EFFECTS OF DIETARY CHROMIUM TRIPICOLINATE AND LYSINE ON GROWTH PERFORMANCE, CARCASS TRAITS, AND PLASMA METABOLITE LEVELS IN PIGS

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ABSTRACT

An experiment was conducted to evaluate the effects of chromium tripicolinate (CrPic) and three levels of lysine in growing-finishing pigs. Average initial weight was 24.10 kg. Six treatments were replicated four times with four pigs per replicate. Three basal corn-soybean meal diets (B1 : 80 % National Research Council (NRC, 1988) lys level ; B2 : 120 % NRC lys level ; and B3 : 160 % NRC lys level) with three main diets supplemented with 200 ppb of Cr from CrPic (B1+ 200 ppb Cr, B2 + 200 ppb Cr and B3 + 200 ppb Cr). During the growing phase, daily weight gain was decreased by chromium tripicolinate ($p < 0.04$), without any effect on total growth performance and carcass traits. CrPic decreased pre-prandial state urea nitrogen values ($p < .003$) and increased post-prandial state urea nitrogen values ($p < 0.02$). On the other hand, lysine levels increased feed efficiency (Lysine linear, $p < 0.08$) in growing pigs. Lysine increased loin eye area (lysine linear, $p < 0.05$; lysine quadratic, $p < 0.05$), but decreased tenth rib fat (lysine linear, $p < 0.03$; lysine quadratic, $p < 0.009$). Cholesterol values were decreased by lysine levels under pre-prandial state (lysine linear, $p < 0.02$; lysine quadratic, $p < 0.08$), and under post-prandial state (lysine linear, $p < 0.02$; lysine quadratic, $p < 0.005$). At the end of the trial, values of non-esterified fatty acids (NEFA) were elevated by lysine (lysine quadratic, $p < 0.08$), and so were those of total proteins (lysine quadratic, $p < 0.02$). Urea nitrogen values were elevated by lysine increment 19 (linear effect of lysine ; $p < 0.0002$). CrPic and lysine interaction was shown on NEFA and 20 urea nitrogen values. These results show that CrPic has minimal effects on growth efficiency, while lysine affects significantly growth performance, carcass characteristics and most of plasma metabolites in growing-finishing pigs.

Key-words : Pig, chromium, lysine, growth, metabolites, USA.

RESUME

EFFETS DU TRIPICOLINATE DE CHROME ET DE LA LYSINE SUR LA CROISSANCE, LA CARCASSE ET LES TAUX DES METABOLITES PLASMATIQUES CHEZ LES PORCS.

Une expérience a été conduite afin d'évaluer l'effet du tripicolinate de chrome (CrPic) et de trois taux de lysine chez des porcs, de la phase de croissance à la phase de finition. Le poids corporel initial des animaux était de 24,11 kg. Six traitements ont été répétés quatre fois, avec quatre porcs par répétition. Au cours de cette expérience, les animaux ont été soumis à trois régimes alimentaires de base, contenant un mélange de maïs et de soja (B1 : 80 % du taux de lys recommandé par National Research Council (NRC.1988) ; B2 : 120 % du taux de lys (NRC) et B3 : 160 % du taux de lys (NRC)), plus trois régimes de base enrichis avec 200 ppb de chrome sous forme de CrPic (B1+200 ppb de Cr, B2+200 ppb de Cr et B3+200 ppb de Cr). Pendant la phase de croissance, le gain quotidien de poids corporel était réduit par le tripicolinate de chrome ($p < 0,04$), sans aucun effet sur la croissance pondérale totale et les caractéristiques de la carcasse. Les résultats obtenus indiquent que le CrPic entraîne une diminution des concentrations plasmatiques de l'azote de l'urée ($p < 0,003$) chez les animaux en état pré-prandial et une augmentation des concentrations plasmatiques de l'azote de l'urée chez les mêmes animaux, mais en état post-prandial ($p < 0,02$). Les taux de lys ont provoqué une augmentation du coefficient d'efficacité de croissance (lys linéaire, $p < 0,08$) chez les porcs pendant la phase de croissance. La lysine a augmenté le tissu maigre de la côtelette au niveau de la 10^{e} paire de côtes (lys linéaire, $p < 0,05$; lys quadratique, $p < 0,05$). Les taux de lys ont diminué la masse de tissu *gras de la côtelette au niveau de la 10e paire de côtes (lys linéaire, p < 0,03 ; lys quadratique, p < 0,009). Les taux plasmatiques de cholestérol ont été réduits par le taux de lysine chez les animaux en état pré-prandial (lys linéaire, p < 0,02 ; lys quadratique, p < 0,08), et en état post-prandial (lys linéaire, p < 0,02 ; lys quadratique, p < 0,005). A la fin de l'essai, les taux des acides gras non estérifiés ont été élevés par la lysine (lys quadratique, p < 0,08), de même que ceux des protéines totales (lys quadratique, p < 0,02). Les valeurs de l'azote de l'urée étaient également élevées par la lysine (lys linéaire, p < 0,0002). L'effet de l'interaction de CrPic et de la lysine a été plus marqué sur les concentrations des acides gras non estérifiés et celles de l'azote de l'urée. Ces résultats indiquent que le picolinate de chrome a très peu d'effets sur la croissance, alors que la lysine altère significativement la croissance, les caractéristiques de la carcasse et les valeurs des métabolites plasmatiques des porcs.*

Mots-Clés : *Porc, chrome, lysine, croissance, métabolites, USA.*

INTRODUCTION

The potential capability of lysine to improve growth performance and carcass composition of growing pigs is well established, since lysine is one of the limiting amino acids in the growth of swine (NRC, 1988). Dubroff *et al.* (1979) showed that diets supplemented with lysine and tryptophane induced an improved growth in swine. Colin *et al.* (1975) reported that low levels of lysine in the drinking water consumption improved considerably growth rate and growth efficiency in rabbits under lysine deficiency. On the contrary, the efficacy of dietary chromium (chromium picolinate) on animal productivity has not been broadly investigated. Jensen *et al.* (1977) determined that chromium increased muscle rate and decreased fat in poultry and in pigs. Page *et al.* (1993a), and Kornegay *et al.* (1997) reported an increased longissimus muscle area and a decreased backfat of carcass when chromium picolinate was fed to growing-finishing pigs. But, these findings have not been corroborated by other studies (Mooney and Cromwell, 1995 ; Crow and New-Comb, 1997). Since currently, the National Research Council (NRC, 1988) does not recommend dietary chromium supplementation for swine, the goal of this work, is to find out if lysine can potentiate the effect of minute amount of dietary chromium tripicolinate (200 ppb of Cr) on growth performance, carcass composition and plasma metabolites in growing-finishing pigs.

MATERIAL AND METHODS

This experiment was conducted with growing-finishing pigs. Three corn-soybean meal basal diets (B1, B2, B3) with 0 ppb of Cr containing 80, 120 and 160 % of lysine (NRC 1988, lysine requirements) respectively, and three other diets made of the basal diets supplemented with 200 ppb of Cr (chromium tripicolinate ; 12 % Cr, Nutrition 21, San Diego, CA).

ANIMALS USED

The pigs used are crossbred (Yorkshire Hampshire Duroc) growing-finishing pigs born and raised at Louisiana State University Agricultural Center Swine Unit in Baton Rouge (La, USA). There were 54 barrows and 42 gilts, penned in total confinement on total slatted floors in 1.8 x 2.4 m pens during the growing period and in an open front building with a solid concrete floor in 1.5 x 6.1 m pens during the finishing period. Two gilts died during the growing phase. Randomised complete blocked designs were used and pigs were allotted to treatments on the basis of weight, ancestry and sex. All treatments were replicated four times with four pigs per replicate. The average initial weight (IW) and final weight (FW) were 24.10 kg and 104.90 kg, respectively. The growing pigs weighed between 20 kg and 50 kg. The finishing pigs weighed between 50 kg and 100 kg. Experimental periods were 83. 97 and 111 days, according to the times animals reached 100 kg. Weight gain and feed consumption were recorded every two weeks until the end of the experiment. Pigs were allowed *ad libitum* access to the experimental diets and tap water. The corn-soybean diets used were formulated to contain 80, 120 and 160 % of the lysine requirement (NRC, 1988) for growing (Table 1) and finishing pigs (Table 2). All diets met or exceeded the requirement of all other nutrients. Pigs were slaughtered at three different periods (after 83. 97 and 111 days of trial).

Table 1 : Composition of grower diet (%)[a].

Composition des aliments de porc en phase de croissance.

Ingredients	Different diet					
	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr
Corn	84.10	72.90	61.71	83.10	71.90	60.71
Soybean meal	13.44	24.75	36.06	13.44	24.75	36.06
D. R. P.	1.54	1.31	1.07	1.54	1.31	1.07
Limestone	0.37	0.49	0.61	0.37	0.49	0.61
LSU Vitamins[b]	0.25	0.25	0.25	0.25	0.25	0.25
LSU Trace minerals[c]	0.30	0.30	0.30	0.30	0.30	0.30
Premix	….	….	….	1.00	1.00	1.00
Total	100	100	100	100	100	100

[a]Calculated composition : CP : B1 : 13 ; B2 : 17 ; B3 : 21 ; lys : B1 : 0.60 ; B2 : 0.92 ; B3 : 1.20 ; Ca : 0.70 ; P : 0.60.
D. R. P. = Defluorinated Rock Phosphate.
[b]Provided the following per kilogram of diet : riboflavin, 4.4 mg ; d-pantothenic acid, 22 mg ; niacin, 22 mg ; vitamin B12, 22 g ; d-biotin, 220 g ; choline chloride, 440 mg ; vitamin A, 4,400 IU ; vitamin D3, 440 IU ; vitamin E, 11 IU ; menadione (as menadione dimethylprimidinol bisulfite), 0.25 mg ; Se, 0.1 mg.
[c]Provided the following per kilogram of diet : Zn, 75 mg ; Fe, 87.5 mg ; Mn, 30 mg ; Cu,.8.75 mg ; I, 1 mg ; Ca, 9 mg.

Table 2 : Composition of finisher diet (%)[a].

Composition des aliments de porc en phase de croissance.

Ingredients	Differents diets					
	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr
Corn	88.96	80.00	71.05	87.96	79.00	70.05
Soybean meal	8.88	17.93	26.98	8.88	17.93	26.98
D. R. P.	1.07	0.89	0.72	1.07	0.89	0.72
Limestone	0.54	0.63	0.70	0.54	0.63	0.70
LSU Vitamins[b]	0.25	0.25	0.25	0.25	0.25	0.25
LSU Trace minerals[c]	0.30	0.30	0.30	0.30	0.30	0.30
Premix	….	….	….	1.00	1.00	1.00
Total	100	100	100	100	100	100

[a]Calculated composition : CP : B1, 11.50 %, B2, 14.70 % ; B3, 17.90 % ; lysine : B1, 0.50 % ; B2, 0.72 % ; B3, 0.90 % ; Ca, 0.60 % ; P, .50 %.
D. R. P. = Defluorinated Rock Phosphate.
[b]Provided the following per kilogram of diet : riboflavin, 4.4 mg ; d-pantothenic acid, 22 mg ; niacin, 22 mg ; vitamin B12, 22 g ; d-biotin, 220 g ; choline chloride, 440 mg ; vitamin A, 4,400 IU ; vitamin D3, 440 IU ; vitamin E, 11 IU ; menadione (as menadione dimethylprimidinol bisulfite), 0.25 mg ; Se, 0.1 mg.
[c]Provided the following per kilogram of diet : Zn, 75 mg ; Fe, 87.5 mg ; Mn, 30 mg ; Cu, 8 .75 mg ; I, 1 mg ; Ca, 9 mg.

CARCASS EVALUATION

Upon termination of the trial, all pigs were slaughtered in a commercial facility and hot carcass weight (CW) were obtained for dressing percentage (DP) calculation. Selected carcass measurements were obtained following a 24 h-chill at 2 °C. Fat thickness over the longissimus muscle at the tenth rib (TRF) and loin eye area (LEA) were obtained by tracing the longissimus muscle surface at the tenth rib fat, and were adjusted to 104.90 kg of body weight, by methods approved by the NSIF (1988). Percentage of muscling (PM) was calculated with the National Pork Producers Council method (NPPC, 1988).

BLOOD ANALYSES

Blood samples were collected from each pig at three different times. Blood was collected on 14 h-fasting pigs (pre-prandial state) for plasma metabolites analyses. Then pigs were allowed to consume feed *ad libitum* for 3 h before bleeding them again (post-prandial state). At the end of the trial (average body weight = 104.90 kg), blood was collected from 14 h-fasting pigs before slaughtering. All blood samples were obtained via the anterior vena cava. For each time, 6 ml of blood were collected and divided into two tubes for hormone (insulin) assay and for metabolites analyses. Collected blood was centrifuged at 1,020 g for 20 min at 4 °C, and plasma samples kept in a freezer (4 °C) until analyses. Plasma was analyzed for glucose (Sigma, 1990), cholesterol (Sigma, 1989a), and total proteins (Sigma, 1989b) concentrations, using spectrophotometric procedure outlined in commercially available kits (Sigma chemical). Plasma urea nitrogen (urea N) concentrations were determined spectrophotometrically using the urease procedure outlined by Fernandez *et al.* (1988). Plasma Non-Esterified Fatty acids (NEFA) concentrations were determined using a commercial enzymatic procedure (NEFA6Ckit, ACS-ACOD Method ; Wako Chemicals USA, Richmond, VA). All samples were assayed in duplicate and measurements resulting in errors greater than 5 % were reanalyzed. Plasma insulin was assayed by RIA method of Fernandez *et al.* (1988). Guinea pigs anti-bovine insulin antiserum (code N°65-101, lot N° GP616 ; ICN ImmunoBiologicals, Lisle, IL) was used at 1 : 60.000 final dilution. Purified porcine insuline (26.1 µU/ng ; Sigma chemical) and bovine (125 I) insulin (ICN Biomedicals, Costa Mesa, CA) were used as the standard and radio ligand, respectively. Sheep anti-guinea pig antiserum produced in our laboratory was used at 1 : 4 dilution as the precipitating antibody. The intraassay and interassay CV for the insulin RIA as determined by pooled bovine plasma samples were 14 % and 13 %, respectively.

STATISTICAL ANALYSES

All data were analysed by ANOVA (Steel and Torrie, 1980) using GLM procedures of SAS (1985), in a randomized complete blocks with the pen of pigs as the experiment unit. The experiment was a complete 3 x 2 factorial arrangement. Basal diets were supplemented with 0 ppb or 200 ppb of chromium and lysine levels (80, 120, 160 %) were separated equally so that linear and quadratic contrasts were used to evaluate lysine treatment effect. Mean values are expressed as LSM, and standard error on the mean as SEM.

RESULTS

EFFECT OF CHROMIUM TRIPICOLINATE ON GROWTH PERFORMANCE

During the growing phase, daily gain (Table 3) was decreased by chromium picolinate ($p < 0.04$) without any effect on feed efficiency (G/F). But, CrPic had no effect on growth performance of finishing and growing-finishing pigs (Table 4, Table 5), and carcass characteristics (Table 6). CrPic decreased pre-prandial state urea nitrogen values ($p < 0.003$. Table 7) and increased post-prandial state urea nitrogen values ($p < 0.02$, Table 8).

Table 3 : Mean values of daily gain (ADG), feed intake (ADFI), and gain/feed (G/F) of growing pigs fed with dietary chromium and lysine[a] .

Moyennes des gains en poids et consommation journaliers, et ratio gain/consommation des porcs en phase de croissance nourris au Cr et au Lysine.

Item	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr	SEM
ADG (kg [b])	0.76	0.87	0.85	0.73	0.80	0.81	0.02
ADFI (kg)	2.25	2.56	2.25	2.35	2.23	2.21	0.16
G/F [c]	0.34	0.35	0.38	0.32	0.36	0.37	0.02

[a]Means (LSM) of four replicates with four pigs per replicate
[b]Effect of CrPic ($p < 0.04$) ; linear effect of lys ($p < 0.005$); quadratic effect of lys ($p < 0.04$)
[c]Linear effect of lys ($p < 0.08$)

Tableau 4 : Mean values of daily gain (ADG), feed intake (ADFI), and gain/feed (G/F) of finishing pigs fed with dietary CrPic and lysine[a] .

Moyennes des gains en poids et consommation journaliers, et ratio gain/consommation des porcs en phase de finition nourris au Cr et au Lysine.

Item	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr	SEM
ADG (kg)	0.83	0.93	0.88	0.88	0.88	0.89	0.03
ADFI (kg)	3.19	3.37	3.36	3.36	3.28	3.35	0.09
G/F [c]	0.26	0.28	0.26	0.26	0.27	0.27	0.01

[a] Data are means (LSM) of four replicates with four pigs per replicate
No effect of CrPic or lys on mean values of ADG, ADFI, and G/F was observed ($p > 0.10$)

Table 5 : Mean values of daily gain (ADG), feed intake (ADFI), and gain/feed (G/F) of growing-finishing pigs fed with dietary CrPic and lysine.[a]

Moyennes des gains en poids et consommation journaliers, et ratio gain/consommation des porcs de la phase de croissance à la phase de finition nourris au Cr et au Lysine.

Item	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr	SEM
IW (kg)	24.18	24.36	23.47	24.47	24.32	23.87	0.34
FW (kg)	104.05	102.38	107.19	109.00	103.25	103.51	2.63
ADG (kg [b])	0.80	0.90	0.87	0.82	0.85	0.85	0.02
ADFI (kg)	2.80	2.99	2.89	2.94	2.81	2.86	0.09
G/F [c]	0.29	0.30	0.30	0.28	0.30	0.30	0.01

[a]Data are means (LSM) of four replicates with four pigs per replicate
[b]Linear effect of lys ($P<.03$) ; quadratic effect of lys ($p < 0.04$)

Tableau 6 : Mean values of some carcass characteristics of growing-finishing pigs fed with dietary CrPic and lysine[a].

Moyennes des gains en poids et consommation journaliers, et ratio gain/consommation des porcs de la phase de croissance à la phase de finition nourris au Cr et au Lysine.

Item	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr	SEM
LEA (cm^2) [b]	28.06	32.27	30.45	27.80	30.02	30.12	1.06
TRF (cm) [c]	3.49	2.79	3.09	3.41	2.99	3.08	0.14
PM [d]	42.92	47.39	45.04	42.71	45.71	45.28	0.82
CW (kg)	80.72	77.62	81.48	84.34	77.88	79.24	2.72
DP [e]	77.70	76.39	75.39	76.23	75.77	76.84	0.54

[a]Data are means (LSM) of four replicates with four pigs per replicate
[b]Linear effect of lysine ($p < 0,05$) ; quadratic effect of lysine ($p < 0.05$)
[c]Linear effect of lysine ($p < 0,03$) ; quadratic effect of lysine ($p < 0.009$)
[d]Linear effect of lysine ($p < 0,02$) ; quadratic effect of lysine ($p < 0.003$)
[e]Linear interaction effect of Cr * Lys ($p < 0.03$)

EFFECT OF LYSINE ON GROWTH PERFORMANCE

Lysine levels increased daily weight gain (lysine linear, $p < 0.005$; lysine quadratic, $p < 0.04$) and feed efficiency (lysine linear, $p <.08$) in growing pigs (Table 3) but had no effect on growth performance of finishing pigs ($p > 0.10$; Table 4). Overall average daily weight gain was increased by lysine levels at the end of the trial (lysine linear, $p < 0.03$; lysine quadratic, $p < 0.04$, Table 5). Table 6 shows that lysine levels increased loin eye area (LEA) (lysine linear, $p < 0.05$; lysine quadratic, $p < 0.05$), percentage of muscling (PM) (lysine linear, $p < 0.02$; lysine quadratic, $p < 0.003$). On the contrary, lysine levels decreased tenth rib fat (TRF) (lysine linear, $p < 0.03$; lysine quadratic, $p < 0.009$), carcass weight (CW) (not significant) and dressing percentage (DP, not significant). Glucose levels were decreased by lysine addition under post-prandial state (lysine linear, $p < 0.08$; lysine quadratic, $p < 0.09$) (Table 8). Cholesterol values were also decreased by lysine levels under pre-prandial state (lysine linear, $p < 0.02$; lysine quadratic, $p < 0.08$, Table 7), under post-prandial state (lysine linear, $p < 0.02$; lysine quadratic, $p < 0.005$, Table 8) and before slaughtering (not significant, Table 9). At the end of the trial (Table 9), values of non-esterified fatty acids (NEFA) were elevated by lysine (lysine quadratic, $p < 0.08$), and so were those of total proteins (lysine quadratic, $p < 0.02$). Urea nitrogen values were elevated by lysine increment in pre-prandial state animals (lysine linear, $p < 0.0002$; lysine quadratic, $P < 0.05$, Table 7), post-prandial state animals (lysine linear, $p < 0.0002$, Table 8) and animals at slaughtering (lysine linear, $p < 0.0002$, Table 9). Insulin levels were increased by lysine (lysine quadratic, $p < 0.02$, Table 9).

INTERACTION EFFECT OF CHROMIUM TRIPICOLINATE AND LYSINE ON GROWTH PERFORMANCE

There was no interaction effect of CrPic and lysine on growth performance and most of carcass characteristics of the animals ($p > 0.10$). A linear interaction effect of CrPic and lysine is reported in table 6 (CrPic x lys, $p < 0.03$) ; this interaction decreased the dressing percentage (DP) values (lysine linear, $p < 0.03$). Under pre-prandial state there was an interaction quadratic effect (lysine quadratic, $p < 0.01$) which decreased plasma NEFA values of pigs. On the same animals, a linear interaction effect increased plasma urea nitrogen values (lysine linear, $p < 0.06$) due to lysine effect (lysine linear, $p < 0.0002$; lysine quadratic, $p < 0.05$) on plasma urea nitrogen (Table 7).

Table 7 : Mean values of plasma metabolites of finishing pigs before feeding with dietary chromium and lysine (pre-prandial state)[a].

Taux de métabolites plasmatiques des porcs en phase de finition avant alimentation en chromium et lysine (état pré-prandial).

Item	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr	SEM
Glucose (mmol/L)	4.52	4.19	4.50	4.54	4.46	4.36	0.11
Cholesterol (mmol/L)[b]	99.49	86.02	89.49	95.25	90.12	88.45	3.02
NEFA (µEq/L)[c]	297.11	394.92	255.78	352.74	261.59	337.02	39.38
Protein (g/L)	55.64	56.81	56.13	55.61	57.85	56.13	1.02
Urea N (mmol/L)[d]	9.12	11.40	16.57	8.31	10.81	13.89	0.45

[a]Data are means (LSM) of four replicates with four pigs per replicate
[b]Linear effect of lys ($p < 0.02$) ; quadratic effect of lys ($p < 0.08$)
[c]NEFA=Non-Esterified Fatty Acids, Quadratic interaction effect of CrPic * lys ($p < 0.001$)
[d]CrPic effect (P<.003) ; linear effect of lys (P<.0002) ; quadratic effect of lys $p < 0.05$) ; linear interaction effect of CrPic * lys ($p < 0.06$)
SEM : Standard Error on the Mean

Table 8 : Mean values of plasma metabolites of finishing pigs after feeding with dietary chromium and lysine (post-prandial state)[a].

Taux de métabolites plasmatiques des porcs en phase de finition avant alimentation en chromium et lysine (état post-prandial).

Item	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr	SEM
Glucose (mmol/L) [b]	4.88	4.40	4.36	5.02	4.23	4.58	0.25
Cholesterol (mmol/L)[c]	89.20	77.60	82.98	89.43	78.55	81.15	2.61
NEFA (µEq/L)	107.89	114.38	118.06	119.57	118.31	107.80	7.53
Protein (g/L)	49.19	50.22	51.5	50.81	51.43	52.66	1.41
Urea N (mmol/L)[d]	11.20	14.57	19.95	11.92	16.19	22.33	0.70

[a]Data are means (LSM) of four replicates with four pigs per replicate
[b]Linear effect of lys ($p < 0.08$) ; quadratic effect of lys ($p < 0.09$)
[c]Linear effect of lys ($p < 0.02$) ; quadratic effect of lys ($p < 0.005$)
[d]CrPic effect ($p < 0.02$) ; linear effect of lys ($p < 0.0002$)
SEM : Standard Error on the Mean

Table 9 : Mean values of plasma metabolites of growing-finishing pigs at slaughter[a].

Taux de métabolites plasmatiques des porcs à l'abattage.

Item	B1	B2	B3	B1+Cr	B2+Cr	B3+Cr	SEM
Glucose (mmol/L)	4.14	3.95	4.11	4.06	3.90	4.06	0.14
Cholesterol (mmol/L)	81.69	70.69	76.19	76.68	74.02	73.43	3.46
NEFA (µEQ/L)[b]	219.15	279.87	235.26	237.29	320.27	225.58	43.26
Protein (g/L)[c]	46.16	48.75	46.93	47.17	50.23	47.87	0.10
Urea N (mmol/L)[d]	7.33	11.21	13.69	8.55	10.34	13.41	0.57
Insulin (µU/mL)[e]	10.64	7.93	14.14	12.15	7.38	14.22	2.20

[a]Data are means (LSM) of four replicates with four pigs per replicate
[b]Quadratic effect of lys ($p < 0.08$)
[c]Quadratic effect of lys ($p < 0.02$)
[d]Linear effect of lys ($p < 0.0002$)
[e]Quadratic effect of lys ($p < 0.02$)
SEM : Standard Error on the Mean

DISCUSSION

EFFECT OF CHROMIUM TRIPICOLINATE ON GROWTH PERFORMANCE

This investigation showed that 200 ppb of chromium from CrPic supplementation of corn-soybean meal diets did not adversely affect carcass traits, feed efficiency, average daily feed intake of growing-finishing pigs. However, average daily gain, during the growing phase was reduced by 200 ppb of Cr. Page *et al.* (1993a) who investigated on the effects of CrPic in pigs, did not find any significant effect of this trace mineral on ADG, ADFI and G/F. They reported that the most striking effects of dietary CrPic on swine productivity were increased LEA and PM, and a decreased TRF. Positive effects of dietary Chromium have been demonstrated by Lindemann *et al.* (1995) in pigs. However, some other results published by Boleman *et al.* (1994), Mooney and Cromwell (1997), and Matthews *et al.* (2003) did not report any significant effect of Cr on growth performance and body composition in pigs. Discrepancies observed in the evaluation of the effect of different kinds, and levels of Cr in pigs, inclined Ward *et al.* (1997) to determine a possible interactive effect of dietary chromium tripicolinate (400 ppb of Cr) and pen space as a stress in growing-finishing pigs. They concluded that pigs provided inadequate pen space had greater LEA and PM and lower TRF than pigs provided adequate pen space. Lindemann *et al.* (1995) suggested that some of the absence of effect of chromium may be explained by the initial weight at the time of supplementation, or the combination of body weight and the duration of trials. While in the present report, no effect of CrPic was noticed on cholesterol values, Evock-Clover *et al.* (1993) reported that supplemented dietary CrPic increased total cholesterol and high density lipoproteins (HDL)-cholesterol in pigs. Amoikon *et al.* (1995) indicated that dietary Cr as CrPic increased fasting plasma cholesterol. However, Riales and Albrink (1981), Mossop (1983) had reported that Cr supplementation decreased serum triglycerides and total cholesterol, and increased high-density lipoprotein cholesterol in diabetics. Page *et al.* (1993b) found that serum cholesterol was reduced by CrPic. Reduced levels of circulating total cholesterol have been also reported in calves fed CrPic (Bunting *et al.,* 1994). Lindemann *et al.* (1995), and Matthews *et al.* (2001) did not observe any effect of Cr on plasma cholesterol. Chromium is known to be efficient on lipids metabolism, despite some contradictory results, chromium seem to reduce cholesterol and triglycerides levels.

EFFECT OF LYSINE ON GROWTH PERFORMANCE

Increasing levels of lysine from crude protein affected positively growth efficiency, carcass characteristics and plasma metabolites of the pigs in this experience. These effects have already been reported by Ward *et al.* (1997) who found that G/F was higher in pigs fed 120 % than in pigs fed 80 % of recommended lysine level. It was also reported by these authors that increasing the protein content of the diet from a deficient (80 %) to adequate lysine level (120 %) will improve longissimus muscle area and lower TRF thickness of the pigs. Lindemann *et al.* (1995) reported an improvement of G/F when Cr was supplemented to a diet providing 100 % NRC (1988) lysine requirement estimates, but not with an excess of NRC (1988) lysine requirement. The results obtained in this experience corroborate those of Van de Ligt *et al.* (2002) who showed that increasing levels of lysine (76 %, 83 %, 90 % of lysine requirement) increased linearly ADG, and that lysine level had a quadratic effect on TRF backfat thickness with the highest response at 83 % of lysine level. In this work, it's reported the influence of lysine on ADG during the growing phase and at the end of the growing-finishing trial ; but not during the finition phase. Glucose levels were lowered by increasing levels of lysine after feeding. Such results were found by Van de Ligt *et al.* (2002) only before feeding animals. NEFA and insulin levels at the end of the trial were increased by lysine levels. Urea nitrogen values were increased by lysine levels in pre-feeding, post-feeding pigs and at slaughter. Lindemann *et al.* (1995), feeding pigs with 120 % of lysine requirement showed that insulin levels and urea nitrogen values were increased, and NEFA values were lowered. These authors found also that lysine (protein) levels increased albumin levels, and lowered creatinine levels. Lysine is generally known to be beneficial for lean mass production. In swine, lysine, threonine and tryptophane have been investigated as limiting amino acids in corn-soybean meal diet. The requirement of these three limiting amino-acids is crucial, since they facilitate digestion and assimilation of proteins in general (NRC, 1988).

INTERACTION EFFECT OF CHROMIUM TRIPICOLINATE AND LYSINE ON GROWTH PERFORMANCE

There were no interaction effects of lysine and chromium on growth performance. However, interaction effect was noted on DP, urea nitrogen, and NEFA values. The effect on plasma urea nitrogen values may be justified by CrPic and lysine which both altered this parameter. Van de Ligt *et al.* (2002) didn't observe any effect of Cr-Lys levels interaction on growth performance and carcass traits ; but, they found that Cr-Lys interaction resulted in improved G/F at the 100 % of required lysine level, but not at the 120 % of required lysine level (Lindemann *et al.,* 1995).

CONCLUSION

Results of this experiment did not show any significant effect of CrPic on growth performance, carcass traits and plasma metabolites. On the contrary, Lysine improved growth efficiency, carcass characteristics and some plasma metabolites, with few Cr*Lys interactions. To date, there is no doubt that chromium can improve carcass composition in humans, pigs and other animal species (rat, calf, lamb, and poultry).

However, some experiments have shown contradictory effects of this compound in pigs.

These changes in the effects of Cr can be explained by the animal models, the amounts of supplemented Cr, the form of Cr and more interestingly, the initial body weight of animals during the experiments. Owing to the significant effect of chromium on tissue partionning in animals and humans, more research need to be done in order to elucidate its mechanism of action.

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