Livestock Hormones in the United States

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The European Community (EC) banned nontherapeutic use of anabolic agents in its livestock industries, as well as imports of meat from treated animals. The EC based its action on internal consumer concerns about food safety and health. The ban on imports, which went into effect on January 1, 1989, is of particular concern to the United States, where anabolic agents —which include hormones—are used extensively in beef production. As a result, the United States has been unable to export beef and veal for human consumption to the EC. However, both parties recently reached an interim agreement that allows U.S. exports into the EC if it can be certified that the cattle were not treated with anabolic agents. *(See The European Ban on Livestock Hormones and Implications for International Trade for more information.)*

The American public's concern over additives and residues in food has also intensified in recent years. In a 1987 Food Marketing Institute survey, American consumers were asked if they believed residues in hormone-treated meat pose a health hazard. The residues were considered a serious hazard by 61 percent of those surveyed and somewhat of a hazard by 32 percent. Most consumers are familiar with the adverse publicity surrounding hormone-related incidents. The controversy over the synthetic hormone Diethylstilbestrol (DES) during the 1970's is a case in point. *(See Regulating Food Safety: The Case of Animal Growth Hormones for details.)*

In the United States, livestock hormones are regulated by the Food and Drug Administration (FDA) and USDA's Food Safety and Inspection Service (FSIS). Hormones must be administered by a time-release pellet inserted under the skin of the animal's ear, which is then discarded at slaughter. The hormone slowly enters the animal's system, with the treatment lasting about 120 days. The exception is Melengestrol acetate (MGA), which is a feed additive not an implant. Producers generally purchase MGA in pure form and add it to feed rations.

Kinds of Hormones

Hormones used in beef and veal production are technically known as anabolic agents. These substances affect animal metabolism by improving the use of nutrients absorbed from feed. Nutrients, such as nitrogen, calcium, and phosphorus, are more likely to be channeled for use in muscle (lean meat) growth than for fat. Anabolic agents can be classified as follows:

- *Natural steroid hormones* are normally produced by nearly all animals. The hormones generate sexual characteristics, maintain reproductive functions, stimulate growth, and are essential for regular body functioning. Many natural steroid hormones are also produced in plants, such as cabbage, peas, and soybeans. The three main types are estrogens, androgens, and progestogens. These hormones are naturally produced by the animal, but they can also be produced in a laboratory. Of the anabolic agents banned by the EC but approved for use in the United States, three fit into this category: estradiol, an estrogen; testosterone, an androgen; and progesterone, a progestogen *(table 1)*.
- *Synthetic steroid hormones* have similar hormonal actions as natural steroid hormones. They are produced in a laboratory and then administered to cattle to enhance the effects of the animals' natural hormones. Two anabolic

Table 1. Anabolic Agents Can Be Classified Into Four Categories

Category	Source	Metabolic action	Anabolic agents
Natural steroid hormones	Produced in animals and humans	Regulates growth, maturity, and sexual characteristics	Estradiol, testosterone, and progesterone
Synthetic steroid hormones	Produced synthetically	Same molecular structure and action of natural steroid hormones	Melengestrol acetate and trenbolone acetate
Natural xenobiotic hormones	Derived from plants	Although not technically steroids, they have similar effects	Zeranol
Growth promoting compounds	Recombinant DNA technology	Improves feed efficiency through nutrient partitioning	Bovine Somatotropin and porcine Somatotropin

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agents—Trenbolone acetate (TBA) and MGA—appear in this category. TBA acts much like natural androgens, but it is 10 to 50 times more active than testosterone. Androgens are hormones that generate secondary male sex characteristics and affect metabolism to stimulate the higher growth rates and greater muscle mass normally found in males. MGA is approved as a feed additive for heifers and acts much like a progestogen. Progestogens, such as progesterone, suppress the heifers' menstrual cycle, and thus conserve metabolic energy. MGA does not make animals grow faster through more efficient nutrient use, but rather allows the conserved energy to be used directly for growth.

- *Natural xenobiotic hormones* are derived from plants and produce effects comparable to those of steroids. This category includes the anabolic agent zeranol, which provides an estrogenic effect. Estrogens are hormones that generate secondary female sex characteristics and affect animals' metabolism to stimulate growth and maintain other bodily functions. Zeranol is derived from the fungus zeralenone.
- *Growth-promoting compounds* include substances such as somatotropins, growth-hormone-releasing factors, and somatostatins. Somatotropins, which are also referred to as growth hormones, are naturally occurring animal hormones that regulate growth and metabolic processes. They can be reproduced in the laboratory through recombinant DNA technology and then injected or implanted into animals. Bovine Somatotropin (bST) increases milk production in dairy cows. Porcine Somatotropin (pST) improves feed efficiency and muscle size in pigs, while cutting feed intake and fat content. Growth-hormone releasing factors and somatostatins regulate an animal's production of somatotropin. These substances are highly species specific, so bST and pST are inactive in humans. None of them has been approved for commercial livestock production in the United States. However, bST and pST are currently under review by FDA.

Why Use Hormones?

Cattle require more feed per pound of weight gain than hogs or poultry. Anabolic agents are used to improve feed efficiency. These substances also help U.S. producers compensate for the practice of raising steers (castrated males) and heifers rather than bulls. Bulls have better feed efficiency and higher growth rates than steers or heifers. They also produce leaner meat and can be fed to heavier weights. But bulls behave aggressively, and steers are easier to manage, so U.S. farmers and feedlots generally raise steers instead of bulls. Further, meat from steers is considered more desirable than bull meat, which is usually less tender, less marbled, and a darker red color, owing to the greater maturity of bulls at slaughter. Castration, however, results in lower internal androgen production. Therefore, androgen implants allow steers to achieve the higher growth rates of bulls.

In bulls, the greatest benefits from hormone treatments are realized with implants of estrogen—hormones that female cattle produce in relatively greater quantities—since bulls already produce high levels of androgens. However, steers achieve greatest feed efficiency and growth rates through use of natural androgens or synthetic hormones that provide androgenic effects. Andro-

gens and progestogens are administered to female cattle, since they naturally produce high levels of estrogen. Implants of androgens in heifers simulate the higher growth rates and feed efficiency of steers and bulls.

Animal drug companies synthetically produce anabolic agents and manufacture them into implants, except MGA, which is sold as a feed additive. Most commercial implants contain either one hormone or a combination of two hormones. For example, Compudose contains only estradiol, while Steer-oid comprises progesterone and estradiol *(table 2)*. In some instances, combination implants can be more effective than implants of a single hormone.

Anabolic agents used in beef production can improve weight gain by 5 to 20 percent, feed efficiency by 5 to 12 percent, and lean meat growth by 15 to 25 percent. A U.S. ban on anabolic agents would probably translate into an annual loss of about 2 billion pounds, carcass weight, or about 13 percent of beef production. The estimated loss to beef producers would range from $1 to $3 billion annually.

In general, beef tenderness, juiciness, and flavor are not adversely affected by anabolic agents in steers and heifers. Steers gain weight more rapidly with the use of anabolic agents, allowing them to be slaughtered at a younger age, yielding leaner and more tender meat products. Concerns have been raised that hormones may increase water retention in treated animals, which may result in a watery residue when the beef is cooked. Although the absolute volume of water retained by the animal does rise with hormone use, so does the amount of protein. Therefore, the ratio of water to protein in muscle mass remains constant.

Scientists at the World Health Organization and FDA have concluded that residues from hormones, when properly

Table 2. The Food and Drug Administration Has Approved Nine Products for Use as Livestock Hormones

Trade name	Manufacturer	Anabolic agents	Approval date	Approved for use on
Compudose	Elanco	Estradiol	March 12, 1982	Calves Steers Heifers
Finaplix	Hoechst Roussel	Trenbolone acetate	June 17, 1987	Steers Heifers
Heifer-oid	Ivy Laboratories	Testosterone propionate and estradiol benzoate	July 24, 1984	Steers Heifers
MGA	Upjohn	Melengestrol acetate	June 3, 1977	Heifers
Ralgro	International Minerals and Chemical	Zeranol	November 5, 1969	Calves Steers Heifers Lambs
Steer-oid	Ivy Laboratories	Progesterone and estradiol benzoate	November 12, 1982	Steers
Synovex C	Syntex	Estradiol benzoate and progesterone	April 9, 1984	Calves
Synovex H	Syntex	Testosterone propionate and estradiol benzoate	July 16, 1958	Heifers
Synovex S	Syntex	Progesterone and estradiol benzoate	February 20, 1956	Steers

administered in both dose and method, pose no threat to human health—residues are minuscule compared with the levels of steroid hormones produced naturally in humans *(see box)*. Nevertheless, some consumers are concerned that hormones may cause cancer. High levels of hormone residues in meat can promote carcinogenic activity already inherent in the human body, but they are not themselves carcinogens. The hormones approved in the United States, however, only pose a danger when given to livestock in very large doses. With approved doses and animal treatment practices, these hormones have no effect on the body's natural rate of carcinogenesis.

Regulating Hormone Residues

FDA limits hormone residues in meat to no more than 1 percent of the natural daily level produced by the most sensitive segment of the population, that is, those people who naturally produce the smallest amount of the hormone in question. For example, FDA sets this number—called the "hormonal no-effect" level—for estrogens based on the daily production of prepubertal boys, who are the lowest producers of estrogen and the most likely to be affected by that hormone. For synthetic or xenobiotic hormones, since there is no natural daily production in humans to serve as a reference point, no-effect levels are established separately for each hormone. Dose levels that create no response in humans are based on appropriate animal tests. All of these no-effect limits may be well below maximum safe levels, since only 10 percent of steroid residues in meat are absorbed by human tissues.

To ensure that producers are in compliance with proper dosage and administration requirements, FSIS operates the National Residue Program. The agency tests samples of meat collected at slaughtering plants for unacceptable hormone residues and other substances, such as pesticides, that may make meat products unsafe. The residue program has been in place since 1978 and has never revealed any misuse of dose or application of hormones in U.S. cattle.

The danger lies in improper and illegal hormone use. Excessive doses and direct injection, which have occurred under black-market conditions, can be harmful to human health. A black market poses dangers because the types and dosages cannot be controlled, and application is likely to be through unsafe direct injection into muscle tissue rather than through the safer and more easily detectable ear implants.

Unlike the EC, where a black market has reportedly developed, the United States apparently shows no black-market activity. It is also not likely that one would develop here. Livestock producers have little incentive to use illegal hormones, such as DES, when alternative hormones are legal and effective.

Scientists have concluded that meat from animals correctly treated with anabolic agents is safe for human consumption. But potential improper use or overdosage of hormones may provide consumers with grounds for concern. Some observers maintain, however, that the misinformation and sensationalism surrounding the hormone issue are the main problems. Thus, the real challenge lies in finding ways to educate producers, consumers, and policymakers about the benefits and possible health effects of hormone use in livestock production. ■

Naturally Occurring Hormones

Natural steroid hormones are an integral part of the metabolic functions of animals and humans. For example, a woman who is not pregnant produces 480,000 nanograms (1 nanogram equals one-billionth of a gram) of estrogen per day. (A pregnant woman produces much more.) In comparison, a 3-ounce serving of lean meat from a steer treated with estrogen contains 1.9 nanograms of that hormone. Therefore, the woman would have to eat 480 pounds of treated beef each day to ingest an amount equaling just 1 percent of her own estrogen production. Progesterone and testosterone residues in treated meat are also minimal relative to normal human hormone production.

In addition, some hormones are biologically less active in humans than in animals. MGA is 200 times less active in humans than in cattle, so low levels can be effective in stimulating growth in cattle without affecting humans.

Other natural foodstuffs, such as wheat germ, soybean oil, butter, and milk, also contain higher hormone levels than residues in meat. For instance, 3,400 nanograms of estrogen are found in 3 ounces of wheat germ.

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