IMPORTANCE OF ORGANIC FORM OF CHROMIUM IN TURKEY FATTENING

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During fattening of female turkey chick of the Large White hybrid, the effects of supplementation of chromium in the form of picolinate and nicotinate chromium into the feed in concentration of 400 µg/kg and 2000 µg/kg. Compared with the control group to 35 and 88 days of age turkey female chicks fed on addition of chromium salts showed higher weight gain, better conversion of feed and lower content of fat in breast muscles.

fattening of turkeys; organic forms of chromium; nicotinate; picolinate; weight; fat in breast muscle; conversion of feed

INTRODUCTION

Importance of chromium as a trace element in animal and human nutrition is marked though the mechanism of its action is known a little. Its full absence in feed ratio of rats results in reduced intensity of saccharide metabolism, decrease of growth intensity, significant decrease of life span, increase of cholesterol level in blood serum, increase of the number of cardiac insufficiencies and decreased counts and fertility of sperms (Anderson, 1994; Evans, Meyer, 1994). At the same time, its deficit, particularly in more intensive influences of internal and external factors (or conditions) on the body. Considering the fact that an absence of chromium in feed ration is not a standard phenomenon (yet the level 10 µg/kg falls the occurrence of given negative phenomena), its addition is manifested positively not only in animals fed on lower than optimum ration.

Indispensability of chromium has already been reported by Schwartz and Mertz (1959). In trials with rats they identified chromium in yeasts as a substance which improved the utilization of glucose by the rat's body and termed it the glucose tolerance factor (GTF) (Schwart, Mertz, 1959). More accurate assessment of chromium function in the body was done by Mertz (1969) who predicted that GTF stimulates above all the effect of

insulin. This stimulation is remarkable in tissues demonstrating the deficit of chromium. At the same time, there are species-specific responses to its supply. Experimental rats responded to chromium addition in the form of chromium trichloride, though for the majority of other organisms chromium from inorganic sources is practically unavailable, it attains absorbability of maximum 5% (Lindemann, 1995). There are many sources with organically bound chromium but chromium picolinate and yeasts containing bound chromium are a very suitable form (Lindemann et al., 1995a, b).

Positive effect of chromium supplementation was observed in oral application when levels of serum lipids are fast influenced (Evans, 1989; Press et al., 1990). Wright et al. (1994) after administration of chromium in the form of chromium picolinate recorded a total reduction of blood glucose, glycosyl hemoglobin and cholesterol a short time after application. Beside the above mentioned forms of response after administration of chromium, a very good health condition and fall in mortality rates were reported. Ward et al. (1993) found that an addition of 200 µg/kg chromium in the form of picolinate in the feed mash increased the portion of proteins and reduced the portion of fats in muscles of experimental animals. On the contrary, addition of chromium trichloride in a dose of 20 $mg.kg^{-1}$ into feed mash for turkey hens was manifested by a low tendency to improvement of growth intensity and almost by indemonstrable improvement of feed conversion (Steel, Rosebrough, 1981).

All the given data gave a chance that in absence of optimum concentration of chromium in feed mashes used by us, an addition of organically bound chromium will show a positive effect on growth intensity, feed conversion,and total health condition of experimental animals.

MATERIALS AND METHODS

Sexed female turkey chicks of Canadian hybrid of large type HYBRID LARGE WHITE (imported by joint-stock company as early as in 1993) were used in the trial.

They were divided into weight-balanced groups of 40 chicks each and placed in boxes of the size 3 x 4 m. This corresponds to the concentration of 3.3 chick per 1 square meter. Temperature and moisture of medium were kept within limits given by technological procedure, illumination of medium of rearing was kept at 9 W/m^2.

Turkey hens to the age of 5 weeks were fed on the feed mash KR1, then on feed mash KR2 up to expedition of one-day poultry. Mash formulation is in Tab. I

I. Mash formulation

Component	KR1 content in %	KR2 content in %
Wheat meal	20	36
Maize meal	27	25
Soybean meal	28	25
Meat-bone meal	7	5
Fish meal	10	0
Dried feedstuffs	0	3
Fat	2	2
Rape oil	2	0
MKP	3	3
DBKR1	1	0
DBKR2	0	1

The above feed mashes were analyzed for the content of important components and elements. The results are presented in Tabs. II and III.

The chromium(III)picolinate has been prepared from sodium picolinate which was obtained by dissolving of picolic acid in NaOH. Picolic acid was synthesized from 2-methylpyridine which by the action of formaldehyde was transformed to 2-(2-hydroxyethyl)pyridine and this was subsequently oxidized by potassium permanganate in water medium into potassium picolinate. Picolic acid was liberated from its potassium salt by acidification of HCl and was separated from a ballast substance as a solid substance. After dissolving of the obtained acid in NaOH chromium picolinate (chromium(III)picolinate) was precipitated by addition of chromium trichloride.

Preparation of chromium(III)nicotinate: This substance has been prepared from nicotinic acid (p.a., LACHEMA) by an identical procedure.

From products obtained doses corresponding to chosen chromium concentrations in feed mash were weighed. Female turkey chicks were divided into seven groups by addition of chromium (Tab. IV).

Turkey hens were weighed at 35 and 88 days of age (during expedition of one-day poultry. Feed consumption was determined continuously to the given dates.

Ten turkey hens were randomly selected from control and experimental groups. A sample of breast muscle was taken from them to determine the fat content. The sample was taken the chest region, 2 cm from the *crista carina sterni* and in the half of its palpable course. After removal of the skin, the sample of breast muscle (*m. pectoralis thoracicus*) was taken by circular

II. The content of investigated components of feed mashes in g per kg

Mash	Dry matter	Crude protein	Fat	Ash	Fibre	MJ.kg^{-1}	Lysine	Met + Cys
KR1	881.0	271.2	62.3	71.0	30.5	11.97	17.1	9.9
KR2	891.2	234.8	71.2	68.8	35.0	12.53	13.2	9.6

III. The content of elements in feed mashes in mg per kg

Mash	Ca	P	K	Fe	Cu	Co	Mn	Zn	I
KR1	14 000	8 100	9 300	131.9	19.23	0.53	116.7	102.8	0.53
KR2	12 800	7 100	7 800	173.4	22.85	0.54	139.2	130.8	0.68

IV. Groups according to feed mashes

Name of group	Chromium as picolinate in µg per kg	Chromium as nicotinate in µg per kg
Control 1 – K1	0	0
Control 2 – K2	0	0
Group P1	400	0
Group P2	400	0
Group P3	2 000	0
Group N1	0	400
Group N2	0	400
Group N3	0	2 000

blade (puncture was led vertically to the plate of the sternum, parallelly with the keel) in the form of a small cylinder of about 10 g of weight.

Fat content was determined by extraction method on Soxhlet apparatus. Weight data and the fat content found in breast muscle were evaluated by common statistical methods. Results of the feed consumption values and its conversion were not statistically evaluated for a small number of data.

RESULTS AND DISCUSSION

Weight balance of one-day turkey chicks is documented in Tab. V.

Presented found differences in different groups were not statistically significant. This suggests a balance of material (animals) used in the trial.

V. Weight of one-day turkey chicks in different groups (in g)

Group						Difference of means										
Code	n	$\bar{x} \pm s_{\bar{x}}$	s	v	K2	K1 + K2	P1	P2	P1 + P2	P3	N3	N1	N2	N1 + N2
K1	40	48.65 ± 0.459	2.905	5.97	0.02	0.01	–0.05	0.55	0.25	0.25	0.10	0.12	0.50	0.31
K2	40	48.63 ± 0.494	3.127	6.43	x	–0.01	–0.07	0.53	0.23	0.23	0.08	0.10	0.48	0.29
K1 + K2	80	48.64 ± 0.335	2.999	6.17	x	x	–0.06	0.54	0.24	0.24	0.09	0.11	0.49	0.30
P1	40	48.70 ± 0.529	3.345	6.87	x	x	x	0.60	0.30	0.030	0.15	0.17	0.55	0.36
P2	40	48.10 ± 0.506	3.201	6.65	x	x	x	x	–0.30	–0.30	–0.45	–0.43	–0.05	–0.24
P1 + P2	80	48.40 ± 0.365	3.267	6.75	x	x	x	x	x	x	–0.15	–0.13	0.25	0.06
P3	40	48.40 ± 0.484	3.062	6.33	x	x	x	x	x	x	–0.15	–0.13	0.25	0.06
N3	40	48.55 ± 0.456	2.882	5.94	x	x	x	x	x	x	x	0.02	0.40	0.21
N1	40	48.53 ± 0.513	3.242	6.68	x	x	x	x	x	x	x	x	0.38	0.19
N2	40	48.15 ± 0.506	3.199	6.64	x	x	x	x	x	x	x	x	x	–0.19
N1 + N2	80	48.34 ± 0.358	3.206	6.63	x	x	x	x	x	x	x	x	x	x

VI. Weight of turkey hens at the age of 35 days in different groups (in g)

Group Code	n	$\bar{x} \pm s_{\bar{x}}$	s	v	Difference of means K2	K1 + K2	P1	P2	P1 + P2	P3	N3	N1	N2	N1 + N2
K1	39	1 201 ± 26.901	168.00	13.99	−23	−11	-80^a	-130^b	-104^b	-107^b	−32	−58	−33	−45
K2	40	1 224 ± 21.171	133.91	10.94	x	12	-57^a	-107^b	-81^b	-84^b	−9	−35	−10	−22
K1 + K2	79	1 212 ± 17.005	151.14	12.47	x	x	-69^a	-119^b	-93^b	-96^b	−21	−41	−22	−34
P1	40	1 281 ± 19.290	122.01	9.52	x	x	x	−50	−24	−27	48	22	47	35
P2	39	1 331 ± 18.962	118.42	8.90	x	x	x	x	26	23	98^b	72^b	97^b	85^b
P1 + P2	79	1 305 ± 13.741	122.13	9.36	x	x	x	x	x	−3	72^b	46	71^b	59^b
P3	39	1 308 ± 14.811	92.49	7.07	x	x	x	x	x	x	75^b	49	74^b	62^a
N3	39	1 233 ± 21.793	136.09	11.04	x	x	x	x	x	x	x	−26	−1	−13
N1	38	1 259 ± 20.998	129.37	10.28	x	x	x	x	x	x	x	x	25	13
N2	40	1 234 ± 21.709	137.31	11.13	x	x	x	x	x	x	x	x	x	−12
N1 + N2	78	1 246 ± 15.086	133.24	10.69	x	x	x	x	x	x	x	x	x	x

For [a] $P \leq 0.05$, for [b] $P \leq 0.01$

Weight was finding in 35-day old turkey hens and is presented in Tab. VI. Already after 35 days the effect of addition of organic chromium on growth intensity was fully provable. The highest significant growth of weight was found in groups P1 and P2 (400 µg/kg Cr), while higher addition of picolinate (group P3 – 2 000 µg/kg Cr) showed the same weight gain as in groups P1 and P2. In chromium in the form of nicotinate, the effect of addition of organic chromium as in the groups with lower addition (N1 and N2 – 400 µg/kg Cr), as in the group with higher chromium content in feed (N3 – 2 000 µg/kg Cr) was insignificant.

In feed consumption up to 35 days of age the effect of addition of organic chromium looks different. Both chromium forms reduced significantly the feed consumption per 1 kg of weight gain (Tab. VII), whereas differences among groups P1 and P2, and N1 and N2 cannot be considered as significant. Higher addition of both chromium forms (groups P3 and N3) varies in the weight gain from the groups with lower addition of chromium only insignificantly and this leads to the prerequisite that higher addition of chromium into feed (in probable further experiments) is useless.

Weight found in 88 day old turkey hens is in Tab. VIII. Longer administration (up to day 88) of feed enriched with chromium gives again other result. Unlike five-week results, addition of both chromium forms was mani-

VII. Feed consumption (in kg) per 1 kg of weight gain in groups 35 days old

Group Code	Mean	Difference of means K2	K1 + K2	P1	P2	P1 + P2	P3	N3	N1	N2	N1 + N2
K1	1.84	0.02	0.01	0.29	0.33	0.31	0.28	0.21	0.36	0.38	0.37
K2	1.82	x	−0.01	0.27	0.31	0.29	0.26	0.19	0.34	0.36	0.35
K1 + K2	1.83	x	x	0.28	0.32	0.30	0.27	0.20	0.35	0.37	0.36
P1	1.55	x	x	x	0.04	0.02	−0.01	−0.08	0.07	0.09	0.08
P2	1.51	x	x	x	x	−0.02	−0.05	−0.12	0.03	0.05	0.04
P1 + P2	1.53	x	x	x	x	x	−0.03	−0.10	0.05	0.07	0.06
P3	1.56	x	x	x	x	x	x	−0.07	0.08	0.10	0.09
N3	1.63	x	x	x	x	x	x	x	0.15	0.170	0.16
N1	1.48	x	x	x	x	x	x	x	x	0.02	0.01
N2	1.46	x	x	x	x	x	x	x	x	x	−0.01
N1 + N2	1.47	x	x	x	x	x	x	x	x	x	x

VIII. Weight of turkey hens at the age of 88 days in different groups (in g)

Group Code	n	$\bar{x} \pm s_{\bar{x}}$	s	v	Difference of means									
					K2	K1 + K2	P1	P2	P1 + P2	P3	N3	N1	N2	N1 + N2
K1	39	6 810 ± 67.217	419.77	6.16	–100	–50	-550^b	-626^b	-587^b	-682^b	-736^b	-564^b	-623^b	-594^b
K2	39	6 910 ± 75.536	471.72	6.83	x	50	-450^b	-526^b	-487^b	-582^b	-636^b	-464^b	-523^b	-494^b
K1 + K2	78	6 860 ± 50.548	446.44	6.51	x	x	-500^b	-576^b	-537^b	-632^b	-686^b	-514^b	-573^b	-544^b
P1	40	7 360 ± 119.435	755.43	10.26	x	x	x	–76	–37	–132	–186	–14	–73	–44
P2	39	7 436 ± 65.868	411.34	5.53	x	x	x	x	39	–56	–110	62	3	32
P1 + P2	79	7 397 ± 68.366	607.64	8.21	x	x	x	x	x	–95	–149	23	–36	–7
P3	39	7 492 ± 90.312	564.00	7.53	x	x	x	x	x	x	–54	118	59	88
N3	39	7 546 ± 92.977	580.77	7.70	x	x	x	x	x	x	x	172	113	142
N1	38	7 374 ± 93.818	578.29	7.84	x	x	x	x	x	x	x	x	–59	–30
N2	40	7 433 ± 84.982	537.51	7.23	x	x	x	x	x	x	x	x	x	29
N1 + N2	78	7 404 ± 62.828	554.89	7.49	x	x	x	x	x	x	x	x	x	x

For ^{a} $P \leq 0.05$, for ^{b} $P \leq 0.01$

fested by significant growth of weight against control groups. Higher additions of both chromium forms then confirm this tendency, but differences between lower and higher chromium additions (group P3 against P1 and P2, the same N3 against N1 and N2) are insignificant. This confirms a prerequisite that the dose of 400 µg/kg Cr in feed is sufficient.

Feed consumption per 1 kg of weight gain in different groups in the period of 35 to 88 days of age and for the entire period of 88 days is presented in Tabs. IX and X.

As in further period of fattening (days 35 to 88), as for the whole time of lasting of the trial (days 1 to 88), groups with addition of chromium demonstrated significantly lower consumption of feed per 1 kg of weight gain, namely without the chromium form and its formulation in feed. There is an interesting phenomenon that differences in feed consumption in the second experimental period (days 35 to 88) do not vary too much from those in the feed consumption during the whole period of fattening (days 2 to 88). The effect of chromium addition on growing body of turkey hens changes in dependence on their age.

Fat content in breast muscle of turkey hens is digestedly presented in Tab. XI. It is evident from the table that the effect of used chromium forms

IX. Feed consumption (in kg) per 1 kg of weight gain in different groups from 36 to 88 days of age

Group Code	Mean	Difference of means									
		K2	K1 + K2	P1	P2	P1 + P2	P3	N3	N1	N2	N1 + N2
K1	3.25	0.11	0.05	0.58	0.61	0.59	0.63	0.65	0.61	0.70	0.65
K2	3.14	x	–0.06	0.47	0.50	0.48	0.52	0.54	0.50	0.59	0.54
K1 + K2	3.20	x	x	0.53	0.56	0.54	0.58	0.60	0.56	0.65	0.60
P1	2.67	x	x	x	0.03	0.01	0.05	0.07	0.03	0.12	0.07
P2	2.64	x	x	x	x	–0.02	0.02	0.04	–	0.09	0.04
P1 + P2	2.66	x	x	x	x	x	0.04	0.06	0.02	0.11	0.06
P3	2.62	x	x	x	x	x	x	0.02	–0.02	0.07	0.02
N3	2.60	x	x	x	x	x	x	x	–0.04	0.05	–
N1	2.64	x	x	x	x	x	x	x	x	0.09	0.04
N2	2.55	x	x	x	x	x	x	x	x	x	–0.05
N1 + N2	2.60	x	x	x	x	x	x	x	x	x	x

X. Feed consumption (in kg) per 1 kg of weight gain in different groups from the beginning of the trial to 88 days of age

Group Code	Mean	Difference of means									
		K2	K1 + K2	P1	P2	P1 + P2	P3	N3	N1	N2	N1 + N2
K1	2.98	0.09	0.04	0.52	0.56	0.54	0.55	0.55	0.55	0.62	0.58
K2	2.89	x	–0.05	0.43	0.47	0.45	0.46	0.46	0.46	0.53	0.49
K1 + K2	2.94	x	x	0.48	0.52	0.50	0.51	0.51	0.51	0.58	0.54
P1	2.46	x	x	x	0.04	0.02	0.03	0.03	0.03	0.10	0.06
P2	2.42	x	x	x	x	–0.02	–0.01	–0.01	–0.01	0.06	0.02
P1 + P2	2.44	x	x	x	x	x	0.01	0.01	0.01	0.08	0.04
P3	2.43	x	x	x	x	x	x	–	–	0.07	0.03
N3	2.43	x	x	x	x	x	x	x	–	0.07	0.03
N1	2.43	x	x	x	x	x	x	x	x	0.07	0.03
N2	2.36	x	x	x	x	x	x	x	x	x	–0.04
N1 + N2	2.40	x	x	x	x	x	x	x	x	x	x

XI. Fat content in breast muscle of turkey hens (in %)

Group Code	n	$\bar{x} \pm s_{\bar{x}}$	s	v	Difference of means			
					P1 + P2	P3	N3	N1 + N2
K1 + K2	10	1.83 ± 0.100	0.315	17.21	0.97[b]	0.83[b]	0.94[b]	0.99[b]
P1 + P2	10	0.86 ± 0.100	0.315	36.63	x	–0.14	–0.03	0.02
P3	10	1.00 ± 0.110	0.348	34.80	x	x	0.11	0.16
N3	10	0.89 ± 0.129	0.407	45.73	x	x	x	0.05
N1 + N2	10	0.84 ± 0.106	0.336	40.00	x	x	x	x

For [b] $P \leq 0.01$

on the fat content in breast muscle is fully significant, whereas the effect of nicotinate is significantly higher against picolinate. Similar (P1 and P2 against P3) and almost identical (N1 and N2 against N3) results in experimental groups with different addition of chromium only confirm that the level of 400 ug Cr per 1 kg of feed should not be increased. Results are almost in full congruency with the data of Hossain (1995) who using yeasts containing bound chromium and addition of 400 µg/kg Cr found decrease in the feed consumption from 2.20 kg to 2.14 kg per 1 kg of weight gain (less than in the presented trial) and decrease in the fat content in breast muscle from 1.23% to 0.56% (more than in our trials).

Feed consumption per 1 kg of weight gain was 2.94 kg in the control groups, in experimental groups 2.40 to 2.44 kg. Though the difference found seems to be conspicuously great, the obtained value of feed consumption is above the value reported in the Technological Procedure for Turkey Fattening by the company HYBRID (XAVEROV, 1996). This gives the value 2.19 per 1 kg of weight gain for the same fattening and age category.

It has been verified that an addition of a very little amount of chromium in the form of salts of pyridincarboxyl acids into feed for turkey fattening had lead to better utilization of feed (probably owing to the stimulation of the effect of insulin and hence to better utilization of glucose), increase in weight and higher quality form of produced muscle mass of animals.

Results correspond to the literary data (Ward et al., 1993) which give that the chromium addition increases also protein production along with decrease in fat production in muscle.

Therefore it is possible that addition (naturally dependent on the chromium content in standard feed ration) to recommend to breeders providing that more available will be chromium nicotinate, because picolic acid and particularly its salts in the meantime do not belong to commercially available compounds.

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Received for publication on May 21, 1997

HOLOUBEK, J. – JANKOVSKÝ, M. – ARENT, E. – LEDVINKA, Z. (Česká zemědělská univerzita, Agronomická fakulta, Praha, Česká republika):

Význam organické formy chromu při výkrmu krůt.

Scientia Agric. Bohem., *28*, 1997 (2): 146–159.

Mikroelementy jsou ve výživě zvířat velmi významné. Jejich nepatrná množství silně ovlivňují některé pochody biosyntézy a mohou tak pozitivně působit na růst a vývoj zvířat. Chrom, především v organické formě, stimuluje účinek inzulinu, ovlivňuje tvorbu a působení sérových lipidů, snižuje v krvi hladinu glukózy a glykosylového hemoglobinu a působí na snižování hladiny cholesterolu. Tato známá fakta byla impulsem k provedení pokusu s výkrmem krůt. Vysexované krůtičky užitkového hybrida Large White byly rozděleny do skupin po 40 kusech. Kontrolní (srovnávací) skupina byla krmena do 5 týdnů krmnou směsí s 27 % N-látek a od 5. do 13. týdne věku směsí s obsahem 23,5 % N-látek. Pokusné skupiny byly krmeny stejnými směsmi obohacenými o 400 µg/kg, resp. 2 000 g/kg chromu ve formě pikolinátu chromitého a nikotinátu chromitého.

U všech pěti skupin krůtiček byla stanovena tělesná hmotnost a spotřeba krmiva na 1 kg přírůstku ke 35. a 88. dni věku. K 88. dni věku byl u 10 náhodně vybraných krůt z každé skupiny stanoven obsah tuku v prsní svalovině.

V pokusné skupině, krmené s přídavkem pikolinátu chromitého, byl ke 35. dni věku zjištěn nejvyšší, vysoce signifikantní nárůst hmotnosti oproti kontrolní skupině, a to jak ve skupině s nižším, tak ve skupině s vyšším přídavkem pikolinátu.

Pokusné skupiny krmené krmivem s přídavkem nikotinátu vykázaly ke 35. dni věku vyšší, ale nesignifikantní přírůstek hmotnosti ve srovnání s kontrolní skupinou.

Přídavek obou forem chromu vysoce statisticky průkazně ovlivnil hmotnost krůt v 88. dni věku, a to bez zřetele na formu i množství přidávaného organického chromu. V rámci pokusných skupin krmených krmivem s přídavkem chromu nebyly v žádném případě zjištěny signifikantně významné diference v hmotnosti krůt.

Naproti tomu všechny pokusné skupiny vykázaly vysoce signifikantně nižší podíl ukládaného tuku v prsní svalovině oproti kontrole (o 0,83–0,99 %) a významně nižší spotřebu krmiva na 1 kg přírůstku (o 0,41–0,50 kg).

výkrm krůt; organické formy chromu; nikotinát; pikolinát; hmotnost; tuk v prsní svalovině; konverze krmiva

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