Feeding strategies for intensive livestock production without in feed antibiotic growth promoters

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SUMMARY – Until recently the main objective of feed formulation was to maximize productive performance in terms of average daily gains and feed efficiency at least cost. However, there are new trends in life styles in developed countries and the consumer is actively seeking foods with more desirable characteristics, including composition of fatty acids, antioxidant content, and wholesomeness of the end products. The use of antibiotics in feeds is under severe scrutiny and there is a niche for changes in dietary composition including the use of new substances that, at a cost, may help to promote stock health. Besides changes in management practices, the new diets will be less dense, both in energy and in crude protein content but enriched in certain fatty acids, vitamins, micro minerals, additives, and dietetic fiber. Among the additives, enzymes to enhance the nutrient availability of feedstuffs, organic acids to promote digestive health, probiotics, saccharomyces, bacillus, oligosaccharides, and immune system enhancers are products to consider in feed formulation for the health conscious consumer.

Key words: Feeding program, growth promoters, additives, organic acids.

***RESUME* –** *"Stratégies alimentaires pour une production animale intensive sans promoteurs de croissance antibiotiques incorporés dans l'aliment". Jusqu'à récemment l'objectif le plus important de la formulation des aliments était d'obtenir la productivité maximale en termes du gain moyen de poids et de l'indice de consommation à coût minimal. Cependant, dans les pays développés, il y a des tendances nouvelles de style de vie et le consommateur cherche des aliments avec des caractéristiques plus désirables, comme une sélection des acides gras, antioxydants et l'hygiène du produit final. De plus en plus, il y a des antibiotiques à usage interdit, ce qui favorise les changements de la composition du régime ou l'utilisation de nouvelles substances, jusqu'à un coût déterminé, qui peuvent aider à prévenir les maladies. En plus, il y aura des changements du management, les nouveaux régimes auront des niveaux énergétiques et en matières azotées plus bas, mais des teneurs plus hautes en certains acides gras, vitamines, minéraux, additifs et fibre diététique. Parmi les additifs, les enzymes, les acides organiques, les probiotiques, les bactéries (saccharomyces, bacillus), les oligosaccharides et les promoteurs du système immunitaires sont des produits à considérer dans l'alimentation des animaux pour le consommateur qui se préoccupe de sa santé.*

Mots-clés : *Programme d'alimentation, promoteur de croissance, additifs, acides organiques.*

Introduction

The use of antibiotics as feed additives has been widely accepted by the industry as a method to improve productivity and decrease the incidence of subclinical infections. Preventive measures to control diseases such as coccidiosis and bacterial enteritis include the use of antibiotic and chemotherapeutic feed additives. Most of the former authorized products (except for the quinoxalines derivatives) were effective against gram positive bacteria and reduced insidious enteric problems, especially in young animals (Bolder *et al.*, 1999). However, there is a growing public concern on the negative effects of this practice, especially because of the possibility of resistance development by gut microorganisms that can be transferred to humans (Anadón and Martinez-Larrañaga, 1999; Spring, 1999). The phenomenon of transferable resistance, although controversial, deserves attention by the scientific community. Recently, this practice has been openly criticized in the European press and a strong negative attitude by consumers towards the use of antibiotics in feeds for livestock has been created. As early as 1986, Sweden introduced a general ban on the use of feed antibiotics. The prohibition increased the incidence of subclinical diseases, and as a consequence the use of therapeutical doses of antibiotics to treat sick animals augmented considerably. The animal industry adapted to the new situation by improving environmental control of poultry and livestock facilities and introducing changes management of the animals in feed composition, feeding programs. Some of the measures implemented have demonstrated to be efficacious and helped to maintain animal productivity at levels close to that obtained when antibiotics were used in feed. There is a clear trend in the European Union toward the development of a "green agriculture and animal production", a trend that is expected to continue in the near future. Therefore, it seems of interest to document changes in feeding strategies that might be of benefit for animal productivity under high intensive production systems.

Prohibition of antimicrobial additives

The major advantage of the antibiotic ban will be an improvement of the perception of the consumers on the wholesome of products of animal origin because of the potential lower risk of meat, eggs, and milk obtained without growth promoter supplementation. Also, the prohibition will fit into the strategy of the "green oriented" and ecological political movements. The disadvantages relate to the increment in cost of production because of the lack of control of subclinical diseases, especially under poor management conditions. According to recent studies, the cost of the ban will affect primarily piglet production and then broilers, while the impact in laying hens and growing-finishing pigs will be very limited (Thomke and Elwinger, 1998; Kjeldsen *et al.*, 1999). Viaene (1997) indicates that the ban of the use of antibiotics in feeds of piglets to 25 kg will increase mortality by 10 to 15% and the quantity of feed required by 2 to 3 kg. Besides, the animals will require 3 to 7 d more to reach the target weight. Tronstad (1997), however, indicated that the economical disadvantages of the ban under the conditions of Sweden were smaller than previously reported. However, there are several circumstances in which the ban of use of antimicrobials as feed additives will have a significant impact on the economics of commercial farms: (i) diarrhoea in piglets after early-weaning because of *E. coli* and swine dysentery contamination; (ii) wet faeces in broilers and other avian species reared on floor because of necrotic enteritis produced by *Clostridium* sp.; and (iii) acidosis and paraqueratosis in intensive beef cattle and subclinical coccidiosis in broilers and other avians in case the use of ionophores is not longer permitted in the feed.

Modifications of management and feeding programs

Management

Under a ban situation, environmental conditions, management of the animals, feeding programs and composition of the feed will need to be adjusted. Housing and facilities will require changes with improved insulation and ventilation systems and a better control of the temperatures. It is believed that more than 50% of the enteric processes affecting early weaned piglets are brought about by cold itself, drafts, or to abrupt changes in barn temperatures. Also, level of NH_3 will need to be monitored and reduced (to less than 10 p.p.m.). Management of piglets will change with commercial weaning at a later age (more than 4 weeks) to improve the resistance of the piglet to environmental stress. Hygiene and disease prevention will be of paramount importance with more restrictions to visits and increased parasite control. It will also be necessary to decrease the density of animals at the farm and to practice systems of all in-all out to reduce the pressure of infective diseases. The use of two bins by barn will be promoted to facilitate treatment on time, and the practice of water and injection treatment will increase. Also, *ad libitum* feeding of piglets will be carefully monitored and feed restriction might have to be implemented often, especially for the first 2 weeks after weaning. This management practice will reinforce studies on the minimum requirements of feeder space needed per piglet at these ages.

Feeding programs and diet formulation

Feeding programs and composition of the feeds will be reprogrammed to insure safety. The energy content of the feeds for piglets, and also calves and broilers will be reduced (in piglets up to 10 to 20% from current standard formulations). Also, the use of cooked cereals will increase in mammals, and more work will be necessary to compare the influence of type of heat processes on the different cereals. Broken rice and partially or totally decorticated oats will be included in diets for piglets. In Table 1 we offer data from 6 trials conducted by us (unpublished data) with piglets from 21 to 49 d of age comparing raw and cooked cereals. From these results it becomes apparent the beneficial effects of heat-processing of cereals. In general, cooking improved piglet health and performance but the differences were more pronounced from weaning (21 d) to 35 d of life. Raw barley and oats allowed good growth and decreased the incidence of diarrhoea with respect to corn and wheat. However, growth and feed conversion were better for raw corn than for barley. From our data (Medel *et al.*, 1999) we recommend the use of a mixture of cooked cereals together with a small amount of raw cereal (preferably oats or barley) to improve gut conditions for piglets fed diets without antibiotics.

Table 1. Influence of heat-processing of cereal on piglet performance. (Improvement over controls; unpublished data)

	Number of trials	ADG†		FC††	
		21-35 d	21-49 d	21-35 d	21-49 d
Barley	5	15	7	9	4
Wheat	2	7	2	6	2
Corn	4	5	9	5	5
Oats	2	6	4	8	6

†ADG = Average daily gain.
††FC = Feed conversion.

From information obtained in practical conditions the risk of scours in piglets increased with the crude protein content of the diet (Goransson, 1997). Therefore, the protein level will be reduced in piglets by 1 to 3 units. Probably, the negative effect is not due to the protein itself but to the non-digested portion of the ingested ingredients or to predisposing factors, such as allergenic molecules contained in the protein sources. As a consequence, the different sources of protein will be tested carefully in pre-starter diets and the use of synthetic amino acids will increase. In piglets and broiler chicks will be necessary to improve the digestibility of the diet by increasing the percentage of high quality animal protein (spray-dried animal plasma, fish meal LT, meat meal, blood meal and other render products correctly processed, milk and egg by-products, etc.).

Minerals are required for growth and most diets for poultry and livestock include inorganic sources of phosphorus and calcium. Both minerals bind acids at a high extent and might increase diarrhoea incidence. Therefore, future formulation will require a reduction of the levels of dicalcium phosphate and of calcium carbonate used. At this respect, the use of phytase will increase, and the level of Ca will be adjusted to less than 0.7% of the diet. These changes are expected to improve palatability and buffer capability of the feed and reduce the incidence of scours.

Dietary fiber

Up to recently, most nutritionists limited the amount of fiber in feeds for piglets and broilers. An excess of crude fiber reduces feed intake and might change the rate of food passage through the digestive tract and decrease nutrient digestibility. Dietary fiber constitutes a large group of compounds and their intestinal properties differ greatly. There is some data, most of it obtained from rats and humans, that fiber, at a given amount and quality, increases gastrointestinal secretions, modify microflora balance of the gut, and benefit digestive mucose growth and overall digestive tract functionality. Some of the components of the fiber fraction may be involved in health-modulating processes and improve digestive trophic status and health (Mosenthin *et al.*, 1999). Dietary fiber defined as the sum of the polysaccharides and lignin which are not digested by the endogenous secretions of the gastrointestinal tract and neutral detergent fiber may play two roles in monogastric nutrition. First, the fiber fraction of the feed might stimulate by contact the peristaltism of the digestive tract, improving its functionality. Also, neutral detergent fiber, especially when the lignin content is low, and pectins may be fermented by the microorganisms present in the large intestine, mostly in the colon. Butyrate is one of the major volatile fatty acids resulting from microbial fermentation which might benefit mucose digestive growth. It is known that butyrate can be metabolized in peripheral tissues and used as an energy source by the colonocites directly and therefore might be of benefit for repairing the mucose of the large intestine, if required. The absorption of volatile fatty acids from the colon stimulates sodium absorption from the intestinal lumen and therefore allows the reabsorption of grater amounts of water. Therefore, the use of non-lignified sources of fiber, such as beet pulp, and soy hulls may act as an anti-diarrhoeic ingredient and might benefit piglet health when no antibiotics are used (Goransson, 1997; Mosenthin *et al.*, 1999).

Grinding size

Raw material grinding is another factor that might influence animal performance, especially in pigs. Fine grinding improves nutrient digestibility and pellet quality. As a consequence, the industry is using finely ground materials in most of the feeds for pigs. However, finely ground ingredients might be detrimental for mucose growth and digestive tract functionality with increased incidence of ulcers, impairment of gut morphology, and losses of digestive wall tonicity. Also, in broilers (Penz, 1998) particle size might influence gut morphology and productive performance.

Additives

There are numerous additives that have shown beneficial effects on performance and control of subclinical diseases when added to poultry and livestock diets (Williams, 1997; Santomá, 1998). Among them, the most widely accepted by the industry are: (i) the organic acids (formic, lactic, propionic, and others), their salts, and their combinations; (ii) the different existing enzymes, including beta-glucanases, xylanases, proteases, phytases, and others; (iii) high doses of selected microminerals, such as copper and zinc; (iv) probiotics, yeasts such as saccharomyces, and other live organisms; (v) immunity enhancers, such as certain fatty acids, carotenoids, vitamins, chelated minerals and peptides; and (vi) complex oligosaccharides and other compounds.

Organic acids are widely used by the industry and improve piglet performance in most situations but their effects in avians are less demonstrated (Eidelsburger, 1998; Bolduan, 1999; Mateos *et al.*, 1999). They control growth of microorganisms by at least two mechanisms: (i) reducing the pH of feeds and digesta and creating negative conditions for microorganism growth; and (ii) entering into the microbial cytoplasm and disrupting the life cycle of the microorganism, especially of the gram positives. According to *in vitro* trials (M. Calvo, pers. comm.) the combination of organic acids with certain types of essential oils obtained from herbal extracts had a synergistic effect on control of most bacterial growth, including salmonellas, *E. coli*, coliforms, *enterococcus, staphylococcus*, and *clostridium.*

Exogenous enzymes are widely used in poultry and pig diets under a wide range of situations and feeding strategies. Plant polysaccharides and phytic acid are major components of animal feedstuffs and exert and anti-nutritive effect in the diet, especially in young animals (Williams, 1997). Non starch polysaccharides, mostly beta-glucanes and xylans (NSP) present in viscous cereals (barley, wheat, rye, etc.) pass through the gut of monogastrics largely untouched affecting digesta viscosity (in the case of the avians) and gut microflora growth. Exogenous enzymes improve nutrient digestibility and decrease the incidence of wet litter in broilers and in turkeys, dirty eggs in laying and breeder hens and also improve consistency of feces in pigs. Although at a lower extent, exogenous amylase improves also the digestibility of dietary starch both in broilers and in piglets (Ankrah *et al.*, 1999; C. Piñeiro *et al.*, pers. comm.).

For many years Zinc as ZnO has been used for prevention of postweaning diarrhoea in piglets in the Scandinavian countries. The recommended dose is of 2000 to 4000 p.p.m. (Goransson, 1997). Trials conducted by us under experimental and practical conditions have consistently demonstrated that ZnO at 3000 p.p.m. is very effective in reducing incidence of diarrhoea in post-weaning piglets but no effect has been detected in broilers or in rabbits. The positive results were more pronounced in non-medicated than in medicated animals (Table 2). However, Zn has to be considered as a potential environmental pollutant and therefore, its use in animal feeding must be controlled and restricted.

Conclusions

Feed formulation for intensive poultry and livestock will need adaptation to market changes. The ban of in feed antibiotics growth promoters will require changes in management, feeding programs and nutrient requirements. The use of additives such as exogenous enzymes, organic acids, immunity, enhancers, and others will increase but more research is needed to improve its acceptance by the animal feed industry.

Table 2. Use of ZnO in diets for piglets (21 to 45 d). Percentage of improvement (unpublished data)

	Number of trials	With antibiotic		Without antibiotic	
		ADG†	FC††	ADG	FC
Experimental farm	2	3	3	6	4
Field conditions	4	2	4	7	6

†ADG = Average daily gain.
††FC = Feed conversion.

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