EFFECT OF ORGANIC CHROMIUM TO CARCASS COMPOSITION AND CHEMICAL COMPOSITION OF ADDUCTOR MUSCLE IN LARGE WHITE BREED

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Abstract

Chromium is an integral part of the biochemical processes of carbohydrates, lipids and proteins. It works like a coenzyme in organism as well as it increases the efficiency of the insulin and the connections to the individual receptors or target cells. It also helps to control the transmission of the glucose. Although chromium is classified as a functional questionable microelements, the results of several studies of the recent times suggest that it might in the future play an important role as a dietary supplement in nutrition of pigs. The objective of the experiment was to find the effect of the organic chromium (Cr^{+3}) on structure of the carcase and parameters of the chemical composition muscle *musculus aductor* of the Large White Breed. The mineral-protein dough used in feed ration for experimental group was enriched by chromium-nicotinate, which was 0,75 $mg.kg^{-1}$ in complete feed. Chromium-nicotinate was in form inactivated yeasts saccharomyces cerevisiae fermented on medium which was from natural sources with higher content trivalent chromium. In parameters of the carcass value we found statistically significant difference at $P \leq 0.05$ in parameter % lean meat cuts in % and in parameter % thigh of weight of carcass side in %. In parameters of the carcass value we found statistically significant difference at $P \leq 0.05$ in parameter of the weight thickness from thigh in kg and in amount of abdominal fat in kg. We found no significant differences in the groups of fatty acids in intramuscular fat in *muscullus aductor*.

Key Words: Meat quality, pork, chromium-nicotinate, Large White Breed, muscullus aductor

According to study WANG et al. (2008) dietary CrPic supplementation increased longissimus muscle area by 17.29%. According to random effects models, dietary Cr supplementation decreased 10th-rib fat thickness whereas percentage carcass lean and LM area increased presented in study by SALES et al. (2011). In addition, studies with chromium picolinate (CrP) have indicated that it decreased weight of backfat (PAGE et al., 1993). According to PAGE et al. (1993) chromium supplementation in pig diets was found to improve feed efficiency, lean meat yield and reduce backfat thickness. On the other hand MOONEY et al. (1997) published in his study that dietary Cr addition had no effect on the performance or backfat measurements of the pigs. Results from experiment by JACKSON et al. (2009) showed that Cr supplementation decreased 10th-rib backfat and increased percentage of muscle. WENK et al. (1995), MATTHEWS et al. (2005) reported no differences in backfat thickness, or loin muscle area in pigs supplemented with chromium. As determined by physical-chemical separation, pigs fed CrP had an increased percentage of intermuscular fat compared with pigs fed the control diets according to study by BOLEMAN et al. (1995). WENK et al. (1995) reported that pigs supplemented with CrP tended to have higher percentages of intramuscular fat. Cr supplementation may affect the fatty acid profile of fat stores in the pig, and this may be the reason for the observed improvement in some aspects of pork quality was published in study by JACKSON et al. (2009). In contrast, dietary chromium picolinate supplementation had a detrimental effect on pork colour in another study OQUINN et al.(1998). Fatty acids synthesized by the pig are more saturated than the fat in typical pig diets. Thus, Cr supplementation may affect the fatty acid profile of fat stores in the pig, and this may be the reason for the observed improvement in some aspects of pork quality presented STAHLY (1984). ROLINEC, KANKA (2009) found a positive correlation between the content of immunoglobulins in colostrum of sows and the presence of Ig in the small intestine of piglets. KANKA, ROLINEC (2009) found some classes of immunoglobulins before colostrum time in the small intestine which indicates that some classes of immunoglobulins may be found in pigs in the prenatal period.

Material and Methods

The objective of the experiment was to find effect of organic chromium (Cr^{+3}) to carcass composition and chemical composition of adductor muscle in Large White breed.

Animal and sample preparations

The experiment was introduced in experimental centre of Department of Animal Husbandry of Slovak University of Agriculture in Nitra. There were 48 Large White Breed pigs used in this experiment. The animals were divided into the control group of 24 pigs (12 barrows and 12 gilts) and experimental group of 24 pigs (12 barrows and 12 gilts). The entire experiment was fed standard diet consisting of three feed rations applied in various growth phases (Tab. 1).

- OŠ3 from 30 to 45 kg
- OŠ4 from 45 to 70 kg
- OŠ5 from 70 to 100 kg.

The mineral-protein dough for experimental group was enriched by chromium-nicotinate, which was 0,75 mg/kg Cr^{3+}. Chromium-nicotinate was in form inactivated yeats *saccharomyces cerevisiae* fermented on medium which was from natural sources with higher content trivalent chromium. All feed was realised from 30 to 100 kg live weight. The growth potential was monitored by weighing of pigs with 0,5 kg accurate. The date of detection age of animals and respective weight had to be consistent. Slaughter and dissection carcasses of pigs was realised at slaughterhouse experimental center of livestock close to department of animal husbandry in Nitra. Dissection of carcass was performed according to the methodology STN 46 61 64. Pigs were slaughtered with an average live weight of 103,1 kg. The samples for the analysis of the chemical indicators were taken from thigh (*muscullus aductor*) during dissection of the right half/ carcase hold in storage for 24 hours *post mortem* at the temperature 3-4 ^{o}C. The sample from adductor muscle (100 g) was taken from the centre and it was hold in storage and dates separately for 14 days at the temperature -19±0,5^{o}C before the analysis was carried out.

Analysis of chemical indicators

The chemical composition indicators of the pork in *musculus aductor* of Large White Breed were measured on the muscular homogenate sample (50g) by the FT IR method using the device Nicolet 6700. We analyzed the total proteins in g.100g^{-1}, the intramuscular fat in g.100g^{-1} and total water in g.100g^{-1}. The infra-red spectrum of the muscular homogenate analysis itself was carried out by the molecular spectroscopy method. The principle of this method is the absorption of the infra-red spectrum during the sample transition where there is a change of the rotary vibrating energetic conditions of the molecule depending on the changes of the dipole momentum molecule. The analytical output is the infra-red spectrum which is a graphic representation of the function dependence of the energy, mostly given in transmittance percentage (T) or absorbance units (A) on wave-length of the incident emission. The transmittance is defined as a ratio of the intensity of the emission which has passed the sample (I) and the intensity of the emission emitted by the source (Io). The absorbance is defined as a decimal logarithm 1/ T. The dependence of the energy on the wave-length is logarithmic, so a repetency - defined as a reciprocal of the wave-length – is used therefore the presented dependence of the energy on the repetency is linear function. The particular fatty acids were evaluated from the muscular homogenate from *musculus aductor* (50g) by the gas chromatography (GC) method at the laboratory of Institute of Chemistry, Faculty of Natural Science, Comenius University in Bratislava.

Statistical evaluation

For control and experimental group were determined basic statistical variation characteristics. For comparison differences between groups we used one-way analysis of variance in pursuance of statistical software package SAS ® version 9.1 (SAS Institute Inc, Cary, NC, 2004). In terms of individual groups of fixed factor was the balance of adequate number of barrows and gilts in the groups.

Table 1. Composition of the diet

Trait	control			chromium nicotinate		
	OŠ-3	**OŠ-4**	**OŠ-5**	**OŠ-3**	**OŠ-4**	**OŠ-5**
Barley %	26,5	26,0	26,0	26,5	26,0	26,0
Wheat %	26,0	24,4	26,0	26,0	24,4	26,0
Corn %	17,7	26,3	27,0	17,7	26,3	27,0
Soybean meal %	26,5	20,0	15,2	26,5	20,0	15,2
Wheat bran %	0,0	0,0	3,0	0,0	0,0	3,0
Mineral and protein supplement %	3,0	3,0	2,8	3,0	3,0	2,8
Fodder acid %	0,3	0,3	0,0	0,3	0,3	0,0
Dry mater, %	90,74	90,17	90,81	90,74	90,17	90,81
N-substances, %	15,28	11,65	11,46	15,28	11,65	11,46
Metabolisable energy, MJ	13,55	13,38	13,06	13,55	13,38	13,06
Lysine, g	9,48	7,41	6,30	9,48	7,41	6,30
Chrom - added, μg.kg^{-1}	-	-	-	750	750	750
Chrom - analysed, μg.kg^{-1}	1,3	1,4	1,3	744	752	724

Results and Discussion

The weight of carcass side 24 hours post mortem was in control group 39,89 ± 1,48 kg in compared with the experimental group, where we found the value of 39,44 ± 1,17 kg (Tab. 2). According to study WANG et al. (2008) dietary CrPic supplementation increased longissimus muscle area by 17.29%. Slaughter indicators showing the conformation represented by lean meat cuts (%) reached higher in the experimental group, 54.07 ± 1.63% compared with the control group, where we found 52.45 ± 2.64% (Tab. 2). We found a statistically significant difference $P \leq 0.05$ between control and experimental group in this indicator. According to random effects models, dietary Cr supplementation decreased 10th-rib fat thickness whereas percentage carcass lean and LM area increased presented in study by SALES et al. (2011). In parameter meat from the thigh (%) side we found documented higher value of 21,94 ± 1,11 % in experimental group in compared with control group where we found value of 21,27 ± 1,48 % (Tab. 2). We found a statistically significant difference $P \leq 0.05$ between control and experimental group. In parameter loin eye area (cm^2) was measured in the control group value of 41,10 ± 5,37 cm^2. In the experimental group was measured value of 41,33 ± 4,72 cm^2 (Tab. 2).

In parameters of the carcass value represented fattiness we found in indicator weight of pork belly value of 7,92 ± 0,41 kg in experimental group compared with control group where we measured value of 8,11 ± 0,46 kg (Tab. 3).

In parameter weight of backfat (kg) we measured value of 3,12 ± 0,50 kg in the control group compared with experimental group where we measured lower value of 2,94 ± 0,40 kg (Tab. 3). In addition, studies with chromium picolinate (CrP) have indicated that it decreased backfat (PAGE et al., 1993). In parameter weight undrerskinfat from thighs (kg) we found statistically significant difference between experimental group 1,64 ± 0,22 kg compared with control group 1,76 ± 0,30 kg (Tab. 3). The statistically significant difference between groups was demonstrated at $P \leq 0.05$. In indicator weight of kidney fat we measured value of 0,49 ± 0,15 kg in experimental group and value of 0,60 ± 0,22 kg in control group (Tab. 3). The statistically significant difference between groups was demonstrated at $P \leq 0.05$. In parameter backfat thickness in cm we measured value of 2,04 ± 0,47 cm in control group compared with experimental group where we measured value of 1,95 ± 0,35 cm (Tab. 3). According to PAGE et al. (1993) chromium supplementation in pig diets was found to improve feed efficiency, lean meat yield and reduce backfat thickness. On the other hand MOONEY et al. (1997) published in his study that dietary Cr addition had no effect on the performance or backfat measurements of the pigs. Results from experiment by JACKSON et al. (2009) showed that Cr supplementation decreased 10th-rib backfat and increased percentage of muscle. WENK et al. (1995), MATTHEWS et al. (2005) reported no differences in backfat thickness, or loin muscle area in pigs supplemented with chromium.

Table 2. Carcass traits describing conformation (n=48)

Trait	Control LSM±SE	Group chrom-nikotinat LSM±SE
Half carcass (kg)	39,89±1,48	39,44±1,17
Lean meat cuts (%)	52,45±2,64[a]	54,07±1,63[b]
Meat from the thigh (%)	21,27±1,48[a]	21,94±1,11[b]
Loin eye area (cm^2)	41,10±5,37	41,33±4,72

[a] Different letters denote significant differences between groups at P=0.05
[b] Different letters denote significant differences between groups at P=0.05

Table 3. Carcass traits describing fatness (n=48)

Trait	Control LSM±SE	Group chrom-nikotinat LSM±SE
Pork belly (kg)	8,11±0,46	7,92±0,41
Weight of backfat (kg)	3,12±0,50	2,94±0,40
Weight undrerskinfat from thighs (kg)	1,76±0,30[a]	1,64±0,22[b]
Kidney fat (kg)	0,60±0,22[a]	0,49±0,15[b]
Backfat thickness (cm)	2,04±0,47	1,95±0,35

[a] Different letters denote significant differences between groups at P=0.05
[b] Different letters denote significant differences between groups at P=0.05

In chemical indicators detected in muscle of tight *muscullus aductor* we found value of total water in control group 72,70 ± 1,04 g.100g^{-1} while we found higher value 72,91 ± 1,41 g.100g^{-1} in control group (Tab. 4). Total protein in % in *muscullus aductor* was measured in the control group 24,27 ± 0,80 g.100g^{-1} and the experimental group, we found 24,33 ± 0,73 g.100g^{-1} (Tab. 4). Total protein in % was not affected by CrPic according to Page et. al. (1993). Values of intramuscular fat in homogenates *musculus aductor* was measured 1,20 ± 0,40 g.100 g^{-1} in the control group compared with the experimental group, where we measured the value of 1,05 ± 0,49 g.100g^{-1} (Tab. 4). As determined by physical-chemical separation, pigs fed CrP had an increased percentage of intermuscular fat compared with pigs fed the control diets according to study by BOLEMAN et al. (1995), WENK et al. (1995) reported that pigs supplemented with CrP tended to have higher percentages of intramuscular fat.In individual groups fatty acids we found following differences between experimental and control group: saturated fatty acids in control group were 37,36 ± 2,34 % while in experimental group, this value was slightly lower 36.22 ± 2.85% (Tab. 5). In the control group there was a slightly lower ratio of the mono unsaturated fatty acids 49,73 ± 2,80 % in comparison to the experimental group where the ratio of the mono unsaturated fatty acids was 50,54 ± 2,73 % (Tab. 5) .

We also found out that in the control group there was ratio of the polyunsaturated fatty acids 11,73 ± 1,98 % but in the experimental group the ratio of the polyunsaturated fatty acids was 11,96 ± 2,27 % (Tab. 5). There was ratio of w3 polyunsaturated fatty acids 0,51 ± 0,08 % from all of the fatty acids in the control group in comparison to the experimental group where we found ratio of w3 polyunsaturated fatty acids 0,52 ± 0,06 % (Tab. 5). We also found out that in the experimental group there was ratio of w6 unsaturated fatty acids 10,87 ± 2,14 % from all the fatty acids and in the control group there was ratio 10,83 ± 1,58 % (Tab. 5). There was ratio of the essential fatty acids 8,97 ± 1,58 % in the control group and there was ratio of the fatty acids 8,99 ± 1,47 % in the experimental group (Tab. 5). Cr supplementation may affect the fatty acid profile of fat stores in the pig, and this may be the reason for the observed improvement in some aspects of pork quality was published in study by JACKSON et al. (2009). In contrast, dietary chromium picolinate supplementation had a detrimental effect on pork colour in another study OQUINN et al.(1998). Fatty acids synthesized by the pig are more saturated than the fat in typical pig diets. Thus, Cr supplementation may affect the fatty acid profile of fat stores in the pig, and this may be the reason for the observed improvement in some aspects of pork quality presented STAHLY (1984).

Table 4. Chemical composition of aductor muscle (n=48)

Trait	**Control LSM±SE**	**Group chrom-nikotinat LSM±SE**
Total water, %	72,70±1,04	72,91±1,41
Protein,	24,27±0,80	24,33±0,73
Intramuscular fat, %	1,20±0,40	1,05±0,49

Table 5. Fatty acids in intramuscular fat of aductor muscle (n=48)

Trait	**Control LSM±SE**	**Group chrom-nikotinat LSM±SE**
Saturated fatty acids	37,36±2,34	36,22±2,85
Monounsaturated fatty acids	49,73±2,80	50,54±2,73
Polyunsaturated fatty acids	11,73±1,98	11,96±2,27
ω3 polyunsaturated fatty acids	0,51±0,08	0,52±0,06
ω6 polyunsaturated fatty acids	10,83±1,83	10,87±2,14
Essential fatty acids	8,97±1,58	8,99±1,47

[a] Different letters denote significant differences between groups at P=0.05
[b] Different letters denote significant differences between groups at P=0.05

Conclusion

In conclusion, we can say that in parameters of butcher worthiness representing conformation we found out significant influence of organic chrome Cr^{+3} in the form of chromium nicotinate and it was mainly in the percentage of valued meat parts where we find in the experimental group 54,07% in comparison to the control group 52,45%.The second significant trait was the percentage of thigh from weight of butcher half where we found out in experimental group amount 21,94 % in comparison to control group 21,27 %. In butcher traits expressing fatness we found out significant differences in parameters of weight of underskinfat from thigh, where we find in the experimental group amount 1,64 kg in comparison to control group 1,76 kg. The amount of abdominal fat was in experimental group 0,49 kg but in the control group there was considerably higher amount 0,60 kg. In traits of chemical composition *muscullus aductor* we did not find out significant differences in any of the researched parameters. Despite of that we found out the average amount of quantity of intramuscular fat was higher than in control group and it was 1,20 g.100g-1 in comparison to experimental, where we measured out amount 1,05 g.100g-1. In composition of fatty acids in intramuscular fat *muscullus aductor* we also did not find out statistically significant differences between the control and experimental group. In order to obtain more accurate results in this area we suppose that higher concentration of trivalent organic chrome in feedstuff for pigs is needed but the additional study is necessary to prove this supposition.

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