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EFFECT OF WEANING ON SOME PLASMA METABOLITES IN BLACK-AND-WHITE CALVES FED DIETS WITH OR WITHOUT SUPPLEMENTAL CHROMIUM PICOLINATE

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Abstract

YANCHEV, I., P. MONEVA, D. GUDEV, S. POPOVA-RALCHEVA, Tz. PEEVA, P. PENCHEV and I. ILIEVA, 2008. Effect of weaning on some plasma metabolites in black-and-white calves fed diets with or without supplemental chromium picolinate. *Bulg. J. Agric. Sci.*, 14: 329-334

The objective of this study was 2 fold: to determine whether the weaning (abrupt transition from liquid to solid diet) at the age of 90 days causes stress in Black-and-white calves, and if so, to alleviate the negative effect of stress by chromium picolinate supplementation (400 µg daily). All calves were separated from their mothers immediately after birth. Chromium supplementation started 3 days before the weaning and was terminated 5 days later.

Plasma cortisol levels in control calves were not significantly influenced by the weaning, but in experimental calves were higher before weaning and by 1st d following the weaning as compared to control group ($P < 0.05$). Plasma cortisol levels declined significantly by 4th and 9th d following the weaning as compared to the preweaning levels.

Plasma glucose levels in control calves did not change significantly throughout the experiment. Glucose levels in experimental calves increased significantly by 4 and 9 d following the weaning as compared to the preweaning level. Plasma cholesterol levels in experimental calves, declined significantly by 4th and 9th d as compared to the preweaning levels.

Plasma urea levels following weaning declined significantly in experimental calves, while in control calves urea levels were not significantly changed as compared to the preweaning levels. Plasma indol levels in experimental calves were significantly lower by 1st and 4th day following weaning relative to control group.

Key words: Black-and-white calves, stress, weaning, cortisol, indol

Introduction

In cattle supplemental high-chromium yeast improved calves performance during the first 28 days

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after their arrival at the feedlot (Chang and Mowat, 1982).

Relatively much have been published concerning the effect of supplemental organic and inorganic chro-

mium compounds on carbohydrate metabolism in calves (Kegley et al., 2000; Bunting et al., 1994; Chang and Mowat, 1992; Kegley and Spears, 1995). However, the effect of supplemental chromium on plasma insulin and glucose levels in calves is not consistent. There are data showing insulin potentiating effect or no effect of chromium in calves (Kegley and Spears, 1995; Bunting et al., 1994)

The results concerning glucose clearance rate during intravenous glucose tolerance test in chromium supplemented calves are not consistent either (Kegley et al., 2000; Bunting et al., 1994). These contradictory data suggest that the observed discrepancy could be due to many factors: bioavailability of the chromium compound, level of chromium sufficiency, environmental stress, age of the animals etc.

The objectives of the present study were to determine whether calves weaning is a stress inducing factor and to study the effect of supplemental chromium on plasma cortisol, cholesterol, glucose, urea and indol levels in calves before and after the weaning.

Material and Methods

Eight Black-and-white calves born within 1 month were separated from their mothers immediately after delivery and fed colostrum and milk respectively: up to 90 days of age. During this period they had access to starter diet and hay *ad libitum*. The calves were randomly allotted to two groups: control and experimental (400 µg Cr daily). Both groups were; abruptly weaned at the age of 90 days, when they were deprived of milk and were only fed solid feed. Chromium picolinate was given within three consecutive days before the weaning and 5 days following the weaning. The following metabolites were determined: cortisol (Kanchev et al., 1976), cholesterol (Watson, 1960), glucose (Profirov, 1990), urea (Rerat et al., 1976), indol (Chilov, 1959).

The results are expressed as means \pm S.E.M. and were analyzed by Student t-test.

Results and Discussion

Plasma cortisol levels in control calves were not significantly influenced by the weaning (Figure 1). These results are consistent with our previous finding in a similarly designed experiment exploiting calves (Gudev et al., 2007), and indicate that the abrupt transition from milk to solid feed do not cause any stress if the calf is separated from the mother immediately after birth and thus deprived from developing strong emotional relationship.

Plasma cortisol levels in experimental calves were higher before weaning and by 1st d following the weaning as compared to control group ($P < 0.05$). Similar to results of our study Heugten and Spears (1997) found higher serum cortisol before adrenocorticotropin treatment in pigs supplemented with organic forms of Cr, than in control and CrCl_3 - fed pigs. Unchanged plasma cortisol levels during the first 28 d after transportation followed by sharp cortisol decline in chromium supplemented feeder calves have also been reported by Moounsie- Shager and Mowat (1993). Similar findings have been reported in lambs (Gentry et al., 1999).

Plasma cortisol levels in experimental calves declined significantly by 4th and 9th d following the weaning as compared to the preweaning levels and tended to be lower by 4th d relative to control group.

The decrease of plasma cortisol levels in our experiment is in agreement with the results of Chang and Mowat (1992) and Mowat et al. (1993) who demonstrated a decrease in cortisol levels in calves exposed to transport stress.

However, numerous investigations concerning plasma cortisol level in Cr-supplemented animals have demonstrated inconsistent increase (Yang et al., 1996; Burton et al., 1995; Pechova et al., 2002) or no effect (Arthington et al., 1997) on plasma cortisol concentration.

This data suggest that supplemental chromium either has no effect on adrenal function or alternatively

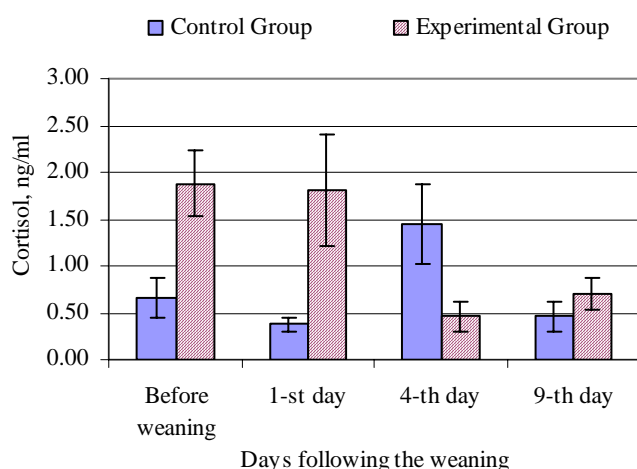


Fig. 1. Plasma cortisol levels (ng/ml) before and after weaning of calves supplemented with Cr picolinate

it exerts indirect effect mediated by many factors. It seems that the level of stress load experienced by the animals is one of the crucial factors that influence adrenal activity as evidenced by the reported increase in urinary excretion of Cr during stress (Borel et al., 1984; Anderson et al., 1988).

From the reported results of other laboratories it is apparent that the effect of supplemental Cr is related also with the employed animal kind, animal age (Depew et al., 1998) and Cr dosage (Moounsier-Shager and Mowat, 1993).

Plasma glucose levels in control calves did not change significantly throughout the experiment (Figure 2). However, glucose levels in experimental calves unlike those in control animals increased significantly by 4 and 9 d following the weaning as compared to the preweaning level, although the difference between the groups was only significant by the 4th d. If we compare plasma cortisol and glucose levels in experimental calves we shall find an obvious inverse relationship between these traits. Numerous investigations have irrefutably demonstrated Cr implication in carbohydrate metabolism (Kegley and Spears, 1995; Kegley et al., 2000; Depew et al., 1998).

Therefore plasma glucose levels in our experiment should be interpreted in close relation to plasma cortisol since glucocorticoids promote hyperglycemia by

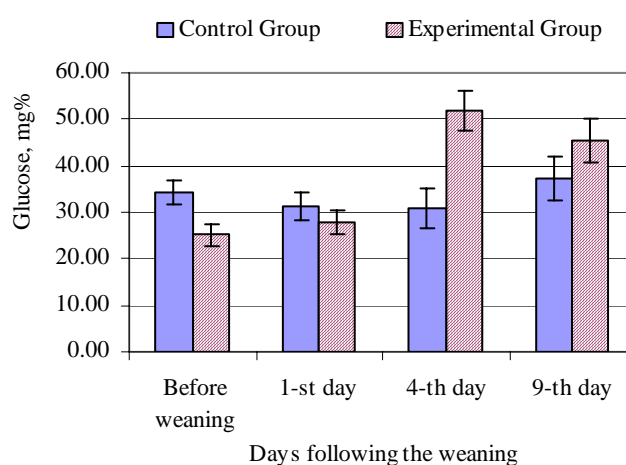


Fig. 2. Plasma glucose levels (mg%) before and after weaning of calves supplemented with Cr picolinate

stimulating gluconeogenesis and reducing glucose utilization (Brockman, 1986). It is known that energy deficiency triggers adrenal response to stress which ultimately leads to cortisol-induced gluconeogenesis and higher plasma glucose level that in its turn stimulates insulin secretion.

The animals in our experiment were free of stress as indicated by plasma cortisol levels in the control group. Therefore the unchanged plasma cortisol levels immediately before the weaning and by 1st d after the weaning followed by decline at 4th and 9th d in experimental calves could be related with the stimulatory effect of Cr on glucose utilization (Colgan, 1993), since the increased glucose supply could signal a homeostatic mechanism that controls carbohydrate metabolism. Thus, the increased plasma glucose level by 4th and 9th d after the weaning could reflect a new level of homeostatic balance aimed at reducing cortisol-induced gluconeogenesis, by maintaining low plasma cortisol level. Chromium implication in adrenal response to stress is further demonstrated by Gentry et al. (1999), who found a delayed return to preinfusion levels of plasma glucose after epinephrine challenge and higher initial concentration of cortisol in lambs fed supplemental chromium.

Plasma cholesterol levels in experimental calves, declined significantly by 4th and 9th d as compared to

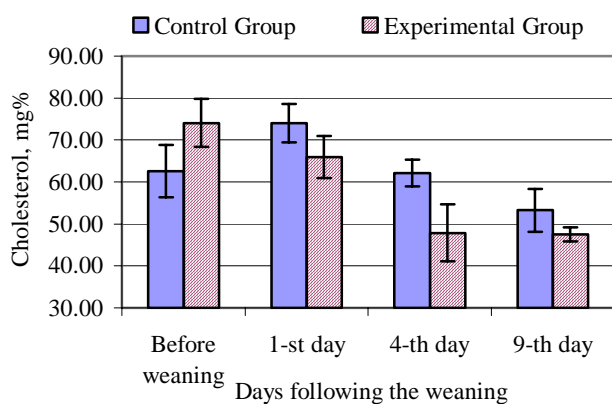


Fig. 3. Plasma cholesterol levels (mg%) before and after weaning of calves supplemented with Cr picolinate

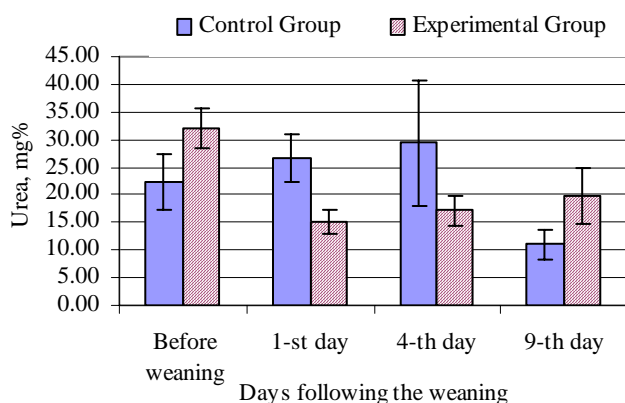


Fig. 4. Plasma urea levels (mg%) before and after weaning of calves supplemented with Cr picolinate

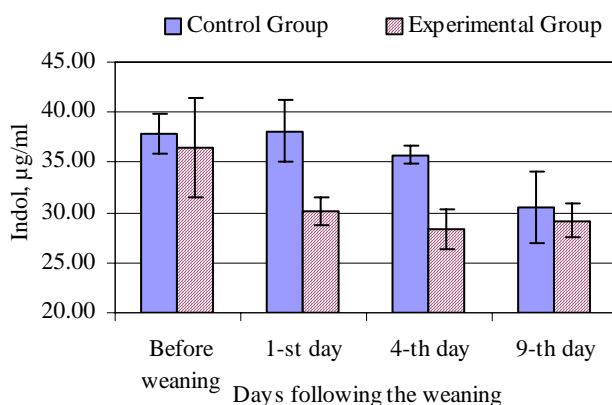


Fig. 5. Plasma indol levels (µg/ml) before and after weaning of calves supplemented with Cr picolinate

the preweaning levels, while in control calves plasma cortisol only declined by 9th d (Figure 3). Plasma cholesterol levels following the weaning tended to be lower in experimental group relative to control group but did not differ significantly. These data are not consistent with the results in our similarly designed previous experiment, exploiting calves, where plasma cholesterol levels in the experimental calves tended to be higher. Numerous studies involving various animals species have shown inconsistent effect of supplemental chromium on plasma cholesterol level: no change of plasma total cholesterol in pigs (Mathews et al., 2001; and rabbits (Sahin et al., 1997)., decrease of plasma cholesterol in calves (Bunting et al., 1994), rats (Cefolu et al., 2002) and Japanese quail (Sahin et al., 2001). Debski and Zalewski (1997) demonstrated increased total cholesterol levels in liver suggesting that Cr plays integral role in the metabolism of cholesterol.

Plasma urea levels following weaning declined significantly in experimental calves, while in control calves urea levels were not significantly changed as compared to the preweaning levels (Figure 4). Plasma urea levels in experimental calves were significantly lower only by 1st d following the weaning. These data are not consistent with those in cows reported by Pechnova et al. (2002) and in calves (Gudev et al., 2007), where plasma urea levels were not influenced by supplemental Cr. These variable results could be related with the level of dietary protein, since supplemental Cr has been demonstrated to decrease or increase plasma urea N in high and low- protein diets respectively (Gentry et al., 1999).

Plasma indol levels in experimental calves were significantly lower by 1st and 4th day following weaning relative to control group (Figure 5). These data suggest that supplemental chromium had a favorable effect on intestinal digestion most probably by improving the quality of intestinal microflora.

Conclusions

- Weaning of calves (abrupt transition from milk to solid feed) at 90 d of age did not cause any stress.

- Chromium supplementation decreased plasma cortisol and cholesterol levels by 4th and 9th d relative to the first few days of its addition.

- Supplemental chromium increased plasma glucose levels by 4th d but decreased plasma urea levels by 1st d and plasma indol levels by 1st and 4th d in comparison with the corresponding values in control calves.

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