjusted using the acidic and oxidative acidic hydrolysis. The chromatographical analysis of sample hydrolysates was performed using Na-citrate buffers and ninhydrin detection according Davídek et al. (1981).

Protein quality of sow's colostrum was assessed using the basic index of essential amino acid ($EAAI_{egg}$) (Davídek et al., 1983). As standard protein was used egg protein and its concentration of essential amino acids was published by Zelenka (2006). Generally, in nutrition the egg protein is used as standard protein. However, for pigs as standard protein is considered the protein of sow's milk. Therefore, $EAAI_{sow's\ milk}$ of colostrum samples were calculated as well with formulas, where the protein of sow's milk was used as standard protein. An average concentration of essential amino acids in sow's milk was calculated from results published by Elliott et al. (1971), Csapó et al. (1996), Dourmad et al. (1998), Daza et al. (2004), Petrikovič et al. (2005).

Gained results were tested for normal distribution, which is needed for statistical analysis as published Schubertová and Candrák (2014). Then were results statistically analyzed by one-way ANOVA, the differences between mean values of

DOI: /10.5513/JCEA01/19.1.2028

EAAI of colostrum collected in different times were tested with Tukey's Studentized Range (HSD) Test (SAS system 9.1, SAS Institute Inc.). $P<0.05$ was considered as significant.

Results and discussion

Development, survival and growth rate of piglets depends mainly on birthweight, nutrition, health status and genetic (Trakovická et al., 2006; Mlynek et al., 2011; Mlynek et al., 2013). However without intake of colostrum by newborn piglet is the survival of first days impossible. Unique properties of colostrum proteins are the results of evolution of mammals. Colostrum and milk proteins are therefore an important factor of piglet's development (Rolinec et al., 2017). Zhou et al. (1992) published, that colostrum and milk composition should not be a major limiting factor in survival of piglets born to Meishan x Yorkshire crossbred gilts.

Table 1. Essential amino acid index (EAAI) in sow's colostrum

Time from birth of the first piglet	$EAAI_{egg}$* %	$EAAI_{sow's\ milk}$** %
0 h	85.7	106.1
1 h	88.8	110
2 h	92.3	114.3
3 h	90.5	112
4 h	97.1	120.2
5 h	92.8	114.9
6 h	89.8	111.2
7 h	96.8	119.9
8 h	91.3	113
9 h	96.6	119.6
10 h	92.1	114.1
11 h	92	113.9
12 h	78.3	96.9

*essential amino acids concentration of egg published by Zelenka (2006) was taken as a standard for calculation of $EAAI_{egg}$; **average essential amino acids concentration of sow's milk calculated from results published by Elliott et al. (1971), Csapó et al. (1996), Dourmad et al. (1998), Daza et al. (2004), Petrikovč et al. (2005) was taken as a standard for calculation of $EAAI_{sow's\ milk}$; there were no significant differences between sampling time.

The sow prioritizes protein content in colostrum and milk if the protein content in the feed is scarce, by metabolizing body reserves, which indicates that protein is extremely important to the piglets (King et al., 1996; Eliasson and Isberg, 2011). The protein–bound and free amino acids from sows colostrum are for neonatal pigs highly digestible and available (Carol et al., 2009). The utilization of through colostrum ingested protein by newborn piglets depends on quality of protein. One of the best way for protein quality evaluation is by calculation of EAAI. The values and development of EAAI in sow's colostrum is shown in Table 1. According to the calculated values of $EAAI_{egg}$, the protein quality of sow's colostrum was in each sampling time worse than that of the egg. The highest value of $EAAI_{egg}$ was at 4^{th} h. Colostrum of sows had from 0 h to 11^{th} h better protein quality ($EAAI_{sow's\ milk}$) compared to the average protein quality of sow's milk. Despite changes of $EAAI_{egg}$ as well as $EAAI_{sow's\ milk}$ between sampling times, there was not found significant difference ($P>0.05$). Similar development of biological value between 0 and 52^{nd} h published Csapó et al. (1996). Hurley (2015) stated, that colostrum compared to milk contains more amino acids. Le Dividich et al. (2005) claimed that threonine concentration of colostrum is higher than it is in milk, because threonine is a part of immunoglobulins.

Conclusions

All changes in $EAAI_{egg}$ or in $EAAI_{sow's\ milk}$ between different sampling times were nonsignificant ($P>0.05$). During the first 12 hours, protein of sow's colostrum had not reached the quality of egg protein. During the first 11 hours, colostrum of sows had better quality of protein compared to the average protein of sow's milk. Hence, not only the protein quality of sow's milk, but also all proteins in pig nutrition should have been compared to protein of sow's colostrum. Results of this research contribute to a better understanding of changes in protein quality of sow's colostrum.

Acknowledgements

This study was supported by the Grant Agency of the Slovak Ministry of Education, Science, Research and Sport and Slovak Academy of Sciences (project n. 1/0723/15).

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