J. Agric. Sci. Mansoura Univ., 33(5): 3181 - 3198, 2008

INFLUENCE OF CHROMIUM PICOLINATE SUPPLEMENTATION ON PRODUCTIVE PERFORMANCE AND SOME BLOOD PARAMETERS OF FATTENING LAMBS.

Moawd, R.I.; A.A. Abu El-Ella; A.A.H. El-Tahan; A.A. Abd El-Hamid and A.A. El-Mekass.
Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt.

ABSTRACT

The present work was carried out to study the influence of chromium picolinate (Cr Pic) supplementation on digestibility, feeding values, productive performance, some blood serum constituents and economical efficiency of fattening lambs. Twenty four Suffolk crossbred lambs with an average live body weight of 17.5 kg were divided into four groups (6 in each) and were all fed a basal diet which supplied of 60% of requirements from CFM + rice straw (RS) *ad lib*. The first group served as control (C), while the second (T1), Third (T2) and Fourth (T3) ones were fed the same diet supplemented with Cr Pic at doses of 20, 40 or 60 mcg per kg concentrate feed mixture intake (CFMI), respectively.

The main results could be summarized as follows:

1-There were no significant differences among treatments in live body weight of lambs from first week up to the end of experimental.

2-The averages of daily body gain were 0.183, 0.192, 0.205 and 0.203 kg for rations C, T1, T2 and T3, respectively, without any significant differences among treatments.

3-Lambs fed T2 and T3 consumed 1.41 and 1.40 kg DMI/ day being more than that by others (1.34 – 1.38 kg DMI / day).

4-Lambs fed rations T2 and T3 were most efficient to convert DM to kg gain (6.90 kg /kg gain).

5-The digestibility of various nutrients and nutritive values for treatments T1, T2 and T3 were higher (P<0..05) than those of control treatment (C) and ration T2 recorded the best (P<0.05) values of previous items.

6- The Cr Pic supplementation for lambs induced significant (P<0.05) increases in serum concentrations of total protein, albumin, globulin, Zn and Fe than those of lambs fed non–supplemented with Cr Pic. However, depressions in serum concentrations of cholesterol, triglycerides and glucose were detected.

7- There were significant (P<0.05) differences in serum albumin, AST, triglycerides, glucose and Zinc concentrations among the age of lambs (duration of feeding the experimental rations).

8-Supplementation with Cr Pic at doses of 20, 40 or 60 mcg per kg CFMI for fattening lambs led to increased return as LE / lamb by 4.73, 12.58 and 11.10 % , respectively, compared with animals fed control ration.

It could be concluded that, supplementation of chromium as chromium picolinate during fattening period of lambs improved digestibilites of various nutrients, feeding values, daily body gain, induced significant increase Zu and Fe in serum this rises the immunity of lambs and return especially with 2 *nd* tested ration (T2) : 60 % of requirements from CFM + RS *ad lib* + 40 mcg Cr Pic / kg CFMI.

Keywords: chromium picolinate, lambs, performance, glucose, hormones.

INTRODUCTION

Chromium (Cr) is a trace mineral that is widely distributed throughout the body. It is involved in carbohydrate, lipid, protein and nucleic acid metabolism (Nielsen, 1994). Previous literature demonstrates that Cr is necessary for growth and protein synthesis (Mertz, 1993) and that Cr supplementation improves animals performance by enhancing energy metabolism (Jacques and Stewart, 1993). Supplemental Cr seems to improve the immune status of stressed ruminants (Chang and Mowat, 1992 and Moonsie –Shageer and Mowat, 1993). However, in the same studies in which Cr has been fed to non – stressed ruminants, growth and metabolic responses to Cr have been variable (Britton *et al.*, 1968 and Chang *et al.*, 1992). Depew *et al.* (1998) showed improved daily body gain in bull calves supplemented with Cr Pic but not that of heifer calves. Whereas, Bunting *et al.* (1994) and Kitchalong *et al.* (1995) found that Cr had no effect on daily body gain of dairy calves and growing lambs. Supplemental Cr would increase growth or milk production in ruminants (Bunting, 1994; Hayirli *et al.*, 2001; El-Tahan *et al.*, 2005 and Smith *et al.*, 2005).

Moonsie – Shageer and Mowat (1993) found that supplemental Cr could reduce the preventative and therapeutic use of antibiotics and possibly enhance the effectiveness of vaccines because Cr tended to reduce morbidity and improve the immunity. Chromium is considered essential for maintenance of normal glucose tolerance (Schwarz and Mertz, 1959) by increasing insulin activity in animals and humans (Anderson, 1987). Bunting *et al* (1994) reported lower plasma total cholesterol and higher glucose clearance rates in Holstein calves fed diets supplemented with Cr Pic. Chromium decreased the total cholesterol (Press *et al.*, 1990) and blood nonesterified fatty acids (NEFA) concentration (Bryan *et al.*, 2003). The absorption and utilization of Cr may be dependent on its association with any organic molecule (Mertz, 1969) such as picolinate (Pic) (Evans and Johnson, 1980). Therefore, this investigation was conducted to study the influence of chromium picolinate (Cr Pic) supplementation on digestibility, feeding values, performance, some blood constituents and economical efficiency of fattening lambs.

MATERIALS AND METHODS

This work was conducted at El- Gemmiza Experimental Station, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt, to study the influence of chromium picolinate (Cr Pic) supplementation on digestibility, feeding values, performance, some blood serum constituents and economical efficiency of fattening lambs. Twenty four Suffolk crossbred lambs with an average live body weight of 17.5 kg (at weaning) were divided into four groups (6 in each), on the basis of their initial LBW and age and were fed the following experimental rations:

Control ration (C) : 60% of requirements from concentrate feed mixture (CFM) + Rice straw (RS) *ad lib.*

Ration (T1) : control ration + 20 mg Cr Pic / kg CFMI.

Ration (T2) : control ration + 40 mg Cr Pic / kg CFMI.
Ration (T3) : control ration + 60 mg Cr Pic / kg CFMI.

Chemical composition of feed ingredients and the basal ration are shown in Table (1).

Table (1): Chemical composition of feed ingredients and calculated composition of basal ration on DM basis.

Items	DM	Composition , % DM basis					
		OM	CP	CF	EE	NFE	ASH
Concentrate feed mixture (CFM)*	90.02	91.10	17.12	12.24	3.74	58.00	8.90
Rice straw (RS)	91.15	83.89	3.18	36.71	0.98	43.02	16.11
Calculated composition of basal ration	90.48	88.13	11.38	22.31	2.60	51.84	11.87

CFM* : The ingredients of concentrate feed mixture were 35 % wheat bran, 12 % undecorticateted cotton seed cake, 8 % soybean meal, 29 % yellow corn, 11 % rice bran, 3 % molasses, 1.5 % limestone and 0.5 % salt.

The Cr Pic was supplemented once daily via an individual oral drench before offering the morning meal. Chromium picolinate was purchased from MEP-ACO Egypt. During the feeding trial (154 days), lambs were fed according to NRC (1986) allowances as a group feeding. The amount of feedstuffs was adjusted biweekly according to body weight changes. The feed residues were taken into account for determination of actual feed intake. Concentrate feed mixture was offered twice daily at 8 a.m. and 4 p.m. and rice straw was offered *ad lib* after feeding CFM. Fresh water was offered to the animals three times daily. Vitamin and mineral blocks were provided freely.

Blood samples were collected by jugular vein puncture in clean test tubes from all lambs in the morning just before feeding and drinking at weaning (60 days old), 90 days old, 120 days old and 150 days old. Blood samples were left to clot for 24 h in the refrigerator and centrifuged at 4000 rpm for 15 minutes. Blood serum samples were carefully separated and stored at - 20 ^{0}C for determination of total proteins (TP), albumin, globulin, albumin / globulin ratio (A/G ratio), aspartate amino transferase (AST), alanine amino transferase (ALT), cholesterol, triglycerides, Glucose, Zn and Fe. Total proteins (TP) and albumin were determined according to Doumas and Biggs (1972 a & b), globulin was calculated by subtraction concentration of albumin from the corresponding total protein then albumin/ globulin ratio (A/G ratio) was also calculated. AST and ALT activities as described by Reitman and Frankel (1957). Commercial kits were used for the calorimetric determination of serum total cholesterol, triglycerides and serum glucose. Concentration of Fe and Zn in serum were determined by the absorption spectrophotometery.

Four digestibility trails were carried out during the feeding experiment to determine the digestion coefficients and nutritive values of the experimental rations using 3 mature rams in each. All rams were individually housed is metabolic cages. The preliminary period extended for 15 days and collection period lasted 7 days. Feces samples were collected twice daily during the collection period. Representative samples of feedstuffs and feces were prepared and analysed according to A.O.A.C. procedures (1990).

The statistical analysis was computed using analysis of variance procedure described in the SAS (1995) and significant differences among means were separated by Duncan's (1955) multiple range test.

RESULTS AND DISCUSSION

Daily dry matter intake:

The data in Table (2) showed that the total quantity of DM intake from all rations was gradually increased with advancing age. Also, the total DM intake from rations T1, T2, and T3 was increased by using Cr Pic at doses of 20, 40 or 60 mcg / kg CFMI as supplementation compared with control ration (C). These results are in agreement with those obtained by Mooney and Cromwell (1995) and Depew *et al.* (1998). In contrast, Boleman *et al.* (1995) reported reduced DM intake by pigs fed Cr Pic from the growing to the finishing phase.

Live body weight:

There were no significant (*P>0.05*) differences among treatments in live body weight (LBW) of lambs through out the experimental period (154 days) as show in Table (3). The averages of final LBW were 45.67, 46.83, 49.33 and 48.50 kg for lambs fed rations C, T1, T2 and T3, respectively, without any significant (*P*>0.05) differences among treatments. These results are in agreement with Gentry *et al.* (1999).

Table (2): Effect of chromium picolinate supplementation on average daily dry matter intake* (g) of lambs during the fattening period (154 days).

Weeks	C			T1			T2			T3		
	CFM	R.S	Total	CFM	R.S	Total	CFM	R.S	Total	CFM	R.S	Total
8-10	583	334	917	583	328	911	583	336	919	583	329	912
10-12	657	418	1075	657	422	1079	657	431	1088	657	436	1093
12-14	677	462	1139	705	470	1175	722	465	1187	718	461	1179
14-16	738	496	1234	788	505	1293	805	509	1314	805	511	1316
16-18	815	532	1347	827	561	1388	853	572	1425	853	568	1421
18-20	853	587	1440	876	592	1468	876	598	1474	876	594	1470
20-22	876	590	1466	889	618	1507	889	627	1516	889	623	1512
22-24	889	595	1484	892	639	1531	947	646	1593	925	652	1577
24-26	925	600	1525	947	642	1589	969	668	1637	927	661	1588
26-28	950	611	1561	960	656	1616	1008	671	1679	970	668	1638
28-30	960	639	1599	970	661	1631	1036	682	1718	1008	682	1690
Av.Daily DM intake(g)	811.18	533.09	1344.27	826.73	554	1380.73	849.55	564.09	1413.64	837.36	562.27	1399.63

* Group feeding (No. of lambs in each group =6).

Growth performance:

The averages of total body gain was 28.17, 29.50, 31.50 and 31.33 kg for lambs fed rations C, T1, T2 and T3, respectively, without any significant (*P*>0.05) difference among treatments (Table 4). The corresponding values of daily body gain were 0.183; 0.192; 0.205 and 0.203 kg. It was noticed that daily body gain for lambs fed rations T1, T2 and T3 insignificantly (*P*>0.05) increased by 4.90, 12.02 and 10.93 % than control ration (C), respectively. The increase in growth rate and final body weight due to supplemented Cr could had resulted from increased nitrogen retention (Kornegay *et al.*, 1997), incorporation and utilization of amino acids and nuclear protein synthesis (Weser and Koolman, 1969). On the other hand, Mowat *et al.* (1993) reported that the positive increases in growth performance by using Cr likely was attributable to the improve of immunity and elevation in growth hormone level (Page *et al.*, 1993) which may emend of growth rate and body gain.

Table (3): Effect of chromium picolinate supplementation on average live body weight (kg) of lambs from weaning* (8 weeks) up to 30 weeks.

Weeks	Live body weight (kg)			
	C	T1	T2	T3
8	17.50 ± 0.89	17.33 ± 0.88	17.83 ± 1.05	17.17 ± 0.48
10	19.67 ± 0.76	19.33 ± 0.88	19.67 ± 1.12	19.00 ± 0.58
12	21.83 ± 1.08	21.33 ± 0.92	22.17 ± 1.30	22.33 ± 0.49
14	24.0 ± 1.00	25.00 ± 0.73	26.17 ± 1.30	26.00 ± 0.58
16	27.33 ± 0.71	29.17 ± 0.79	29.83 ± 1.56	30.17 ± 0.75
18	31.17 ± 0.98	32.83 ± 0.95	33.83 ± 1.30	34.67 ± 0.84
20	34.0 ± 1.39	36.00 ± 1.13	37.33 ± 1.36	36.33 ± 0.95
22	37.17 ± 1.40	38.67 ± 0.92	39.33 ± 1.56	38.83 ± 1.35
24	39.33 ± 1.45	40.17 ± 0.95	42.67 ± 1.28	41.67 ± 1.58
26	41.0 ± 1.59	42.83 ± 1.11	46.17 ± 1.19	44.17 ± 1.51
28	43.17 ± 1.28	45.00 ± 1.15	48.00 ± 1.44	46.67 ± 1.23
30	45.67 ± 1.45	46.83 ± 1.17	49.33 ± 1.15	48.50 ± 1.02

*** (6 lambs in each group).**
No significant (*P*>0.05) differences among all treatments.

Depew *et al.* (1998) showed improved daily body gain in bull calves supplemented with Cr Pic but not that of heifer calves. Whereas, Bunting *et al.* (1994) found that Cr had no effect on daily gain of dairy calves. Also, Samsell and Spears (1989) and Kitchalong *et al.* (1995) found that Cr had no effect on daily body gain of growing lambs. In contrast, Boleman *et al.* (1995) reported reduced daily body gain in pigs fed Cr Pic from the growing to the finishing phase.

Data presented in Table (4) indicated that, the highest DM intake was found for T2 and T3 which contained Cr Pic at doses of 40 and 60 mcg / kg CFMI being 1.414 and 1.400 kg / lamb / day, respectively. However, control ration (C) recorded the lowest one (1.344) kg.

Table (4): Effect of chromium picolinate supplementation on performance of lambs.

Items	C	T1	T2	T3
Initial weight (kg)	17.50 ± 0.89	17.33 ± 0.88	17.83 ± 1.05	17.17 ± 0.48
Final Weight (kg)	45.67 ± 1.45	46.83 ± 1.17	49.33 ± 1.15	48.50 ± 1.02
Total gain (kg)	28.17 ± 0.95	29.50 ± 1.02	31.50 ± 0.96	31.33 ± 0.80
Daily body gain (kg)	0.183 ± 0.006	0.192 ± 0.007	0.205 ± 0.006	0.203 ± 0.005
Av. Daily feed intake (kg)*	1.344	1.381	1.414	1.400
Feed conversion (Feed/ gain):				
kg DMI/kg /gain*	7.34	7.19	6.90	6.90

***Group feeding.**
No significant (P>0.05) differences among all treatments.

The data of daily body gain (kg) and daily feed intake (kg) reflected the feed conversion (kg DMI / kg gain) which was the best for both treatments T2 and T3 (6.90). While, treatments C and T1 had inferior values (7.34 and 7.19), respectively.

Digestibility trails:

The daily DM intake expressed as g /h /d or per g /kgw$^{0.75}$ were nearly similar for lambs fed T1, T2 and T3 rations, but control ration (C) recorded the lowest values (Table 5). These results are in agreement with those obtained by Mooney and Cromwell (1995) and Depew *et al.* (1998).

The data in Table (5) showed that, the DM,OM, CP, CF and NFE digestibilites were affected (P<0.05) by Cr Pic supplementation. Treatment 2 recorded the highest (P<0.05) values of the pervious items. Also, the EE digestibility of rations T2 was significantly (P<0.05) higher than rations C and T1, and insignificantly higher than ration T3.

Generally, it could be noticed that, the digestibility of various nutrients were significantly (P<0.05) increased with Cr Pic supplementation specially T2. These results are in agreement with those obtained by El-Tahan *et al.* (2005).

Table (5): Effect of chromium picolinate supplementation on feed intake, digestibility and nutritive values of experimental rations by rams.

Items	C	T1	T2	T3
Body weight (kg)	· 64.00 ± 1.15	64.67 ± 0.88	65.00 ± 2.03	64.00 ± 1.53
Daily DM intake g/h/d:				
CFM	960.00 ± 17.32	970.00 ± 13 23	975.00 ± 22.91	960.00 ± 22.91
RS	671.67^{b} ± 9.02	684.67^{ab} ± 4.07	718.00^{a} ± 9.45	693.34^{ab} ± 14.45
Total DM intake (g)	1631.67 ± 23.90	1654.67 ± 16.75	1693.00 ± 36.94	1653.34 ± 9.94
Total DM intake g/kgw$^{0.75}$	72.10 ± 0.31	72.57 ± 0.15	73.96 ± 0.73	73.06 ± 0.94
Digestion coefficients (%):				
DM	66.36^{d} ± 0.34	68.47^{c} ± 0.28	71.97^{a} ± 0.33	70.50^{b} ± 0.16
OM	68.14^{d} ± 0.17	69.69^{c} ± 0.28	73.02^{a} ± 0.21	71.48^{b} ± 0.14
CP	68.19^{d} ± 0.12	70.58^{c} ± 0.25	74.50^{a} ± 0.41	73.44^{b} ± 0.14
CF	60.07^{d} ± 0.15	61.83^{c} ± 0.17	65.74^{a} ± 0.17	64.63^{b} ± 0.15
EE	74.33^{b} ± 0.24	74.42^{b} ± 0.10	75.50^{a} ± 0.30	74.90^{ab} ± 0.19
NFE	70.09^{d} ± 0.05	72.29^{c} ± 0.13	77.87^{a} ± 0.23	76.12^{b} ± 0.50
Nutritive values (%):				
TDN	61.85^{d} ± 0.06	63.85^{c} ± 0.34	67.80^{a} ± 0.15	66.54^{b} ± 0.31
DCP	7.76^{d} ± 0.02	8.01^{c} ± 0.03	8.35^{a} ± 0.02	8.28^{b} ± 0.01
Daily feed units intake:				
TDN g / h / d	1009.19^{c} ± 15.64	1056.51^{bc} ± 12.24	1147.85^{a} ± 23.90	1100.13^{ab} ± 11.79
TDN g/kgw$^{0.75}$	44.60^{d} ± 0.22	46.34^{c} ± 0.15	50.15^{a} ± 0.35	48.61^{b} ± 0.46
DCP g / h / d	126.62^{c} ± 1.90	132.54^{bc} ± 1.42	141.37^{a} ± 2.83	136.90^{ab} ± 1.06
DCP g/kgw$^{0.75}$	5.60^{c} ± 0.04	5.81^{b} ± 0.01	6.17^{a} ± 0.05	6.05^{a} ± 0.07

A, b, c and d: Means in the same row with different superscripts are significantly (P<0.05) differ.

The nutritive values as TDN and DCP for rations supplemented with Cr Pic were significantly (P<0.05) higher than those of the control ration (C) as shown in Table (5). Also, ration T2 had the highest values of nutritive values, while the control ration (C) showed the lowest (P<0.005) ones. This improvement in nutritive values was associated with high nutrients digestibility coefficients of rations supplemented with Cr Pic (Table 5).

Generally, it could be noticed that T2 showed the superior values of digestibility of nutrients and nutritive values.

The feed units intake as TDN and DCP per g/h/d from rations T2 and T3 were significantly (P<0.05) higher as compared to control ration (C) as shown in Table (5). Also, the results showed that, the rations supplemented with Cr Pic had the highest (P<0.05) values of TDN and DCP intake per g / kgw $^{0.75}$ compared with control ration (C). These results may be due to higher nutrients digestibilites or DM intake or both for rations supplemented with Cr Pic.

Blood serum parameters :

Concentrations of total protein, albumin and globulin for treatment T3 were higher (P<0.05) than those of control. The A/G ratio values for T1 and T2 were lower (P<0.05) than those of other groups (Table 6). In general, T3 recorded the highest (P<0.05) value of serum total protein followed by T2 and T1 than control. These results agree with those obtained by Chang and Mowat (1992) who found that the chromium supplementation increased (*P*<0.05) serum total protein in calves. The increase in serum total protein and protein fraction in response to Cr Pic supplementation may be attributed to an improved of nitrogen absorption (Kornegay *et al.* 1997). Amino acid synthesis increased in the liver, in which Cr Pic may enhance amino acid synthesis, was possibly via insulin and incorporation of several amino acid into protein (Moonsie-Shageer and Mowat, 1993).

These results were parallel with the results of OM and CP digestibility (Table 5), which indicated better utilization of dietary protein through digestive tract. These results agree with the conclusion of Kumar *et al.* (1980) who reported that there was a positive correlation between dietary protein and serum protein concentration. Yousef and Zaki (2001) noticed that the increase in digestibility of CP may be a reason for the increase of serum total protein. Also, serum proteins are considered a reliable index reflecting health and animal performance (Okelly, 1973). El-Masry and Marai (1991) related the variations in serum proteins to the alteration in thyroid hormone level and in albumin or globulin concentrations.

There were no significant (*P*>0.05) differences in serum total protein fraction level among the age of lambs (duration of feeding the experimental rations) (Table 6) expect for albumin, which was significant between duration of feeding the experimental rations.

Albumin concentration in blood serum was significantly (P<0.05) lower in control, T1 and T2 than T3 (Table 6). It can be noticed that T3 recorded the highest significantly (P<0.05) values of serum albumin by about 10.60 9.80 and 7% than control, T1 and T2, respectively. The increase of albumin in response to Cr Pic supplementation may be associated with improved nitrogen absorption (Kornegay *et al.*, 1997). Serum albumin have been shown to be a good indicator of nitrogen status, especially in small ruminants (Ingraham and Kappel, 1988; Gaskins *et al.*, 1991 and Laborde *et al.*, 1995). This results may to due higher (P<0.05) digestibility of crude protein for treatments than control (Table 5). Rowlands (1980) reported that dietary protein could affect the concentration of serum albumin.

Table (6):Effect of chromium picolinate supplementation and age on lambs blood serum protein fraction, liver function and minerals after feeding.

Blood components	Age of lamb	Treatments: C	T1	T2	T3	Overall mean
Total protein (g/dl)	60 days at weaning	5.86 ± 0.59	6.23 ± 0.22	6.06 ± 0.15	7.63 ± 0.86	6.44 ^{a} ± 0.16
	90 days	5.72 ± 0.60	6.11 ± 0.51	6.58 ± 0.43	6.30 ± 0.22	6.18 ^{a} ± 0.27
	120 days	6.45 ± 0.01	6.74 ± 0.26	6.83 ± 0.27	6.92 ± 0.46	6.73 ^{a} ± 0.67
	150 days	6.43 ± 0.32	6.59 ± 0.42	7.08 ± 0.23	6.67± 0.18	6.69 ^{a} ± 0.24
	Overall mean	6.11 ^{b} ± 0.38	6.42 ^{ab} ± 0.35	6.64 ^{ab} ± 0.27	6.88 ^{a} ± 0.43	
Albumin (g/dl)	60 days at weaning	4.34 ± 0.18	4.26 ± 0.35	4.32 ± 0.09	4.38 ± 0.10	4.33 ^{a} ± 0.18
	90 days	3.88 ± 0.19	3.70 ± 0.26	3.83 ± 0.18	4.09 ± 0.37	3.87 ^{b} ± 0.25
	120 days	3.97 ± 0.07	4.37 ± 0.16	4.71 ± 0.26	4.83 ± 0.19	4.47 ^{a} ± 0.17
	150 days	4.41 ± 0.14	4.39 ± 0.06	4.31 ± 0.12	5.05 ± 0.14	4.54 ^{a} ± 0.11
	Overall mean	4.15 ^{a} ± 0.15	4.18 ^{a} ± 0.21	4.29 ^{a} ± 0.16	4.59 ^{b} ± 0.20	
Globulin (g/dl)	60 days at weaning	1.52 ± 0.75	1.97 ± 0.35	1.74 ± 0.13	3.25 ± 0.01	2.12 ^{a} ± 0.31
	90 days	1.84 ± 0.06	2.41 ± 0.50	2.75 ± 0.33	2.21 ± 0.46	2.30 ^{a} ± 0.34
	120 days	2.48 ± 0.53	2.37 ± 0.11	2.12 ± 0.02	2.09 ± 0.34	2.26 ^{a} ± 0.25
	150 days	2.02 ± 0.25	2.20 ± 0.76	2.77 ± 0.54	1.62 ± 0.12	2.15 ^{a} ± 0.42
	Overall mean	1.97 ^{b} ± 0.40	2.24 ^{a} ± 0.43	2.35 ^{a} ± 0.25	2.29 ^{a} ± 0.23	
A/G ratio	60 days at weaning	2.85 ± 0.31	2.16 ± 0.41	2.28 ± 0.10	1.35 ± 0.01	2.16 ^{a} ± 0.21
	90 days	2.11 ± 0.08	1.53 ± 1.22	1.39 ± 0.15	1.85 ± 0.46	1.72 ^{a} ± 0.47
	120 days	1.60 ± 0.29	1.84 ± 0.20	2.22 ± 0.13	2.31 ± 0.59	1.99 ^{a} ± 0.30
	150 days	2.18 ± 0.29	1.99 ± 0.23	1.55 ± 0.63	3.12 ± 0.14	2.21 ^{a} ± 0.32
	Overall mean	2.18 ^{a} ± 0.24	1.88 ^{b} ± 0.51	1.86 ^{b} ± 0.25	2.16 ^{a} ± 0.30	
Liver function AST (U/L)	60 days at weaning	35.67 ± 1.76	18.00 ± 8.67	27.00 ± 1.16	25.00 ± 1.16	26.42 ^{b} ± 3.19
	90 days	33.00 ± 4.17	43.33 ± 10.18	20.67 ± 2.61	13.33 ± 4.63	27.58 ^{b} ± 5.40
	120 days	43.67± 5.34	48.67 ± 10.69	46.00 ± 1.73	55.33 ± 3.33	48.42 ^{a} ± 5.27
	150 days	71.67± 17.92	79.33 ± 6.68	38.00 ± 0.58	37.00 ± 2.00	56.50 ^{a} ± 6.80
	Overall mean	46.00 ^{a} ± 7.30	47.33 ^{a} ± 9.05	32.92 ^{b} ± 1.52	32.67 ^{b} ± 2.78	
ALT (U/L)	60 days at weaning	5.33 ± 1.85	3.67 ± 0.66	4.00 ± 0.58	6.67 ± 0.88	4.92 ^{a} ± 0.99
	90 days	7.67 ± 4.67	3.33 ± 0.34	4.33 ± 0.66	3.00 ± 0.71	4.58 ^{a} ± 1.59
	120 days	6.33 ± 2.40	3.67 ± 0.66	3.00 ± 0.71	3.67 ± 0.66	4.17 ^{a} ± 1.11
	150 days	4.33 ± 0.87	4.00 ± 0.58	3.00 ± 0.71	3.00 ± 0.71	3.58 ^{a} ± 0.72
	Overall mean	5.92 ^{a} ± 2.45	3.67 ^{b} ± 0.56	3.58 ^{b} ± 0.67	4.08 ^{ab} ± 0.74	
Cholesterol (mg/dl)	60 days at weaning	31.05 ± 9.05	36.93 ± 6.30	47.39 ± 3.31	37.06 ± 6.05	38.11 ^{a} ± 5.43
	90 days	41.40 ± 7.18	46.80 ± 5.12	37.06 ± 6.38	42.36 ± 5.94	41.91 ^{a} ± 6.15
	120 days	67.39 ± 5.66	54.02 ± 10.44	48.70 ± 2.72	33.69 ± 8.16	50.95 ^{a} ± 6.75
	150 days	41.40 ± 4.62	36.45 ± 5.10	37.97 ± 5.22	51.02 ± 2.72	41.71 ^{a} ± 4.41
	Overall mean	45.31 ^{a} ± 6.63	43.55 ^{a} ± 5.49	42.78 ^{a} ± 4.40	41.03 ^{a} ± 5.72	

Table 6: (Continued).

Blood components	Age of lamb	Treatments C	T1	T2	T3	Overall mean
Triglycerides (mg/dl)	60 days at weaning	18.03 ± 4.48	21.64 ± 4.16	19.85 ± 0.86	20.80 ± 4.88	20.08 ^{ab} ± 3.60
	90 days	21.01 ± 0.72	20.35 ± 0.86	14.72 ± 0.17	22.17 ± 3.87	19.56 ^{cb} ± 1.40
	120 days	19.85 ± 3.66	18.86 ± 5.26	15.71 ± 0.98	14.87 ± 1.03	17.32 ^{c} ± 2.07
	150 days	25.14 ± 2.44	24.15 ± 0.92	29.61 ± 2.44	21.29 ± 2.50	25.05 ^{a} ± 2.07
	Overall mean	21.01 ^{a} ± 2.82	21.25 ^{a} ± 2.80	19.97 ^{a} ± 1.11	19.78 ^{a} ± 3.07	
Glucose (mg/dl)	60 days at weaning	7.50 ± 0.78	8.50 ± 1.03	7.17 ± 0.17	7.55 ± 0.77	7.68 ^{a} ± 0.69
	90 days	6.90 ± 1.06	7.53 ± 0.28	6.70 ± 0.25	6.85 ± 0.53	6.99 ^{b} ± 0.53
	120 days	8.34± 0.81	7.35 ± 0.65	7.20 ± 0.10	6.82 ± 0.54	7.43 ^{a} ± 0.52
	150 days	8.30 ± 0.35	7.26 ± 0.46	7.81 ± 0.17	6.12 ± 0.56	7.37 ^{ab} ± 0.38
	Overall mean	7.76 ^{a} ±0.75	7.66 ^{a} ± 0.61	7.22 ^{ab} ± 0.17	6.83 ^{b} ± 0.60	
Minerals Zinc (µg/dl)	60 days at weaning	272.22 ± 58.81	363.89± 32.70	487.50 ± 16.86	387.50 ± 48.17	377.78 ^{c} ± 39.13
	90 days	423.61 ± 57.75	469.44 ± 10.02	518.06 ± 32.34	534.72 ± 9.73	486.46 ^{b} ± 27.46
	120 days	591.67 ± 27.98	620.83 ± 14.45	672.22 ± 46.28	609.72 ± 51.79	623.61 ^{a} ± 35.12
	150 days	704.17 ± 40.94	616.67 ± 33.46	347.22 ± 48.12	586.11 ± 13.90	563.54 ^{ab} ±34.10
	Overall mean	497.92 ^{b}± 46.37	517.71 ^{a} ± 22.66	506.25 ^{b} ± 35.90	529.51 ^{a} ± 30.90	
Fe (µg/dl)	60 days at weaning	37.42 ± 2.38	18.48 ± 8.14	34.55 ± 1.84	35.30 ± 1.97	31.44 ^{a} ± 3.58
	90 days	21.67 ± 8.85	4.70 ± 1.32	8.18 ± 2.33	52.42 ± 2.68	21.74 ^{b} ± 3.79
	120 days	17.73 ± 8.43	24.09 ± 6.85	31.67 ± 1.18	24.91 ± 5.93	24.60 ^{ab} ± 5.60
	150 days	26.52 ± 1.09	28.03 ± 5.61	33.18 ± 0.26	19.09 ± 4.83	26.70 ^{ab} ± 2.95
	Overall mean	25.83 ^{ab} ± 5.19	18.82 ^{b} ± 5.48	26.89 ^{ab} ± 1.40	32.93 ^{a}± 3.85	

a, b and c : Means in the same column or row with different superscripts are significantl (P<0.05) differed.

Yousef and Zaki (2001) noticed that the increase in digestibility of CP may be a reason for the increase of albumin concentration. Data indicated the normal status of liver since, the liver is the main organ of albumin synthesis.

The globulin content in blood serum was the highest (P<0.05) with T2, while control had the lowest value (Table 6). Intermediate values of serum globulin were found for T1 and T3. There was no significant difference between T1 and T3. These results agreed with those obtained by El-Masry *et al.* (2001) who found that the concentrations of serum total protein and globulin significantly (P<0.05) increased with chromium supplementation. The increase in globulin level may be induced by an improved immune response in lambs supplemented with Cr Pic, since, Cr Pic may had an effect on certain enzymes that increase immunoglobulin synthesis (Moonsie and Mowat, 1993). These results agreed with those obtained by Chang and Mowat (1992) who showed that serum immunoglobulin and total immune globulin in calves were increased with chromium picolnate supplementation, this improves the immune state of the animals. The high levels of globulin of T2 treatment may indicate good developed immunity status (Kitchennham *et al.*, 1975). Maxine (1984) reported that albumin tends to predominate over globulin in sheep and goats. The globulin concentrations were within the normal values indicating good immunity status of animals.

The A/G ratio in the present study ranged from 1.86 to 2.18, showing lowest (P<0.05) values for treatment T2, meanwhile the control recorded the highest (P<0.05) value (Table 6). It is important to note that all values of A/G ratio were higher than 1.0, which indicate that animals did not suffer from any health problems that might affect the performance of experimental animals as reported by EL- Sayed *et al.* (2002).

The AST and ALT activities in blood serum of control were higher (P<0.05) than other treatments (Table 6). Data of this study, indicated that the values of serum AST and ALT activities decreased (P<0.05) in lambs supplemented with Cr Pic when compared with non–Cr Pic treated lambs. Value of serum AST activity in T3 was lower (P<0.01) than T1 or T2 and ALT of T2 than that of T1 or T3. The present results disagree with results obtained by Gaber and Abd El-Monem (2003) who showed that the prolonged daily oral administration Cr Pic elicited insignificant increase in the AST and ALT levels at does of 20 and 60 mg Cr Pic per / kg DMI.

The values of serum AST and ALT obtained in the present study are comparatively higher and lower, respectively than the normal range for lambs which may be due to several factors as feeding practices, genetics control, response to stress, age, liver function and body weight (Boots *et al.*, 1969).

Results in Table (6) showed that the concentrations of total cholesterol and serum triglycerides were decreased in lambs supplemented with Cr Pic than that of control lambs. The cholesterol concentrations were 4.36, 5.58 and 9.45 % lower for those supplemental with 20, 40 and 60 mg Cr Pic per kg CFMI, respectively compared to the control group. Several studies suggest that Cr plays an integral role in the metabolism of cholesterol and related lipids in ruminants. Investigators (Liu and Morris, 1978; Offenbacher and Pi-Sanyer, 1980 and Riales and Albrink, 1981) indicated that Cr supplementation decreased total serum cholesterol by the magnitude of 5 to

12 %, while, Kitchalong *et al.* (1995) reported 17 % decrease in circulating total cholesterol was observed in the Cr Pic supplemented lambs. The effect on serum cholesterol observed in this study is similar to that reported in dairy calves supplemented with Cr Pic (Bunting *et al.*, 1994). Abraham *et al.* (1980) provided evidence that Cr not only decreased cholesterol accumulation in rabbits, but also it increased the removal rate of cholesterol already deposited in the aorta. The present results are in accordance with those obtained by Boyd *et al.* (1998) who reported that Cr Pic supplementation with exercise decrease total cholesterol, LDL. Gaber and Abd El-Monem (2003) showed that the cholesterol level was significantly ($P<0.05$) decreased at doses of 20, 40 or 60 mg per kg DM of Cr Pic. On the other hand, the variation in cholesterol level may be accompanied with changes in cortisol concentration, since the change in concentration of cholesterol is controlled by adrenocorticotropin hormone, which has an effect on some steps related to the conversion of cholesterol to pregnenolone and consequently to cortisol (Harper *et al.*, 1979).

Serum triglycerides concentrations in lambs were insignificantly decreased at doses of 20, 40, and 60 mg Cr Pic per kg CFMI. Serum triglycerides concentrations were 1.1, 4.95 and 5.85 % lower at doses of 20, 40 and 60 mg Cr Pic per kg CFMI, respectively than in those fed the control diet (Table 6). The present results are similar to those of Lee and Reasners (1994); El-Masry *et al.* (2001) and Gaber and Abd El-Monem (2003) They recorded that Cr Pic supplementation was associated with lower serum triglycerides. Moreover, the results of this study are in the same line with those of El-Gharably (2000), who proved that Cr Pic lower both serum cholesterol and triglycerides.

Data presented in Table (6) showed that serum glucose concentration was significantly ($P<0.05$) decreased in lambs supplemented with Cr Pic compared to the non-supplemented lambs. However, glucose concentration in blood serum was significantly ($P<0.05$) lower in T3 than control and T1 (Table 6). It can be noticed that T3 recorded significantly ($P<0.05$) the lowest values of serum glucose by about 13.6, 12.15 and 5.7% than the control, T1 and T2, respectively. The decrease in glucose level may be attributed to the depression in cortisol level (Munck *et al.*, 1984) which has been found to be associated with reducing gluconeogenesis process and increasing glucose utilization as response to an increase in insulin concentration (Brockman, 1986), since Cr seems to be an integral component of glucose tolerance factor to potentiate the action of insulin (Anderson and Mertz, 1977). On the other hand, Mersmann (1986) suggested that Cr may decrease the uptake of glucose in the liver and increase glucose uptake in adipose tissue. Ward *et al.* (1994) showed that Cr Pic reduced binding of insulin to liver cell membranes. This could imply that Cr Pic may decrease hepatic storage of glucose and increase glucose utilization by other tissue. The present results are similar to those reported by Chang and Mowat (1992) who found that the serum glucose level in steers supplemented with Cr Pic tended to be lower than that of steers non-supplemented with Cr Pic. El-Masry *et al.* (2001) showed that the serum glucose level was significantly ($P<0.01$) decreased in claves received 0.6 mg Cr Pic / kg DM under solar radiation as compared with untreated claves under the same environmental conditions. However, the results of this study disagree with those obtained by Lindemann *et al.*, (1995); Forbes *et* al. (1998) and Gentry *et al.* (1999) who reported that the serum glucose concentrations were not affected by the dietary supplementation of Cr Pic.

There were significant (P<0.05) differences in serum AST, triglycerides and glucose concentrations among the age of lambs (duration of feeding the experimental rations) (Table 6) expect for ALT and cholesterol which showed non significant (*P*>0.05) difference between duration of feeding the experimental rations.

From the present study, it can be concluded that Cr Pic supplementation for lambs induced significant (P<0.05) increases of Zn and Fe levels in serum than the control lambs (Table 6). Chang and Mowat (1992) suggested that Cr supplementation may improve Zn status. The increase in serum Zn and Fe levels may be attributable to the apparent effect of Cr on minerals release from the animals body, in which Cr supplementation has been shown to protect animals against the stress which induces losses of several trace elements such as Zn, Fe, Cu and Mn in growing claves (Chang and Mowat, 1992). The present results are similar to those of El-Masry *et al.* (2001) who reported that supplementation with Cr for calves exposed to solar radiation condition exhibited significant (*P*<0.01) increases in serum Zn and Fe as compared with non-supplemented claves under the same condition. On the other hand, it is well known that immunoglobulin production is regulated by specific enzymes that have a trace elements at their core, the most common being Zn , Cu and Fe (Fielden and Rotilio, 1984). Possibly, Cr may be another trace element that participates in certain enzymes that increase immunoglobulin synthesis or Cr may influence Zn , Fe and or Cu metabolism , which indirectly affect immunoglobulin levels (Chang and Mowat, 1992).

There were significant (P<0.05) differences in serum Zn and Fe levels among the age of lambs (duration of feeding the experimental rations) (Table 6).

Economical efficiency:

Values of total cost as LE per lamb were 454.79, 459.29, 476.56 and 467.20 for rations C, T1, T2 and T3, respectively (Table 7). The corresponding values of return as LE per lamb were 321.60, 336.82, 362.05 and 357.30. The data indicated that, return / lamb increased by 4.73, 12.58 , 11.10% for rations supplemented with Cr Pic T1, T2 and T3 respectively, compared with control ration. Also, feeding rations supplemented with Cr Pic improved economical efficiency more than control ration. These results are in agreement with those obtained by El-Tahan *et al.* (2005).

Table (7): Economical efficiency of lambs fed rations supplemented with chromium picolinate.

Items	C		T1		T2		T3	
	Weight (kg)	Price (LE)	Weight (kg)	Price (LE)	Weight (kg)	Price (LE)	Weight (kg)	Price (LE)
Initial weight (kg)	17.50	297.50	17.33	294.61	17.83	303.11	17.17	291.89
Final weight (kg)	45.67	776.19	46.83	796.11	49.33	838.61	48.50	824.50
Total gain (kg)	28.17	.	29.50		31.50		31.33	
Feed intake as feed :								
CFM (kg)	138.77	149.18	141.43	152.04	145.33	156.24	143.25	153.99
RS (k g)	90.07	8.11	93.60	8.42	95.30	8.58	95.00	8.55
Cr.Pic (mcg)			20546.4	4.20	5233.2	8.63	7737	12.77
Total feed cost / lamb (LE)		157.29		164.66		173.45		175.31
Cost of kg gain (LE)		5.58		5.58		5.51		5.60
Total cost / lamb (LE)		454.79		459.29		476.56		467.20
Return / lamb (LE)		321.60		336.82		362.05		357.30
Improving in return, (%)		-		4.73		12.58		11.10
EE*		0.71		0.73		0.76		0.76

*Economical efficiency (EE) = $\frac{\text{Return / lamb}}{\text{Total cost /lamb}}$

The price of feedstuffs and products :

Live weight = 17 LE per kg , CFM = 1075 LE per ton, RS = 90 LE per ton , Cr Pic = 1.65 LE per 1000 mcg.

Conclusion:

From the previous data, it could be concluded that, supplementation of chromium as chromium picolinate during fattening period of lambs improved digestibilites of various nutrients, feeding values, daily body gain, induced significant increase Zu and Fe in serum this rises the immunity of lambs and return especially with 2 *nd* tested ration (T2) : 60 % of requirements from CFM + RS *ad lib* + 40 mcg Cr Pic / kg CFMI.

REFERENCES

Abraham, A.S.; M. Sonnenblick; M. Eini; O. Shemesh and A.P. Batt. (1980). The effect of chromium on established atherosclerotic plaques in rabbits. An. J. Clin. Nutr., 33: 2294.

Anderson, R.A. (1987). Chromium . In : W. Mertz (Ed.) Trace Elements in Human and Animal Nutrition (5Th Ed.) p 225. Academic Press, San Diego, CA.

Anderson, R.A. and W. Mertz (1977). Glucose tolerance factor as essential dietary agent. TIBS December: 277.

A.O.A.C. (1990). Association of Official Analytical Chemists. Official Methods of Analysis. 13th ED. Washington D.C.,U.S.A.

Boleman, S.L.; S.J. Boleman; T.D. Binder; L.L. Southern; T.L. Ward; J.E. Pontif and M.M. Pike (1995). Effect of chromium picolinate on growth, body composition and tissue accretion in pigs. J. Anim. Sci., 73: 2033-2042.

Boots, L. R;. Ccrist, W. L; Davis, D. R.; Brum, E. W. and Ludwick, T. M. (1969). Effect of age, body weight, stage of gestation and sex on plasma glutamic-oxaloacetic and glutamic-pyrucic transaminase activities in immature Holstein cattle. J. Dairy Sci., 52, 2: 211.

Boyd, S.G.; B. E. Boon; A.R. Smith; J. Conner and G.I. Dohm (1998). Combined dietary chromium picolinate supplementation and exercise program leads to a reduction of serum cholesterol and insulin in college aged subject. J. Nutrition Biochem, 9: 471-475.

Britton, R.A.; G.A. Mclaren and D.A. Jott (1968). Influence of cane molasses on NPN utilization and fiber digestibility. J. Anim. Sci. 27: 1510 (Abstr.).

Brockman, H.P. (1986). Pancreatic and adrenal hormone regulation of metabolism. In : L.P. Milligan; W.I. Grovum and A. Dobson (Ed.). Control of Digestion and Ruminants. pp 405-419. Prentice Hall Englewood Cliffs, NJ.

Bryan, M.A.; M.T. Socha and D.J. Tomlinson (2003). Effect of supplementing intensely grazed late gestation and early lactation dairy cows with chromium-L- methionine. J. Dairy Sci. 86 (Suppl. 1): abstract.

Bunting, L.D.; J.M. Fernandez; D.L. Thornpson, Jr. and L.L. Southern (1994). Influence of chromium picolinate on glucose usage and metabolic criteria in growing Holstein calves. J. Anim. Sci , 72: 1591-1599.

Chang, X. and D.N. Mowat (1992). Supplemental chromium for stressed and growing feeder calves. J. Anim. Sci., 70: 559.

Chang, X.; D.N. Mowat and G.A. Spiers (1992). Carcass characteristics and tissue mineral contents of steers fed supplemental chromium. Cam. J. Anim. Sci., 72: 663.

Depew, C.L.; L.D. Buntting; J.M. Fernandez; D. L. Thornpson, jr. and RAdkinson (1998). Performance and metabolic responses of young dairy claves supplemented with chromium tripicolinate. J. Dairy Sci., 81:2916.

Doumas, B.T. and Biggs, H.G. (1972a). The colorimetric determination of total protein in serum or plasma. Standard Methods of Clinical Chemistry. Vol 7. Academic Press. New York.

Doumas, B.T. and Biggs, H.G. (1972b). The colorimetric determination of albumin in serum or plasma. Standard Methods of Clinical Chemistry. Vol 7. Academic Press. New York.

Duncan, D.B. (1955). The multiple range and F. test. Biometrics, 11: 1-45.

El-Gharably, H.J.H. (2000). Some hormonal and biochemical changes in response to chromium in goat. M.Sc. thesis, Faculty, Veterinary, Zagazig University, Egypt.

El-Masry, K.A.; H.A. Fouly and S.A. Gabr (2001). Physiological action of chromium on some blood biochemical constituents and immune response in relation to growth performance of heat stressed calves. Egyptian J. Nutrition and Feeds, 4: 453-463.

El-Masry, K.A. and I.F. Marai (1991). Comparison between Friesian and water buffaloes in growth rate, milk production and some blood constituents during winter and summer conditions of Egypt. Anim. Prod. 53:39.

EL-Sayed, H. M., EL-Ashry, M. A., Metwally, H.M., Fadel, M. and Khorshed, M. M. (2002). Effect of chemical and biological treatments of some crop-residues on their nutritive value: 3- Digestion coefficient, rumen and blood serum parameters of goats. Egyptian J. Nutrition and Feeds, 5 (1): 55-69.

El-Tahan, A.A.; R.I. Moawd; A.A. Abd El –Hamid and K.M. El-Gandy (2005). Effect of chromium piclonate supplementation on productive performance of lactating cows. Egyptian J. Nutrition and Feeds, 8 (Special Issue) 555-565.

Evans, G.W. and E.C. Johnson (1980). Growth stimulating effect of picolinic acid added to rot diets. Proc. Soc. Exp. Biol. Med., 165-457.

Fielden, E.M. and G. Rotilio (1984). The structure and mechanism of Cu / Zn super oxide dismutase. In: R. Lontie (Ed.). Copper Proteins and Copper Enzymes Vol. II. P 27. CRC Press, Boca Raton, FL.

Forbes, C.D.; J.M. Fernandez; L.D. Bunting; L.L. Southern; D.L. Thompson, Jr.; I.R. Gentry and A.M. Chapa (1998). Growth and metabolic characteristics of Suffolk and Gulf Coast Native Yearling ewes supplemented with chromium tripicolinate. Small ruminant Res., 28: 149-160.

Gaber, Fatma, El-S. and U.M. Abd El-Monem (2003). Effect of chromium picolinate supplementation on growth performance, carcass traits, biochemical parameters and blood constituents of growing rabbits under the summer Egyptian conditions. SCVMJ, VI (1): 24-32.

Gaskins, H.R.; W.J. Croom, Jr; J.M. Fernandez; J.E. Van Eys; W.M. Hagler, Jr; and W.L.Johnson (1991). Metabolic responses to protein supplementation and slaframine in goats and sheep fed roughage. Small Ruminant Res., 6: 73-84.

Gentry, L.R.; J.M. Fernandez; T.L. Ward; T.W. White; L.L. Southern; T.D. Bidner; D.L. Thompson, jr.; D.W. Horohov; A.M. Chapa and T. Sahlu (1999). Dietary protein and chromium tripicolinate in Suffolk wether lambs: effect on production characteristics, metabolic and hormonal responses and immune status. J. Anim. Sci., 77: 1284-1294.

Harper, H.A.; V.W. Rodwell and P.A. Mayes (1979). Review of physiological Chemistry. 17th E dition. pp.511. Middle East Edition, Long Medical Publications, Beirut, Lebanon.

Hayirli, A.; D.R. Bremmer; S.J. Bertics; M.T. Socha and R.R. Grummer (2001). Effect of chromium supplementation on production and metabolic parameters in per parturient dairy cows. J. Dairy Sci., 84: 1219.

Ingraham, R.H. and L.C. Kappel (1988). Metabolic profile testing. Vet. Clin. North Am. Food Pract., 4: 391-411.

Jacques, K. and S. Stewart (1993). Does chromium hare future in fed. J. Feed Tech. Market., Vol. *44*, No.2.

Kitchalong, L.; J.M. Fernandez; L.D. Bumting; L.L. Southern and T.D. Bidner (1995). Influence of chromium tripicolinate on glucose metabolism and nutrient partitioning in growing lambs. J. Anim. Sci., 73: 2694-2705.

Kitchennham, B.A.; Rowlands, G.J.; Manston, R. and Dew, S.A. (1975). The blood composition of dairy calves reared under conventional and rapid growth system. Brit. Vet. J., 31.

Kornegay, E.T.; Z. Wany; C.M. Wood and M.D. Lindemann (1997). Supplemental chromium picolinate: Influence nitrogen balance, dry matter digestibility and carcass traits in growing finishing pigs. J. Anim. Sci., 75: 1319.

Kumar. N. U. B.; B.Singh and D. N. Verma (1980). Effect of different levels of dietary protein and energy on growth of male buffalo calves. Ind. J .Anim. Sci., 51:513.

Laborde, C.J.; A.M. Chapa; D.W. Burleigh; D.J. Salgado and J.M. Fernandez (1995). Effects of processing and storage on the measurement of nitrogenous compounds in ovine blood. Small Ruminant Res., 17: 159-166.

Lee,V.A. and C.A. Reasners (1994). Beneficial Effect of chromium supplementation on serum triglycerides level in NIDDM. Diabetes Care, 17 (12): 1449-1452.

Lindemann, M.D.; C.M. Wood; A.F. Harper; E.T. Kornegay and R.A. Anderson (1995). Dietary chromium picolinate additions improve gain feed and carcass characteristics in growing finishing pigs and increase litter size in reproducing sows. J. Anim. Sci., 73: 457-465.

Liu, V.K.J. and J.S. Morris (1987).Relative chromium response as an indicator of chromium status. Am. J. Clin. Nutr., 31: 972.

Maxine, M. B. (1984). Outline of Veterinary Clinical Pathology. (Fourth Ed.), The Iowa state Univ. Press Anim. Iowa USA.

Mersmann, H.J.(1986). Lipid metabolism in swine. In: H.C. Stanton and H.J. Mersmann (Ed.). Swine Cardiovascular Research. Vol 1. p 75 CRC Press, Boca Raton FL.

Mertz, W. (1969). Chromium occurrence and function in biological systems. Physiol. Rev., 49:163.

Mertz W. (1993). Chromium in Human Nutrition: A review. J. Nutr., 123: 626.

Mooney, K.W. and G.L. Cromwell (1995). Effect of dietary chromium picolinate supplementation on growth, carcass characteristics and accretion rates of carcass tissue in growing finishing swine. J. Anim. Sci., 73: 3351-3357.

Moonsie- Shageer, S. and D.N. Mowat (1993). Effect of level of supplemental chromium on performance, serum constituents and immune status of stressed feeder calves. J. Anim. Sci., 71: 232-238.

Mowat, D.N.; X. Chang and W.Z. Yang (1993). Chelated chromium for stressed feeder calves. Com. J. Anim. Sci., 73: 44-55.

Munck, A.; P. Guyre and N. Holbrook (1984). Physiological functions of glucocorticoids in stress and their relation to pharmacological actions. Endocrinal. Rev., 5:25.

Nielsen, F.H. (1994). Chromium In: M.E. Shils, J.A. Olson and M. Shik (Eds.) Modern Nutrition in Health and Disease (8^{th} Ed.). Lea & Febiger, Philadelphia, PA.

N.R.C. (1986). Nutrient Requirements of Domestic Animals. Nutrient Requirements of Sheep. National Academy of Sciences, Washington, D.C.

Offenbacher, F. G. and F.X. Pi-Sanyer (1980). Beneficial effect of chromium – rich yeast on glucose tolerance and blood lipid in elderly subjects. Diabetes, 29: 919.

Okelly, J.C.(1973). Seasonal variation in the plasma lipids of genetically different types of cattle steers on different diets. Com. Bichem. Physical, *44*: 303.

Page, T.G.; L.L. Southern; T.L. Ward and D.L. Jr. Thompson (1993). Effect of chromium picolinate on growth and serum and carcass traits of growing – finishing pigs. J. Anim. Sci., 71: 656-662.
Press, R.L.; J. Geller and G.W. Evans (1990). The effect of chromium picolinate on serum cholesterol and apolipoprotein fraction in human subjects, West. J. Med., 152: 41-45.
Reitman, S. and S. Frankel (1957). Acolorimetric method for determination of serum glutamic oxaloacitic and glutamic pyruvic transaminases Amer. J. Clin. Path., 28, 56-63.
Riales, R. and M.J. Albrink (1981). Effect of chromium chloride supplementation on glucose tolerance and serum lipid including high density lipoprotein of adult men. Am. J. Clin. Nutr., 34:2670.
Rowlands, G. J. (1980). A review of variation in the concentration of metabolism in the blood of beef dairy cattle associated with physiology, nutrition and disease with particular reference to the interpretation of metabolic profiles. Wld. Rev. Nutr. Diet., 35:172.
Samsell, L.J. and J.W. Spears (1989). Chromium supplementation effects on blood constituents in lambs fed high or low fiber diets. Nutr. Res., 9: 889-899.
SAS (1995). SAS Users Guide, Statistical Analysis System Institute Inc., N.C.U.S.A.
Schwarz, K. and W. Mertz (1959). Chromium (III) and glucose tolerance factor. Arch. Biochem. Biophys., 85: 292.
Smith, K.L.; M.R. Waldron; J.K. Drackley; M.T. Socha and T.R. Overton (2005). Performance of dairy cows as affected by pre-partum dietary carbohydrate source and supplementation with chromium throughout the transition period. J. Dairy Sci., 88 (1) : 255- 263.
Ward, T.L.; L.F. Berrio; L.L. Southern; J.M. Fernandez and D.L. Thompson, Jr. (1994). *In-vivo* and *in-vitro* evaluation of chromium tripicolinate on insulin binding in pig liver cell plasma membranes. FASEB J. 8:A 194 (Abstr.).
Weser, U. and J. Koolman (1969). Reactivity of some transition metals on nuclear protein biosynthesis in rate liver. Experientia , 26: 246.
Yousef, H.M. and A.A. Zaki (2001). Effect of barley radical feeding on body weight gain and some Physiological parameters of growing Friesian crossbred calves. Egyptian J. Nutrition and Feeds, 4 (Special Issue) 465-472.

تأثير إضافة بيكلونات الكروميوم على الأداء الانتاجى وبعض قياسات الدم عند تسمين الحملان

رأفت ابرهيم معوض ، أمجد أحمد أبو العلا ، علاء الدين أحمد حسن الطحان ، أيمن عبد الحي عبد الحميد و أحمد عبد العزيز المقص
معهد بحوث الإنتاج الحيواني - مركز البحوث الزراعية - وزارة الزراعة

أجريت هذة الدراسة بمحطة بحوث الإنتاج الحيواني بالجميزة التابعة لمعهد بحوث الإنتاج الحيواني - مركز البحوث الزراعية، وذلك بهدف دراسة تأثير بيكلونات الكروميوم على الأداء الانتاجى وبعض قياسات الدم عند تسمين الحملان.

استخدم في هذة الدراسة عدد ٢٤ حمل متوسط أوزانها ١٧,٤٦ كجم قسمت إلى أربعة مجاميع لتقييم المعاملات التجريبية التالية من خلال تجارب نمو على الحملان وتجارب هضم على كباش تامة النمو وذلك طبقا لمقررات NRC (1986) .

أ- ٦٠ % من الاحتياجات من علف مخلوط مركز + قش أرز للشبع (عليقة المقارنة) .
ب- عليقة المقارنة + ٢٠ ميكروجرام بيكلونات كروميوم / كجم مخلوط علف مركز مأكول (المعاملة الأولى)
ج- عليقة المقارنة + ٤٠ ميكروجرام بيكلونات كروميوم / كجم مخلوط علف مركز مأكول (المعاملة الثانية)
د- عليقة المقارنة + ٦٠ ميكروجرام بيكلونات كروميوم / كجم مخلوط علف مركز مأكول (المعاملة الثالثة).

استمرت التجربة لمدة ١٥٤ يوم وكان يتم إضافة جرعة بيكلونات الكروميوم عن طريق الفم مرة واحدة يوميا قبل وجبة الصباح وتم إجراء أربع تجارب هضم على الكباش لتقيم العلائق السابقة وكانت أهم النتائج المتحصل عليها كالاتي:-

١- لم يكن هناك فرق معنوي في وزن الجسم الحي للحملان بين جميع المعاملات حتى نهاية التجربة.
٢- كانت الزيادة اليومية في الوزن ٠,١٨٣ ، ٠,١٩٢ ، ٠,٢٠٥ ، ٠,٢٠٣ كجم / يوم للمعاملات المقارنة والأولى والثانية والثالثة على التوالي وبدون فرق معنوي بين جميع المعاملات.
٣- الحملان المعاملة ببيكلونات الكروميوم كانت أكثر استهلاكا للعليقة مقارنة بالحملان التي تغذت على عليقة الكنترول.
٤- أظهرت كل من المعاملة الثانية والثالثة أكفأ معدل تحويل غذائي مقارنة بالمعاملات الأخرى.
٥- كانت معاملات هضم المركبات الغذائية المختلفة للعلائق المضاف إليها بيكلونات الكروميوم أعلى معنويا من عليقة المقارنة وكذلك نفس الاتجاة بالنسبة لكل من المركبات الكلية المهضومة والبروتين الخام المهضوم وسجلت المعاملة الثانية ارتفاعا معنويا عن باقي المعاملات في معظم معاملات هضم المركبات الغذائية وكذلك المركبات الكلية المهضومة والبروتين الخام المهضوم.
٦- أظهرت النتائج حدوث زيادة معنوية في تركيزات كل من البروتين الكلى ، الألبيومين، جلوبيولين المناعة ، الزنك والحديد مع حدوث نقص معنوي في تركيزات الكولستيرول والجليسريدات الثلاثية والجلوكوز.
٧- أظهرت النتائج إن إضافة بيكلونات الكروميوم بمعدل ٢٠، ٤٠ ، ٦٠ ميكروجرام / ١كجم مخلوط علف مركز مأكول لعلائق تسمين الحملان إلى زيادة العائد / حمل بنسبة ٤,٧٣ ، ١٢,٥٨ ، ١١,١٠ % على التوالي مقارنة بالعليقة المقارنة.

وتوصى الدراسة بإضافة بيكلونات الكروميوم إلى علائق تسمين الحملان بمستوى ٤٠ ميكروجرام /١كجم مخلوط علف مركز مأكول لأن ذلك يؤدى الى تحسين معاملات هضم المركبات الغذائية والقيم الغذائية ومعدل النمو اليومي وكذلك زيادة معنوية في تركيز كل من الحديد والزنك وبالتالي زيادة مناعة الحملان وزيادة العائد الاقتصادي.