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Hormonal Residues in Feedlot Pens and Runoff

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Summary

Two identically designed trials were conducted in separate years at the University of Nebraska Haskell Agricultural Laboratory, Concord, Neb., using 192 crossbred heifers (96/trial). Within a trial, heifers were assigned randomly to 2 groups (3 pens/group): 1) treatment (TRT) animals were administered synthetic hormones via subcutaneous implants (Ralgro and Revalor-H) and fed Melengesterol Acetate (MGA), or 2) control (CON) animals with no synthetic hormone provided.

Gains and feed conversions were 18.8 and 7.5% better, respectively, for TRT, while CON had 16.7% greater choice and prime carcasses. In runoff samples, progesterone was greater for CON. With the exception of androsterone, average hormonal concentrations in pen surface samples were less than 11 ng/g and concentrations of all compounds were not different across treatments. Results indicate that low levels of both natural and synthetic hormones are found on the feedlot surface and in runoff from feedlot pens.

Introduction

Over 90 percent of the cattle fattened in the United States are finished in feedlots on diets high (70-80%) in grain. Of the feedlots in the U.S., approximately 90 percent administer growth hormones by implants. These growth promoting implants are manufactured from compounds that mimic steroidal hormone activity in the animal. There is rising concern that natural and synthetic hormones found in livestock waste could reach groundwater and surface waters causing disturbances in aquatic ecosystems. The objective of this study was to quantify hormone concentrations in various stages of the manure pathway. No previous study has directly compared implanted and unimplanted cattle regarding the hormones found in manure. The data generated in this study provides an insight to the potential concentrations of both natural and synthetic steroid hormones leaving the feedlot (*Environmental Science & Technology*, 2012, 46:1352).

Procedure

For each of two identically designed trials, 96 previously processed (vaccinated with Vision 7 and Vista Once) heifers with an average weight of 852 pounds were assigned to 6 pens (3 pens/treatment) of 16 heifers/pen. Prior to the cattle going on test, pen preparation included removal of all manure deposited from previous studies and building up of mounds with fresh soil.

All cattle were fed a common ration at approximately 95% of ad libitum for 3 days prior to trial initiation, and had no access to water the night prior to processing to minimize fill differences. Upon trial initiation, cattle were re-weighed, re-vaccinated (Vision 7) and moved to the finishing ration. Also at trial initiation, cattle assigned the hormone treatments were implanted (Ralgro). All cattle were fed a common finishing ration for the duration of the trial, with the TRT cattle receiving an MGA supplement top-dressed in the bunk. On day 35, TRT cattle were re-implanted (Revalor-H) and all cattle were weighed. On average, cattle were on feed 126 days (year 1, 111 days; year 2, 141 days).

Data Collection

To minimize contamination, all personnel handling cattle wore nitrile gloves and boot covers any time cattle were handled and upon pen entry. Gloves and boot covers were also changed when moving from CON to TRT pens and CON cattle were always handled first.

Dry matter intakes were recorded daily and weights were obtained on days 1 and 35 as well as at trial termination.

Pen surface samples were collected prior to trial initiation, on days 7, 45, and upon termination of the trial. Prior to sampling, all equipment was cleaned with methanol. Each pen sample was a composite of 15 sub-samples taken from the pen

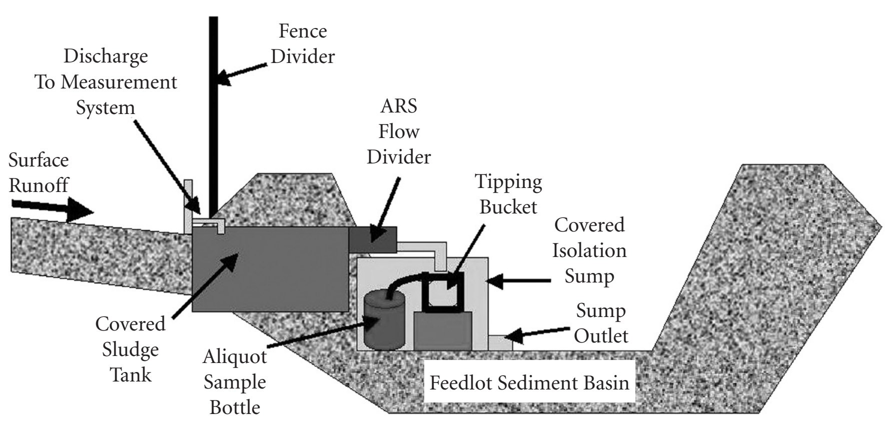

Figure 1. Diagram of runoff sampler.

Table 1. Performance and carcass data.

	CON	TRT	% Change
Heifers, n	96	96	10.2%
DMI, lb/day[1]	20.54	22.63	18.8%
ADG, lb/day[1,2]	2.84	3.37	-7.5%
F:G[2]	7.32	6.77	
Choice (Ch) + Prime (Pr), %	87.50	72.92	-16.7%
Yield Grade	2.85	2.96	3.7%

[1]($P < 0.05$)
[2]Based on a common dressing percent of 62.

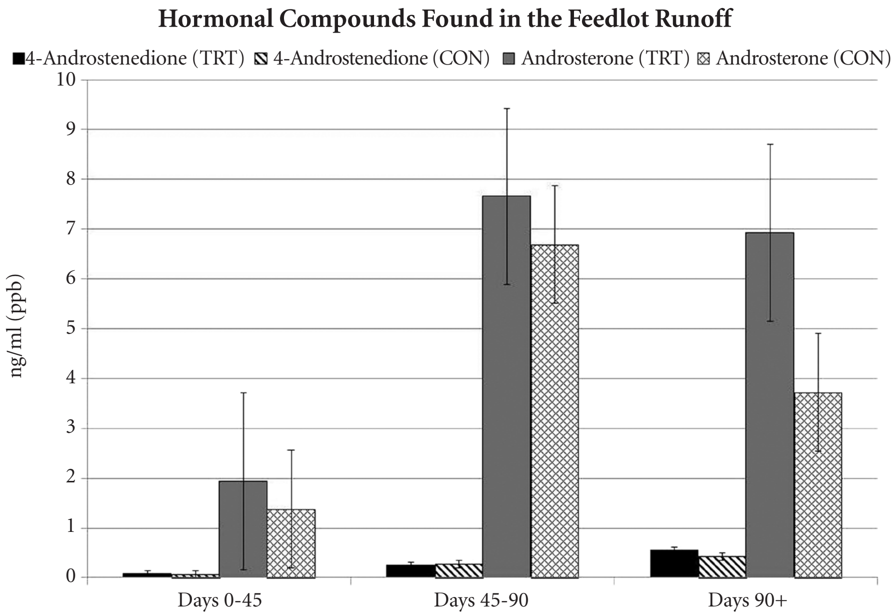

Figure 2. Androgenic compounds in feedlot runoff.

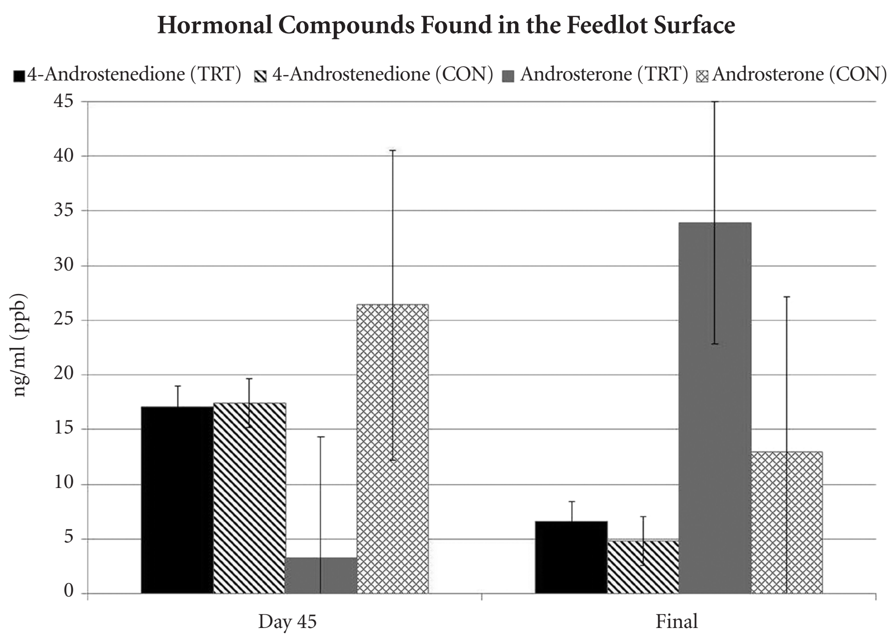

Figure 3. Androgenic compounds on the feedlot surface.

plus four sub-samples taken from the alley directly below the pen. Samples were obtained using a bulb planter pushed into the surface until hardpan was reached, but no more than 1 inch deep. Samples were stored in foil pouches inside plastic bags. During sampling, soil samples were held in a cooler with ice packs. Sampling always began in the CON pens. Different sampling equipment was used for the CON and TRT pens. Upon completion of each sampling day, all samples were placed in a freezer until analysis.

Runoff water samples were obtained from the alley below each pen during precipitation events during the post 45-day implant period of the first year and throughout the second year. To facilitate runoff sample collection, earthen berms were placed on the two sides and the down slope end of the alley below each pen. The runoff sampling device used in this study consisted of a galvanized steel tank fitted with a runoff splitter, tipping bucket mechanism, event data logger, and sampling jars, as shown in Figure 1. The tank served as a settling basin for large suspended materials which, if not removed, would have blocked the slots of the splitters. One-ninth of the runoff leaving the tank through the splitter was directed to the tipping bucket for flow volume measurement and runoff sampling. Tipping buckets were fitted with a pulse counter to count the number of tips during each runoff event. Data loggers were used to record the number of tips. The total volume of runoff was calculated using the total number of tips and the geometry of the tipping bucket.

Runoff water samples of approximately 250-300 mL were collected in amber glass collection jars during each runoff-creating rainfall event. Runoff and sediment samples were kept frozen until analysis. Data were analyzed using MIXED procedures of SAS (SAS Inst. Inc., Cary, N.C.). Pen was used as the experimental unit. Year and year x treatment effects

(Continued on next page)

were included in the model for data obtained over both years.

Results

The purpose of administering hormones is to improve performance, so enhanced performance of TRT groups was expected. The TRT cattle consumed 10.2 % more feed and had an 18.8% higher ADG but tended to have lower quality grades than CON cattle (Table 1). The TRT cattle tended to be more efficient but also tended to have more dark cutters.

Due to the large variation observed in some compounds, means and standard deviation are shown graphically (Figures 2-6). By the end of the study, hormonal compounds in both runoff and surface samples were not found to be significantly different, and for many of the compounds, levels were very small or undetectable.

In the runoff, androgens such as 4-androstenedione and androsterone were found to have the greatest numerical concentrations when compared to other compounds. Concentrations in TRT samples tended to be greater than in CON samples (Figure 2). At the end of the study, progesterone concentrations in the runoff were low (<1 ppb) but were found to be slightly greater in CON versus TRT pens.

Androgenic hormonal compounds were also found to be similar between TRT and CON samples in samples obtained from the feedlot surface (Figure 3).

There was a trend for zeranol compounds to be greater in CON pens, but by the end of the study, that trend was less apparent (Figure 4).

Of the estrogenic compounds shown in Figure 5, estrone and 17β-estradiol tended to be greater in TRT pens at the end of the trial.

Testosterone was not detected in the feedlot surface samples. Progesterone, as shown in Figure 6, in feedlot surface samples reflected a similar trend to that in the runoff. It tended to be greater for CON pens, which is likely due to these heifers not being fed MGA, thus they were going through active reproductive cycles.

Based on this study, it appears that synthetic hormones administered to beef cattle (particularly TBA) are metabolized and are generally not found on the feedlot surface and runoff. At the end of the study, nearly all hormonal compounds found were at low concentrations (<10 ppb). Further dilutions of these compounds could occur when the manure is spread on land application areas.

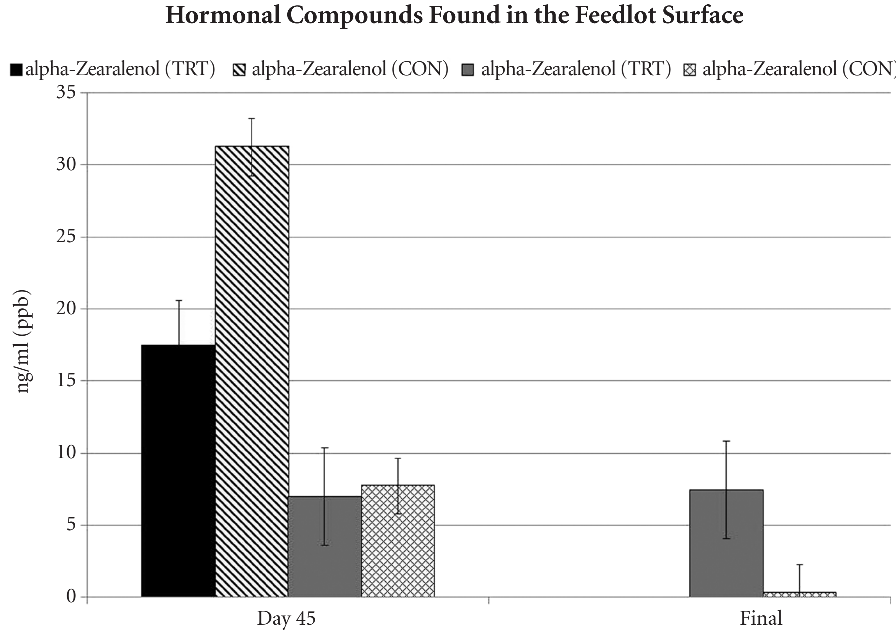

Figure 4. Zeranol compounds on the feedlot surface.

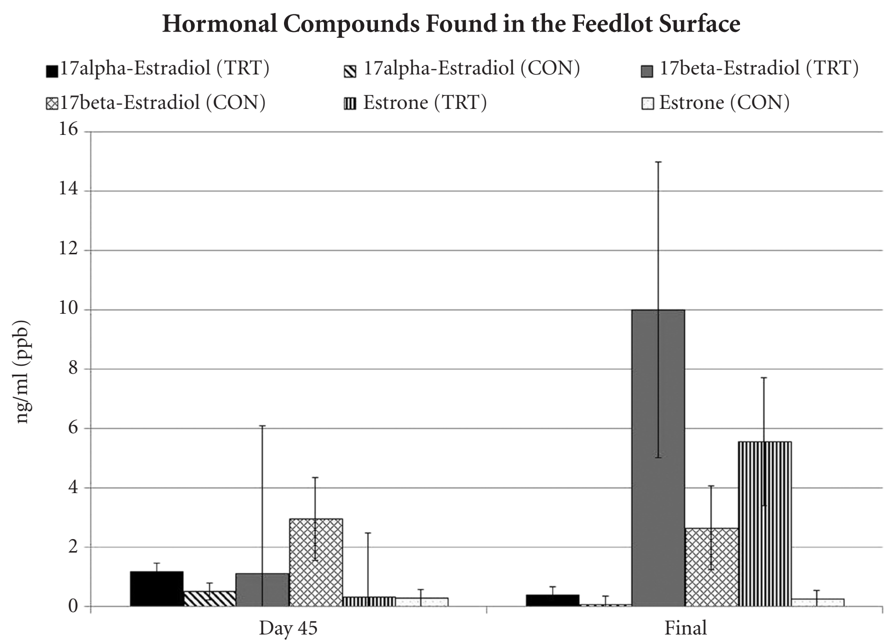

Figure 5. Estrogenic compounds on the feedlot surface.

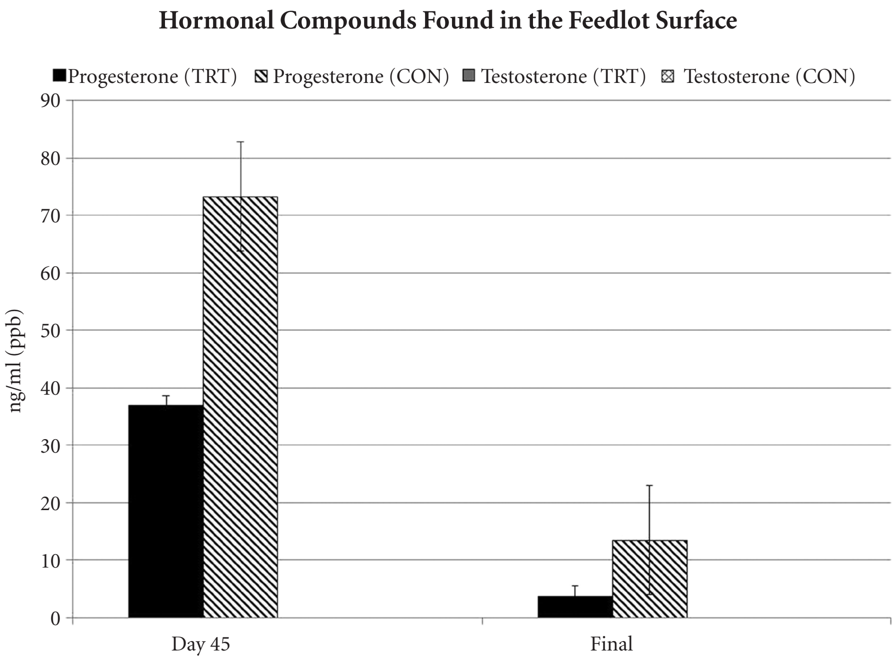

Figure 6. Progesterone and testosterone on the feedlot surface.

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Additional data from this study are published in: Effect of Growth Promotants on the Occurrence of Endogenous and Synthetic Steroid Hormones on Feedlot Soils and in Runoff from Beef Cattle Feeding Operations. Shannon L. Bartelt-Hunt, Daniel D. Snow, William L. Kranz, Terry L. Mader, Charles A. Shapiro, Simon J. van Donk, David P. Shelton, David D. Tarkalson, and Tian C. Zhang. *Environmental Science & Technology* 2012 *46* (3), 1352-1360.