The effect of dietary conjugated linoleic acid on the production performance of gilts

Vliv zkrmování konjugované kyseliny linolové na produkční užitkovost prasniček

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Abstract

The aim of this study was to evaluate whether the supplementation of conjugated linoleic acid (CLA) in feed mixtures influences the parameters of production performance in gilts. The experimental work was realized in operating conditions of a production pig farm. Total number of 40 gilts (20 gilts in control group and 20 gilts in experimental group) of hybrid combination Czech Large White x Czech Landrace (CLW x CL) were included in the observation. During the experiment the gilts kept for rearing were fed with a control compound feed and an experimental compound feed suplemented with 2% of CLA for the time of 65 days. At the beginning and the end of the experiment, performance tests were conducted in accordance with the methodology of ČSN 466164 on Performance and progeny testing in pigs. The gilts in the experimental group reached higher weight 148.05 ± 15.80 kg versus 135.75 ± 17.60 kg ($P < 0.05$) at the end of the test. The evaluation of mean achieved daily gain for the time from birth to the end of the test confirmed higher values for the gilts in the experimental group 586.05 ± 66.64 g*day^{-1} against 539.00 ± 62.19 g*day^{-1} for the gilts in the control group ($P < 0.05$). Within other parameters of efficiency in gilts, i.e. lean meat content, backfat thickness and depth of MLLT muscle, no significant influence of CLA on their phenotypic manifestation was found. The results of study indicate, that the supplementation of feed mixture for rearing gilts with conjugated linoleic acid can influence the growth ability of gilts.

Keywords: conjugated linoleic acid, gilts, pigs, production performance

Abstrakt

Cílem práce bylo vyhodnotit, zda přídavek konjugované kyseliny linolové (CLA) do krmné směsi ovlivní parametry produkční užitkovosti prasniček. Pokus byl realizován v provozních podmínkách užitkového chovu prasat. Do sledování bylo zařazeno celkem 40 prasniček hybridní kombinace České bílé ušlechtilé x Česká Landrase, přičemž 20 prasniček bylo v kontrolní a 20 prasniček v pokusné skupině. Během sledování byly prasničky ustájeny v odchovně a krmeny kontrolní krmnou směsí a pokusnou směsí s přídavkem 2% CLA, a to po dobu 65 dnů. Na začátku a na konci pokusu byla provedena kontrola užitkovosti prasat dle metodiky České státní normy 466164. Prasničky pokusné skupiny dosáhly na konci testu vyšší hmotnosti 148,05 ± 15,80 kg oproti 135,75 ± 17,60 kg u skupiny kontrolní ($P < 0,05$). Vyhodnocení průměrného denní přírůstku od narození do konce testu prokázalo vyšší hodnotu u prasniček pokusné skupiny 586,05 ± 66,64 g*den^{-1} oproti 539,00 ± 6219 g*den^{-1} u skupiny kontrolní ($P < 0,05$). V rámci ostatních parametrů produkční užitkovosti prasniček, tj. u podílu libového masa, výšky hřbetního tuku a hloubky MLLT, nebyl zjištěn vliv CLA na jejich fenotypový projev. Získané výsledky ukazují, že přídavek konjugované kyseliny linolové do krmné směsi prasniček během odchovu může ovlivnit jejich růstovou schopnost.

Klíčová slova: konjugovaná kyselina linolová, prasata, prasničky, produkční užitkovost

Detailní abstrakt

Cílem chovatele by mělo být zajistit odchov prasniček směřující k odpovídajícímu tělesnému vývinu a nástupu pohlavních funkcí. Dosažení dobrých výsledků ovlivňuje řada faktorů, z nichž velice podstatným exogenním faktorem je krmná dávka, respektive její složení. Kromě potřebné energie, aminokyselin, vitaminů a minerálních látek jsou velmi podstatnou složkou výživy mastné kyseliny. Předmětem značného zájmu, a to jak ve sféře humánní, tak i v oblasti výživy zvířat, se v posledním období stala konjugovaná kyselina linolová (CLA). Důvodem zvyšujícího se zájmu využití konjugované kyseliny linolové jsou její fyziologické účinky.

V práci byl sledován vliv přídavku konjugované kyseliny linolové (CLA) do krmné směsi na produkční užitkovost prasniček během odchovu. Do sledování bylo zahrnuto celkem 40 prasniček kombinace ČBU x ČL, přičemž 20 ks bylo zařazeno do kontrolní skupiny a 20 ks do pokusné skupiny. Pokusné skupině byla zkrmována kompletní krmná směs s přídavkem 2% CLA. Na začátku a na konci pokusu byly u prasniček provedeno měření dle metodiky zkoušek vlastní užitkovosti. Produkční užitkovost prasniček byla hodnocena v rámci každé skupiny. Hodnocení zahrnovalo, a to jak na začátku, tak na konci sledování, následující parametry: živá hmotnost (kg), průměrný denní přírůstek (g*day^{-1}), výška hřbetního tuku (mm), hloubka MLLT (mm), podíl libového masa (%). Statistická analýza byla provedena pomocí programu STATISTICA (10.0). Získané výsledky ukazují, že přídavek konjugované kyseliny

linolové do krmné směsi pro prasničky během odchovu ovliňuje jejich růstovou schopnost, resp. průměrný denní přítůstek. Ostatní parametry produkční užitkovosti, tj. výška hřbetního tuku, hloubka MLLT a podíl libového masa, ovlivněny nebyly.

Introduction

One of the essential prerequisites for achievement of profitable lifelong performance of sows is appropriate preparation before their productive period. Improper rearing of gilts before their inclusion to the reproductive cycle does not ensure subsequent achievement of maximum performance. Breeders‘ goal should therefore be to secure rearing of gilts leading to appropriate body development and onset of reproductive functions. Creation of optimal conditions in individual phases of reproductive cycle for full exploitation of reproductive potential of sows is basic prerequisite for effective breeding of sows. Feed ration, or its composition, is one of the very substantial exogenous factors. Besides necessary energy, amino acids, vitamins and minerals, also fatty acids are very important compounds of nutrition (Horký, 2014). Both in human and in animal nutrition sphere, conjugated linoleic acid (CLA) became an object of remarkable interest. The reason for increasing interest in using the conjugated linoleic acid are its physiological effects. Stachowska (2008) state that interest in CLA increased with published results on anticancer and lipodystrophic effects, impact on changes in body composition, on diabetes, hypercholesterolemia and on immune system, growth ability and reproduction.

The effects of CLA was studied in various animal species, including farm animals, in terms of possible influencing their performance, but also in terms of animal products quality. Studies were conducted regarding effects of various levels of CLA supplementation in feed mixtures on productive and reproductive characteristics of pigs, however the published results are not consistent. Corino et al. (2009) state that the biggest problem is in using different levels of CLA supplementation, length of supplementation and also limited numbers of animals in individual studies. For this reason, the aim of this study was to confirm possible effects of conjugated linoleic acid in feed mixtures on production parameters of gilts in operating conditions during rearing.

Materials and methods

Animals, housing and experimental design

Altogether 40 gilts of hybrid combination Czech Large White x Czech Landrace (CLW x CL) were included in the observation. The gilts were divided into two groups of the same number, i.e. 20 gilts in the control and 20 gilts in the experimental group. The gilts were stabled in common operating conditions of rearing house. Intake of feed and water was *ad libitum*. The experimental work was started when mean weight 108.10 ± 6.56 kg was achieved in the experimental group (at the age of 177.20 ± 12.31 days) and 109.80 ± 9.67 in the control group (at the age 179.20 ± 9.92 days). From this moment the experimental group was fed only with complete compound feed for rearing gilts supplemented with conjugated linoleic acid at the level of 2% for 65 days.

Diets and Conjugated linoleic acid (CLA)

The source of synthetic conjugated linoleic acid was the preparation Lutalin (C 18:2 trans – 10 cis – 12) from BASF, Germany. The preparation was added to the experimental compound feed at the level of 2% by spraying with the use of vacuum mixer. Analysis of compound feed composition was performed in the Laboratory of the Department of Animal Nutrition and Forage Production. Composition and nutrition content of the control and the experimental complete compound feed for gilts are shown in Table 1 and Table 2.

Table 1. Composition of the control and the experimental compound feed for gilts kept for rearing

Tabulka 1. Složení kontrolní a pokusné krmné směsi pro prasničky v odchovu

Components proportion (%)	Control compound feed	Experimental compound feed
Wheat	39.00	39.00
Wheat bran	5.00	5.00
Spring barley	31.00	31.00
Soybean, toasted	9.00	9.00
Rapeseed oil	2.00	0.00
Sugar beet pulp	5.00	5.00
Protein dried fodder	3.00	3.00
Yeast Vitex	1.50	1.50
Conjugated linoleic acid	0.00	2.00
Calcium carbonate	1.40	1.40
Calcium hydrogen phosphate	1.00	1.00
Sodium chloride	0.40	0.40
Copper sulphate pentahydrate ($mg*kg^{-1}$)	23.00	23.00
3 – phytase (PPU)	500.00	500.00
Vitamin A ($IU*kg^{-1}$)	15 000	15 000
Vitamin D 3 ($IU*kg^{-1}$)	1 500	1 500
Vitamin E ($IU*kg^{-1}$)	52.00	52.00

Table 2. Nutrient content of the control and the experimental compound feed for gilts kept for rearing

Tabulka 2. Obsah živin v kontrolní a pokusné krmné směsi pro prasničky v odchovu

Nutrient content (g*kg^{-1})	Control compound feed	Experimental compound feed
Water	111.53	113.75
Dry matter	888.47	886.25
Nitrogen	23.38	23.45
Crude protein	146.13	146.56
Indigestible N - substances	17.25	18.00
Digestible N – substances	128.88	128.56
Roughage	37.33	37.00
Fat	48.59	45.78
Ash	57.43	57.13
Sacharose	21.77	19.56
Starch	438.90	434.26
Lysine	7.55	7.55
Methionine	2.41	2.41
Met + cys	4.79	4.79
Threonine	4.94	4.94
Tryptofan	1.66	1.66
Calcium	0.69	0.69
Total phosphorus	4.52	4.52
Digestible phosphorus	1.19	1.19
Sodium	1.64	1.64
ME (MJ*kg^{-1})	13.36	13.22

Production performance of gilts

At the beginning and at the end of the experiment, the actual performance was tested in accordance with methodology of ČSN 466164 on Performance and progeny testing in pigs. Live-weight of animals was measured by weighing using digital scales. Measuring of performance parameters was done by the means of PIGLOG 105 device. Mean daily gain from birth to the day of measuring is calculated as the ratio of weight and age of individuals. Mean backfat thickness is calculated from measured values of fat in points A and B, while points A and B are defined as follows: starting points of measurement are determined in the mid dorsal line. Point A_0 is on the withers perpendicular to the projection of the elbow. Point C_0 is in lumbar region perpendicular to the patella. The middle between these points represents point B_0. Measuring point A is between points B_0 and C_0 caudally. Measuring point B is between points A_0 and B_0 + 3 cm caudally. Both measuring points are 70 mm from mid dorsal line. Measuring point A is used for measuring thickness of backfat, measuring point B is used for measuring fat and muscle. Measuring is conducted in the caudo-cranial direction. Achieved phenotypic levels of mean daily gain and backfat thickness are corrected to a uniform weight of 90 kg. Phenotypic value of percentual proportion of lean meat is corrected to a uniform weight of 100 kg.

Statystical analysis

The data were analysed using software STATISTICA (10.0). All data were expressed as mean ± SD. The Student's test was used to determine differences between the means of control and experimental group. A probability value of $P > 0.05$ was considered statistically non-significant (NS), $P < 0.05$ as statistically significant (x).

Results

Growth ability of gilts

Mean values of live-weight and mean daily gain of gilts at the beginning and the end of the experiment are presented in Table 3. At the beginning of supplementation, no significant differences were found between groups of gilts in observed parameters. Weight evaluation of gilts at the end of the test showed difference between observed groups, when higher weight was achieved by the gilts with supplementation of CLA. The difference in achieved weight of gilts at the end of the test, which was 12.3 kg, was found statistically significant ($P < 0.05$). Evaluation of achieved mean daily gain for the period from birth to the end of the test proved higher value for gilts in the experimental group compared to the value of the control group. The difference in achieved values between observed groups was 47.05 $g*day^{-1}$ and was statistically significant ($P < 0.05$). The results of the test show significant effect of conjugated linoleic acid supplementation on growth ability of gilts.

Table 3. Parameters of growth ability in gilts at the start and at the end of the experiment

Tabulka 3. Parametry růstové schopnosti prasniček na začátku a na konci pokusu

Parameter	Group		Significance
	Control	Experimental	
Live weight at the start of the test (kg)	109.80 ± 9.67	108.10 ± 6.56	NS
MDG from birth to the start of the test (g*day^{-1})	573.10 ± 47.10	595.20 ± 46.26	NS
Live weight at the end of the test (kg)	135.75 ± 17.60	148.05 ± 15.80	x
MDG[a] from birth to the end of the test (g*day^{-1})	539.00 ± 62.19	586.05 ± 66.64	x

[a]MDG - mean daily gain

Parameters of production performance in gilts

Achieved mean values of observed performance parameters in gilts at the beginning of the experiment are presented in Table 4. The differences between mean values of backfat thickness, depth of MLLT muscle and lean meat content in observed groups at the beginning of the test were not statistically significant.

Table 4. Parameters of production performance in gilts at the start of the experiment

Tabulka 4. Parametry produkční užitkovosti prasniček na začátku pokusu

Parameter	Group		Significance
	Control	Experimental	
Live weight (kg)	109.80 ± 9.67	108.10 ± 6.56	NS
Backfat thickness (mm)	9.30 ± 0.27	9.60 ± 0.23	NS
Depth of MLLT[b] muscle (mm)	51.55 ± 5.67	51.90 ± 5.10	NS
Lean meat content (%)	60.01 ± 3.26	60.85 ± 2.99	NS

[b]MLLT – *musculus longissimus lumborum et thoracis*

Mean values of observed parameters in gilts at the end of the test are presented in Table 5. Measuring of the backfat thickness revealed an increase of 2.1 mm in the control group and 2.3 mm in the experimental group. Neither the difference between mean values of this parameter at the end of the experimental work neither the change of height of fat cover were statistically significant. Based on achieved results it can be concluded that addition of conjugated linoleic acid to growing gilts had no significant effect on dorsal fat deposition.

Table 5. Parameters of production performance in gilts at the end of the experiment

Tabulka 5. Parametry reprodukční užitkovosti prasniček na konci pokusu

Parameter	Group		Significance
	Control	Experimental	
Live weight (kg)	135.75 ± 17.60	148.05 ± 15.80	x
Backfat thickness (mm)	11.40 ± 0.32	11.90 ± 0.35	NS
Depth of MLLT[b] muscle (mm)	59.40 ± 7.71	64.21 ± 8.46	NS
Lean meat content (%)	58.74 ± 3.68	58.40 ± 3.86	NS

[b]MLLT – *musculus longissimus lumborum et thoracis*

Another observed parameter was the depth of MLLT muscle. During experiment the depth of MLLT muscle increased of 7.85 mm in the control group and in gilts receiving addition of CLA in feed mixture the increase was 12.31 mm. Although the difference of mean values between evaluated groups at the end of observation reached 4.81 mm in favor of the experimental group, it was not statistically significant. Neither ultrasound examination of the lean meat content revealed a statistically significant difference.

During the testing period, the lean meat content decreased in the control group of 1.27%. In gilts of the experimental group after the termination of feeding mixture supplemented with CLA the decrease of mean lean meat content was 2.45%.

The results gained within the experimental observation indicate that addition of conjugated linoleic acid to feed mixture had no significant effect on production parameters of gilts.

Discussion

Growth ability of gilts

Results gained from the experiments showed significant effect of 2.0% addition of CLA to feed mixture for gilts on their growth ability, with higher value of mean daily

gain proved in the experimental group of gilts. West et al. (1998) report increased metabolic utilization of nutritients in case when conjugated linoleic acid is included into feed ration, which according to authors indicates, that CLA can positively influence production parameters, mainly gain and conversion. Similar conclusion was published by Evans et al. (2002) who found in their work, that addition of conjugated linoleic acid increases efficiency of nutrition. Also Thiel-Cooper et al. (2001) proved an increase of mean daily gain in case of supplementation of feed ration with CLA. Parrish et al. (1997) performed an experiment in order to asses an effect of several levels of conjugated linoleic acid supplementation on growth ability of gilts. Within observation, they fed CLA in following levels: 0.12%, 0.25%, 0.50% and 1.0%. On the basis of achieved results the authors state that mean daily gain increased linearly with increasing level of fed CLA ($P < 0.01$).

Contrary to previous results, most authors say that supplementation of feed ration with conjugated linoleic acid has no significant effect on growth ability. Martin et al. (2008) studied effect of different levels of conjugated linoleic acid on growth parameters of gilts. Hybrid gilts were fed with feed mixtures with three levels of CLA, 0%, 1.0% or 2.0% for 53 days. However, the level of CLA supplementation had no significant effect on mean daily gain and feed conversion. Neither Ostrowska et al. (1999), who fed hybrid gilts (LW x L) with 0.125%, 0.25%, 0.50%, 0.75% and 1.0% of CLA, proved an effect of any of these levels of CLA supplementation on growth ability of gilts.

Based on the evaluation of 0.5% CLA supplementation, O´Quinn et al. (2000) report that mean daily gain was lowered compared to a control group.

Parameters of production performance in gilts

The achieved results of the experimental observation proved no effect of supplementation of feed ration with CLA on the backfat thickness. The same results were published by Chartrand et al. (2003), who report that 2% dose of CLA fed for 36 days during rearing did not influence the backfat thickness. Gatlin et al. (2002) fed gilts with 1% CLA supplementation for 47 days and found no effect on the backfat thickness as well. Martin et al. (2008) tested two levels of CLA supplementation (1.0% or 2.0%) in feed mixtures for gilts for 53 days. On the basis of achieved results they state that neither of the levels had significant effect on the backfat thickness. Neither Eggert et al. (2001) found a change in backfat thickness with 1% dose of CLA. Results, when the backfat thickness was increased in case of conjugated linoleic acid supplementation were published by Estienne et al. (2006). After 44 days of 1% addition, the authors reported highly statistically significant difference ($P < 0.01$). On the contrary, decrease of the backfat thickness by the effect of CLA was published by Weber et al. (2006). After eight-week feeding with 1% CLA the backfat thickness decreased ($P < 0.01$). Ostrowska et al. (1999) say that back fat deposition decreased linearly with increasing level of CLA supplementation. Decrease of backfat thickness ($P < 0.05$) after feeding mixtures with CLA is reported also by Jiang et al. (2010). Conclusions of authors mentioned above correspond to the findings of Brodie et al. (1999), who same as Degrace et al. (2004), report that feeding conjugated linoleic acid leads to decrease of body fat content, because CLA decreases weight of adipose cells by the means of increased apoptosis of preadipocytes and adipocytes.

Neither the effect of CLA on the depth of MLLT muscle was confirmed in the experiment. Gained results correspond to results of authors Degrace et al. (2004) who found no statistically significant effect of feeding 1% CLA supplementation on the depth and the area of MLLT in gilts. The same conclusions were published by Tous et al. (2013), when 4% supplementation of conjugated linoleic acid for 54 days did not significantly influence the depth of MLLT muscle.

Neither the effect of CLA on the lean meat content was proved during observation in study. However, results found in this observation do not correspond with statements of authors Park and Pariza (2007), who attributed to CLA not only decrease of body fat content, but also an ability to support muscle formation. According to Ostrowska et al. (1999), the effects of conjugated linoleic acid on skeletal muscles are less examined, however the results show that CLA can increase deposition of proteins in muscles and ratio of lean meat to fat deposition. They prove their claim with results of their study when the formation and deposition of muscle tissue was increased after eight-week supplementation to the detriment of fat deposition. Their statement is confirmed by conclusions published by Weber et al. (2006), who report that eight-week supplementation of 1% CLA led to an increase of the lean meat percentage in gilts ($P < 0.05$). Tous et al. (2013) fed gilts with higher levels of CLA in their study for the purpose of possible effect enhancement, particularly 4.0% CLA for 54 days. After evaluation of the results the authors state that higher levels of CLA significantly increased the lean meat content. Results confirming positive effect of conjugated linoleic acid supplementation on muscle tissue formation in gilts were published also by Dugan et al. (2001) whose conclusions speak about increase of the lean meat content of 2.7%.

Conclusions

The aim of the realized experiment was to analyze the possibility of influencing the parameters of production performance in gilts during rearing by the means of supplementing the feed mixture with conjugated linoleic acid. On the basis of the achieved results it can be concluded that the supplementation of CLA can influence the growth ability of gilts.

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