

Chapter 5 – Feed Additives and Growth Promotants in Animal Production



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■ Learning Objectives:

- 1) To describe some of the major feed additives used in livestock production and to indicate why they are effective in improving some aspect of animal performance.
- 2) To discuss the risks versus benefits of major feed additives.
- 3) To present background information on feed additives prior to discussion (Chapter 9) on societal concerns regarding use of feed additives.

Chapter Outline:

- I. ADDITIVES THAT INFLUENCE STABILITY AND NON-NUTRIENT PROPERTIES OF FEEDS
- II. ADDITIVES THAT MODIFY FEED INTAKE OR DIGESTION
- III. ADDITIVES THAT MODIFY METABOLISM
- IV. ANTIBIOTICS AS FEED ADDITIVES
- V. ALTERNATIVES TO ANTIBIOTICS
- VI. REPARTITIONING AGENTS
- VII. MISCELLANEOUS FEED ADDITIVES
- VIII. OTHER GROWTH PROMOTANTS THAT ARE NOT FEED ADDITIVES
- VI. CONCLUSIONS



Feed Additives – “Are non-nutritive substances added to feeds to improve the efficiency of feed utilization and feed acceptance or to be beneficial to the health or metabolism of the animal in some way”.

- Substances other than nutrients or sources of nutrients.
- Excludes synthetic amino acids, vitamin preparations, and mineral supplements.
- Are feed additives hazardous to humans?
- Inhumane to animals?
- Symptom of undesirable dependence on chemicals and technology?

natural ≠ organic

Everyday on-farm dairy practices

	"NATURAL DAIRY"	CERTIFIED ORGANIC
Take synthetic pesticides, herbicides, fungicides or fertilizers?	ALLOWED	NEVER
Always conduct with no antibiotic residues?	ALLOWED	NEVER
Animal feed may be given with chemical drugs and genetically modified organisms (GMOs), including synthetic animal by products?	ALLOWED	NEVER
Antibiotics used to compensate for an unhealthy diet and stress?	ALLOWED	NEVER
Genetically engineered ingredients and breeding hormones?	ALLOWED	NEVER
Use increasing amounts of soil-enriching synthetic nitrogen fertilizer and pesticides used to make food grow?	ALLOWED	NEVER

Who's hogging our antibiotics?

Tell the FDA:
Protect human and animal health by saving antibiotics

Various Types of Feed Additives:

1. Additives that influence feed stability, feed manufacturing, and non-nutritive properties of feeds
 - A. Mold inhibitors (antifungals)
 - B. Antioxidants (preservatives)
 - C. Pellet binders
2. Additives that modify feed intake, digestion, growth, feed efficiency, metabolism, and performance
 - A. Feed flavors
 - B. Digestion modifiers
 - C. Metabolic modifiers
 - D. Growth promotants
3. Additives that modify animal health
 - A. Drugs
 - B. Environmentally active substances
4. Additives that modify consumer acceptance of animal products
 - A. Pigmenting agents

Issues: Use of feed additives is highly controversial

I. Additives that Influence Stability and Non-Nutrient Properties of Feeds

Issue: The processing of corn causes rancidity (page 134).

- ❖ Peroxides are formed that react to produce aldehydes and ketones, reduces palatability and performance and destroy vitamins.
- ❖ Adding **antioxidants** to the diet inactivates peroxides. Rancid oils can be toxic. Natural antioxidants include Vitamins C and E and selenium, but these are expensive. Synthetic Antioxidants are used (BHT). Extensive animal testing has been done. **Preservatives** may reduce risk of CHD and cancer and(or) increase longevity.
- ❖ Another groups of preservatives is **mold inhibitors**. Some mold substances are highly toxic (aflatoxins, zearalenone, and vomitoxin).
- ❖ Adding 1% **propionic acid** to diet prevents mold growth.
- ❖ **Ammoniation** of stored grains both prevents aflatoxins and provides a source of non-protein nitrogen (NPN.)
- ❖ Another feed additive is **pellet binders** (bentonite, a clay mineral). How does pellet quality relate to animal performance?

Conclusions: No known hazards. Need to educate public.

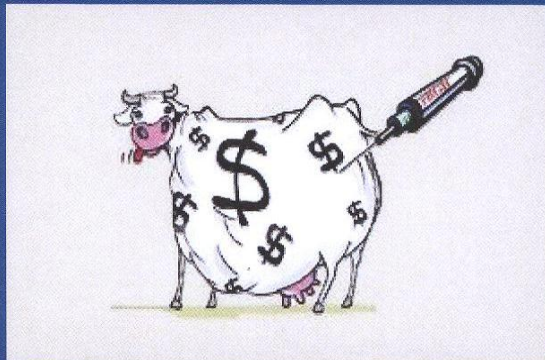
II. Additives that Modify Feed Intake or Digestion

- **Feed flavors** – Aim is to increase feed intake.
- **Enzymes** – Enhance digestibility (β -glucanase), and improves litter and air quality and performance. **Phytases** increase the bio-availability of P so less is excreted. Also **Cellulase** and **Lactase**.
- **Buffers** – compounds that resist changes in pH. Prevents acidosis in ruminants fed high grain diets in feedlots and dairies (sodium bicarbonate).
- **Antibloat agents** – Bloat Guard (**Poloxalene**, a detergent) is used to break down foam bubbles, releasing gas.
- **Defaunating agents** – Substances that kill protozoa (protozoa consume rumen bacteria). **Bovatec** (a coccidiocide) and **Saponins**, a natural compound found in yucca and other plants, are used.
- **Ionophores** – Class of antibiotics that inhibit growth of gram-positive bacteria. **Rumensin** (Monensin) is a common product. Improves FE. gram-negative bacteria produce more propionic acid, which yields more ATP. Ionophores also reduce methane production.

Conclusions: No known hazards. Need to educate public.

III. Additives that Modify Metabolism

Issues: In the U.S., only one hormone is used, melengestrol acetate (MGA), a heifer heat-suppressant. Livestock are administered hormones, but not as feed additives (e.g., implants such as Ralgro; an estrogenic compound produced by a corn mold (zearalenone)) or is administered by injection such as GH.



Will later cover the implications of hormone use.

IV. Antibiotics as Feed Additives

Definition: **Antibiotic** - Ability to kill or suppress bacteria. Substances produced by living organisms (usually molds); harmful substances are called **mycotoxins**. Used since 1940's after discovery of penicillin when grain fermentation residue was fed to livestock, which increased growth.

How are antibiotics made commercially?

Mechanisms of action:

1. Suppress mild but unrecognized subclinical infections
2. Inhibit the growth of toxin-producing gut microbes
3. Reduce microbial destruction of essential nutrients in the gut or improve the gut synthesis of vitamins
4. Improve nutrient absorption by causing a thinning of the intestinal mucosa
5. Two or more combinations of the preceding

IV. Antibiotics as Feed Additives

Facts:

- Bacteria can rapidly develop resistance to antibiotics by mutation... implications in human health. A recent CDC study reported that human fatality rate was 21 X higher with **antibiotic-resistant** Salmonella infection, arising from use of antibiotics in livestock.
- Antibiotics are routinely fed to poultry and swine, not ruminants. The main beneficiaries are the pharmaceutical companies (a profit) and consumers (lower food prices).
- Antibiotics, which have existed for eons, are natural compounds and the level of effectiveness have remained the same for decades.
- The "risk vs. benefit" debate. Reported cases often involved poor food sanitation practices. Examples?
- *Ethical*, not a scientific issue (Rollin, 2001)?
- Relevancy to the present era of bioterrorism?

V. Alternatives to Antibiotics

Alternatives:

- **Probiotics** – “pro life”. Also called direct-fed microbials. Live microbial supplements that beneficially affect the host animal by improving its GIT microbial balance, possibly due to competitive inhibition (*Lactobacillus acidophilus*). However, lack of scientific evidence of effectiveness. In the future, it may be possible to custom design microbes that secrete amino acids, enzymes, detoxifying compounds, etc.
- **Copper sulfate** – Improves growth, FE, and reduces enteric disease through modification of gut microflora. (Cu excreted in manure causes pollution). Dried poultry waste (from Cu-fed birds) fed to ruminants has also caused copper toxicity. However, no excess Cu in tissues, except liver. (There appears to be no human hazards.)
- **Arsenicals, Nitrofurans, and Sulfonamides** (sulfa drugs) – Problem in swine industry (residues in pork), thyroid inhibitors at high levels, cancer in lab animals. Use of sulfur drugs under review by FDA. Continued use is questionable. Arsenicals function in gut, not absorbed.

VI. Repartitioning Agents

Substances that cause a change in the nutrient profile of body tissues, or a “repartitioning” of nutrients from fat to protein. They either stimulate protein formation (increased synthesis or decreased degradation) and decrease body fat (either decreasing fat synthesis or increasing its mobilization). Net effect is an increase in muscle tissue and reduction in body fat. Over 5 billion pounds of fat is trimmed from carcasses each year.



- **Ractopamine** – Approved by FDA. Illicit use in show animals and in humans.
- **Clenbuterol** – Not approved by FDA (“lean meat powder”, “fat burners”)



VII. Miscellaneous Feed Additives

Additives that are included in the diet that have favorable effects on the environment or in the food product:

- **Yucca-extract compounds** – used to control atmospheric ammonia levels in animal facilities (binds with ammonia released by bacteria in manure). **Zeolites** are clay minerals used for same purpose.
- **Phytases** – Reduce P in manure wastes
- **Modified “Designer eggs”** – Contain more vitamin E, iodine, and unsaturated fat due to feeding of special diets. A challenge to lower cholesterol in eggs.
- **Pigmenting agents** – Xanthophyll, a carotenoid pigment (but no Vitamin A activity), causes more yellow color in egg yolks and skin. Sources? Also used in salmon and trout production.

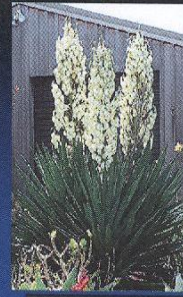
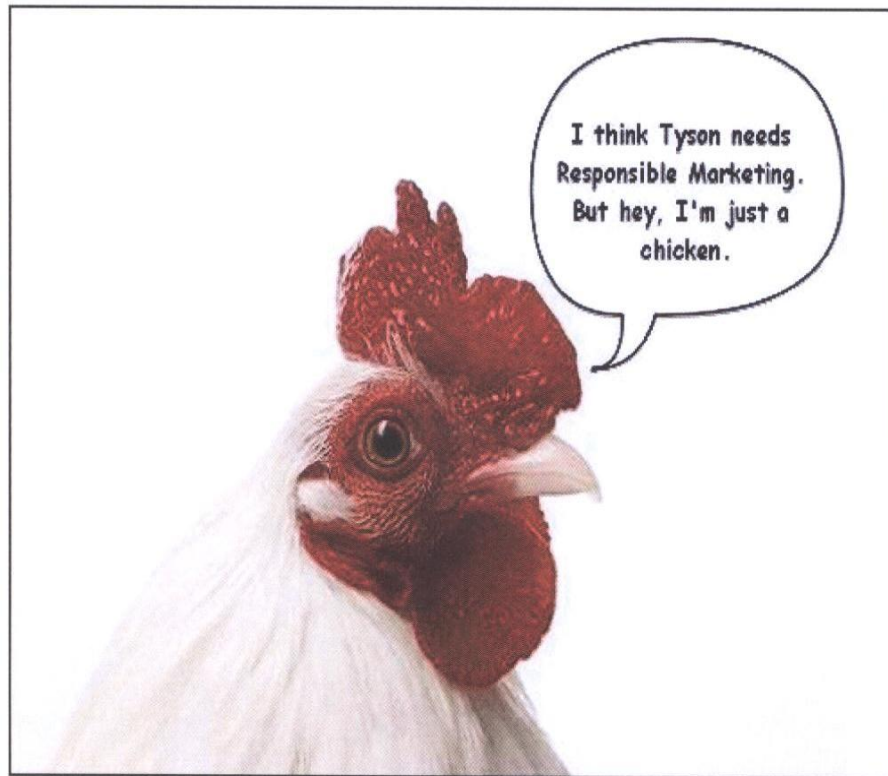


Table 1. Classification of nutrients found in the egg by responsiveness to dietary change.*

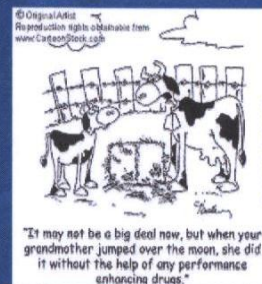
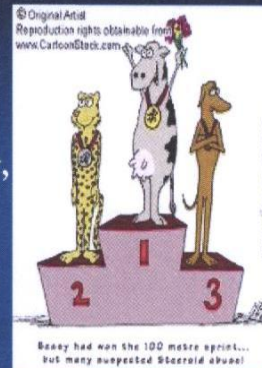
Little or no variation	Positive or marked influence on diet	No information found
Water	Iodine	Zinc
Calories	Fluorine	Niacin
Protein	Manganese	Pyridoxine
Fat	Vitamin A	Inositol
Carbohydrate	Vitamin D	Arachidonic acid
Calcium	Vitamin E	
Phosphorus	Vitamin K	
Iron	Thiamin	
Sodium	Riboflavin	
Potassium	Folic acid	
Chloride	Biotin	
Magnesium	Vitamin B ₁₂	
Copper	Oleic acid	
Sulfur	Linoleic acid	
Acidity	Linolenic acid	
Ash		
Ascorbic acid		
Choline		
Stearic acid		
Palmitic acid		
Cholesterol		
Amino acids		

* Nabor, 1979.



VIII. Other Growth Promotants that are not Feed Additives

- **Growth hormone (GH)** – Multiple physiological effects on growth and lactation (e.g., increases amino acid transport into muscle cells). Commercially, bST and pST are produced by bacteria by DNA technology.
 - Studies show higher milk yields by 10-40% and faster growth rate in pigs by 10-25% and leaner carcasses.
 - Use of bST or pST may alter nutrient requirements due to accelerated protein synthesis.
 - Transgenic pigs (bGH) have improved growth and FE, but show adverse pathological effects.
 - Some states have banned bST in dairy cows (must be injected daily – Why?). Ethical and social concerns. What are these?
 - Believed by scientists that there are no real health concerns. Why?
 - Biotechnology is moving faster than its ramifications can be agreed upon by society.

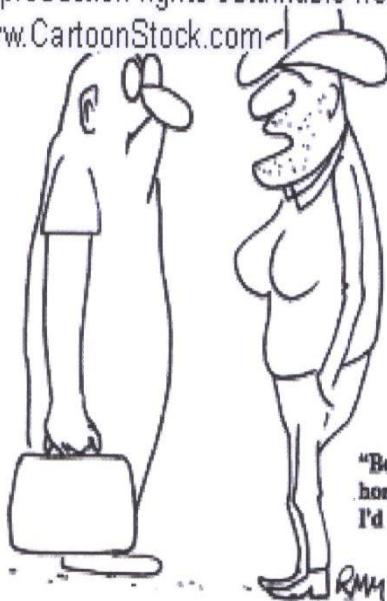


VIII. Other Growth Promotants that are not Feed Additives

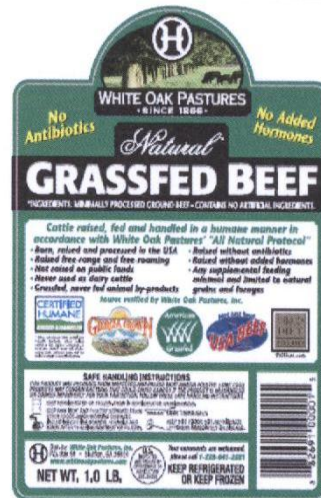
- **Androgen and Estrogen (anabolic steroids) hormones** – Natural compounds that influence animal growth & development.
 - Diethylstilbestrol (DES) has already been banned by FDA. What is the Delaney Clause?
- **Implants** – Estradiol and zearalenol (estrogens) are used as slow-releasing implants. Zearalenol is a mycotoxin, known as Ralgro. Trenbolone acetate is a synthetic androgen that promotes growth. (C. Croney)
 - Used in feedlot animals to improve FE, lowering meat prices. Steers are more responsive than heifers. Why?
 - Use of implants is highly controversial. Banned in Europe. Negative public perceptions possibly outweigh benefits.
 - Key is a successful strategy for educating public and responding to challenges to the use of safe biotechnological developments.



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"Before we treat any more steers with hormone implants, there's a few details I'd like cleared up about residues in the meat."



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