The Influence of Feed Additives on the Production of Food

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Since 1950, feed additives with a varied chemical nature ranging from antibactericidal agents to hormonelike substances have improved feed efficiency in beef cattle as much as 17%, in lambs 10%, in poultry 15%, and in swine 15%. Beneficial feed additives, nutrients, and chemical compounds have a requirement level, a tolerance level, and a toxic level. Zero tolerance exists with very few substances. Where a small amount may be highly beneficial, a larger amount may be toxic. The use of feed additives and the fortification of livestock rations with essential chemical nutrients must continue on a safe and tolerance base (not zero) if we expect to improve feed conversion and feed the increasing population.

FEED ADDITIVES that stimulate growth and improve feed efficiency without leaving harmful residues in the edible product have made an important and permanent contribution to the production of livestock. Man and animal no longer live in a backward environment but in a chemical world stimulated by new discoveries that improve nutrient utilization, reduce disease level, and enhance nutritional value of the product produced. Since 1950, feed additives with a varied chemical nature ranging from antibactericidal agents to hormonelike substances have improved feed efficiency in beef cattle as much as 17%, in lambs 10%, in poultry 15%, and in swine 15%. Without these discoveries and use of these chemical products, the livestock industry would not be a very profitable enterprise today.

Feed additives were created not to destroy man or animal but to be biologically helpful. Beneficial feed additives, nutrients, and chemical compounds have a requirement level, a tolerance level, and a toxic level. Zero tolerance exists with very few substances. Where a small amount may be highly beneficial, a larger amount may be toxic. The medical profession has recognized this fact for many years and has controlled the use of certain drugs and chemicals by "prescription only."

The major segment of our population not trained in the biological sciences have the philosophy that if nature includes a substance in food, it is useful and nontoxic. Plant life concentrates many elements in toxic amounts such as fluorine and selenium but which are beneficial at lower levels. Vitamin D, iodine, chlorine, copper, and molybdenum are essential for metabolism of living cells but are highly toxic when used in improper amounts.

This paper will discuss the effect of certain feed additives on the performance of cattle and swine.

Cattle

Over the past 50 years, rate of gain in beef cattle has increased about 42% and feed efficiency 30% by improvement in cattle rations. Although a major part of this improvement is due to better nutrition, a significant part can be attributed to the use of such feed additives as antibiotics and diethylstilbestrol.

Antibiotics. These have made a definite contribution in improving the gain, feed efficiency, carcass quality, and general health of beef cattle and dairy calves. Usually chlorotetracycline and oxytetracycline are the most effective antibiotics for ruminants. However, recent research has indicated a favorable response from zinc bacitracin under certain feed conditions. The response to antibiotics varies with the energy level in the ration and disease level of the cattle. On high-roughage growing rations, feeding 75 to 80 mg. of antibiotic (tetracyclines) daily increased daily gain 9% and improved feed efficiency 8% (31 experiments). In 48 high-grain fattening experiments, antibiotics stimulated gain 4% and reduced feed requirement 5%.

Antibiotics are additive in their effect over and above stilbestrol. In a summary of 20 experiments with beef cattle on fattening rations, stilbestrol alone improved gain and feed efficiency 12% and 9%, and a combination of antibiotic-stilbestrol 17% and 12%, respectively.

Feeding antibiotics also reduces the incidence of condemned livers, improves carcass grade, and reduces disease problems.

Diethylstilbestrol. This is widely used as a growth stimulant for growing and fattening cattle either as an implant or fed orally. A recent summary of 66 college experiments indicated that gain was increased 14% and feed efficiency improved 10%. Feed saving alone will amount to $5 to $7 per steer depending on the type of ration and length of feeding period. If properly used, stilbestrol is safe and beneficial to cattle feeders and the consumer.

Enzymes. One of the newer innovations in feed additives for cattle is research on the use of amylolytic, proteolytic, cellulolytic, and fungal enzymes in an attempt to improve the utilization of feedstuffs. In general, the results reported to date on the effect of amylolytic and proteolytic type of enzymes have been negative and inconsistent. Occasionally some favorable results have been obtained with cellulolytic and fungal type enzymes. To date, enzymes have made very little clear-cut contribution to the production of cattle. Additional research is needed to detect an enzyme that is more effective. Papain is being used successfully to inject in steers prior to slaughter to tenderize beef.

Tranquilizers. A classical contribution in changing the response of man to his environment has been made by tranquilizers, but none of the tranquilizing drugs have shown any consistent beneficial response in beef cattle except for medical purposes. Many tranquilizers, such as hydroxyzine, reserpine, rauwolfia, trifluomeprazine, trilafon, and Tranimal, have been tested as a feed additive for cattle, but the results to date do not look promising. A review of 90 experiments on various tranquilizers indicates a wide variety of results; but a majority of the tests show no significant effect on gain, feed consumption, feed conversion, or animal behavior. The animal response to tranquilizers is a puzzling phenomenon and needs further investigation.

Eventually feed additives will be discovered which will control bloat, foot rot, flies, and grubs, and thus eliminate these diseases and pests from cattle feeding operations.

Swine

Progress in swine feeding over the past 50 years has resulted in a 49% increase in daily gain and a 25% improvement in feed efficiency in growing and finishing hogs. Part of this improvement is due to fortification of swine rations with high quality proteins, vitamins, and minerals; and a definite portion is due to the universal use of antibiotics, arsenicals, and other bactericidal agents.

Numerous experiments have shown beneficial effects from using antibiotics, arsanilic acid, furazolidone (NF-180), and other feed additives during different stages in the life cycle of the pig and sow.

Many antibiotics, such as aureomycin, terramycin, penicillin, streptomycin, oleandomycin, tylosin, zinc bacitracin, and certain combinations of these antibiotics, have consistently increased gain and improved feed efficiency and health of pigs.

It is difficult to arrive at a single set of figures that will truly assess the contribution of antibiotics, arsenicals, and other bactericidal agents to the swine industry. The stimulation from antibiotics and arsenicals varies with the age of the pig and the disease level. Fourteen experiments conducted at the Ohio Experiment Station from 1957 to 1961 have shown that feeding aureomycin from weaning to 120 pounds improved gain 8.6% and feed efficiency 9.6% and from 120 pounds to market 3.4 and 7.1%, respectively. An over-all average showed a 6% increase in gain and an 8.4% improvement in feed conversion. Many times the response from antibiotics is not so great under carefully controlled conditions and selected pigs in an experiment station herd as on the average swine farm.

Poor-doing pigs ("tail-end") respond more favorably to antibiotics than healthy, thrifty pigs. Research at Purdue has clearly shown fortifying a pig ration with 100 grams of either aureomycin or terramycin per ton will increase the growth rate of "tail-end" pigs 0.53 pound daily or an increase of 49%. Also, field studies have indicated that early weaned pigs (3 weeks) respond markedly to antibiotic feeding with an increase in gain of 42% on 11% less feed.

Similar responses have been obtained in young pigs and growing-finishing pigs by feeding 90 grams of arsanilic acid per ton of feed or a combination of arsanilic acid with an antibiotic.

In four trials at the Missouri Experiment Station, sows fed 500 mg. of a tetracycline antibiotic per head daily for 10 to 21 days at breeding time farrowed 19% larger litters than sows not fed antibiotics. In two recent tests, there was no increase in the number of pigs farrowed, but all the sows fed antibiotics settled on the first service.

Research by Kentucky and Southern Illinois University has revealed that furazolidone (NF-180), when fed to the brood sow and young pigs, reduced death losses and increased weaning weight 3 to 6 pounds. Antibiotics have also been shown to be effective against certain types of pig scours.

Enzymes, tranquilizers, and hormone-like substances have not shown any consistent beneficial response as a feed additive for swine.

Guide for the Future

The use of feed additives and the fortification of livestock rations with essential chemical nutrients must continue on a safe and tolerance base (not zero) if we expect to improve feed conversion and feed the increasing population. Animal and human life are basically and essentially series of biological and chemical reactions fed by chemical substances. Man voluntarily or involuntarily consumes, breathes, and uses more potentially toxic products than will ever exist or be allowed in human foods. There are no more wholesome and nutritious products produced than milk, meat, and eggs. Through careful screening and research, we can keep animal products free from harmful substances. We need to control the use of feed additives not with a zero concept but with a tolerance and safe level concept.

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FEED ADDITIVES

The Significance for the Processor of Feed Additive Residues in Food

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ANIMAL feeds are customarily supplemented with nutrients and other additives to improve the quality and yield of foods of animal origin. This practice results in the production of more and better and cheaper foods; but these desirable consequences are somewhat offset by widespread concern over the possible existence in the food of residues of the feed additives.

Disagreements over the significance of residues, which may or may not exist, have been responsible for controversies growing out of legislation relating to this problem. There has been no disagreement with the objectives of the legislation, i.e., with protection of the food supplies.

Engel (*7*) has indicated that additives have an important place in present-day feeding practices and that these practices have significant influences on the quantity, quality, and cost of animal foods. As we deal with it here, wholesomeness is a defined characteristic, rather than an inherent property. Whether or not a substance or a food containing a substance is safe for human consumption depends upon the quantities consumed, the conditions under which it is consumed, the frequency of consumption, and many other factors. While safety is the principal criterion in considering additives, failure to use appropriate additives will result in fewer, lower quality, and more expensive foods.

The immediate topic of this paper relates to the significance for the processor of feed residues in foods. For this purpose, processing shall be defined as a conversion of the products of ranches or farms into forms suitable for purchase by the ultimate consumer. This excludes breeding, feeding, and shipping of the animal to the point of processing and retailing of finished foods. For the most part, these operations are beyond control of the food processor. Furthermore, this discussion will be directed toward products of animal origin, essentially meat, poultry products, and milk.

Food processors are in an unenviable position with respect to this problem. They do not benefit in any direct way from the improved yields brought about by feed additives, nor are they able to discern in many cases whether or not additives have been used. On the other hand, they are held accountable for the appearance of even the least detectable amounts of certain of these additives should they occur as residues in their products. In fact, they are held responsible for amounts presently undetectable, should improved methods be developed. Fortunately, realistic enforcement of clauses relating to "no-residue" provisions of food protection regulations would be expected to allow ample time to adapt feeding and operating practices to take improved methodology into account.

To scientists, considerations of residues of feed additives imply ability to detect and measure the residues with a satisfactory degree of accuracy. With many additives this is a major problem, particularly when there is insistence that no traces of residue remain. Chemists who have had experience with determinations of trace ingredients in foods or feeds are well aware of the complexity of the techniques needed. The procedures sometimes require several days for completion, even on a routine basis, and the determinations are prohibitively costly.

Additives are usually administered at concentrations measured in p.p.m. in the feed. Unless there is accumulation or localization of these residues in specific tissues, concentrations within the animal