FEED SUPPLEMENTS VIS-À-VIS SAFE FOOD THROUGH ANIMAL HUSBANDRY: A REVIEW

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ABSTRACT

The aim of this article is to review the literature on producing the animals and animal products free from diseases producing organisms by using various kinds of feed supplements. Recent outbreaks of food-borne diseases highlight the need for reducing microbial pathogens in the foods of animal origin. Animal enteric pathogens are a direct source for food contamination. The safe dose of feed additives provides resistance against many diseases like Coccidiosis, Salmonellosis and vibriosis etc. also decrease the resistance of diseases in animals infected with Escherichia coli O157:H7 and Salmonella. The role of supplementation of ionophore, antibiotics, organic acids, plant secondary metabolites, essential oils, probiotics etc are discussed for safe animal production. In this way it is found that the uses of feed supplement have not only improved the productivity of animals; produces animals and animal products free from any kind of infestatious and infectious diseases.

Key words: Climate change, Food-borne diseases, Feed additives, Food safety.

One of the biggest challenges facing animal sector in the 21st century is to produce safe and traceable foodstuffs of animal origin in sufficient volumes and quality besides the lowest possible load on the environment. A point to consider is how animal feeding and nutrition can contribute to the solution of this challenge. Another question is that the results of which new scientific fields should be used in the area of innovation to achieve the desired product quality. Many minerals (iron, zinc, manganese, selenium and copper), vitamins (carotenoids, vitamins E and C), probiotics and prebiotics have been identified as an important tool for normal immune function and disease resistance in farm animals. Saponins, tannins, essential oils and many other plant secondary metabolites appear to be future potential feed additives to improve production in animal production system. Food safety is now universally recognized as a public health priority. It requires a global approach, from production to consumption. This article addresses the first stage of the food chain & the steps show that the farmers can take precautions to optimize the food safety control of products of animal origin. This inevitably means controlling the health status of the animals from which food products are derived.

The present article addresses all those hazards which control at farm level can have a beneficial or even decisive effect on the food safety of products of animal origin (eg: milk and milk products, meat and meat products, eggs and egg products). It is divided in eight sections: Probiotics and prebiotics, Sulfonamides, Antibiotics, coccidiostat, Ionophores, Essential oils, Saponins, Mineral mixture and Vitamins in animal feeding for safe food production. However, it is expected that detailed study of feed supplements will bring forth many issues which are important for animal husbandry sector.

Probiotics and prebiotics feeding

Recent outbreaks of food-borne diseases highlight the need for reducing bacterial pathogens in foods of animal origin. Animal enteric pathogens are a direct source for food contamination. Potential combinations of suitable probiotics and prebiotics may prove to be the next step to reduce the risk of intestinal diseases and remove specific microbial disorders.
The intestinal microbiota, epithelium, and immune system provide resistance to enteric pathogens. Recent data suggest that resistance is not solely due to the sum of the components, but that cross-talk between these components is also involved in modulating this resistance. Inhibition of pathogens by the intestinal microbiota has been called bacterial antagonism, bacterial interference, barrier effect, colonization resistance, and competitive exclusion. Consumption of fermented foods has been associated with improved health, and lactic acid bacteria (lactobacilli and bifidobacteria) have been implicated as the causative agents for this improved health (Patterson and Burkholder, 2003). Research over the last century has shown that lactic acid bacteria and certain other microorganisms could increase resistance to disease and that lactic acid bacteria could be enriched in the intestinal tract by feeding specific carbohydrates. Increased bacterial resistance to antibiotics in humans has caused an increase in public and governmental interest in eliminating sub-therapeutic use of antibiotics in livestock. Thus an alternative approach to sub-therapeutic antibiotics in livestock is the use of probiotic microorganisms, prebiotic substrates that enrich certain bacterial populations, or symbiotic combinations of prebiotics and probiotics will be helpful inhibiting the intestinal pathogens. Further Piva et al., 2006; Gaggia et al., 2010) reported that the gastrointestinal tract of growing animals represents a complex and constantly changing milieu; addition of organic acids, prebiotics and probiotics, as well as lowering the dietary buffering capacity and direct feeding of specific nutrients to sustain intestinal mucosa functions, were all strategies that require in-depth investigation. Kukkonen et al. (2008) reported that long term use of probiotic and prebiotics in postnatal feeding to the animal increased the resistances power against various diseases. Some efforts are in progress to assess the advantages of “combo strategies” where, for example, a blend of organic acids could cumulate the effects of the different acids on animal physiology and microbial metabolism, while a symbiotic combination could maximize the efficacy of a prebiotic Nondigestible Oligosaccharide by coupling it with a probiotic strain that can electively ferment it. Science in the post-antibiotic era of animal farming is facing intriguing challenges that will give a successful return by using probiotics and prebiotics.

Sulfonamides feeding

Use of sulfonamides in production of layers is a public health risk since it inevitably results in sulfonamide residues in eggs. The presence of the residues may be influenced by knowledge, attitudes and practices of farmers regarding the use of sulfonamides (and other antimicrobials) in poultry. Sasanya et al. (2005) studied the possible contribution of the knowledge, attitudes and practices of poultry farmers about the levels of sulfonamide residues in hen eggs. In the said context a descriptive cross sectional study was done in the 5 political divisions (and surroundings) of Kampala district of Uganda. Each farmer provided sixty eggs for analysis of sulfadiazine and sulfamethazine residues. Ninety-five percent of the farmers never observed withdrawal periods although 80% of them knew the importance of withdrawal periods. While 98.3% of the samples that had detectable sulfonamide residues came from farmers who applied antimicrobials in feeds/water. Consumers of hen eggs in Kampala district are at high risk of sulfonamide residue exposure due to poor farming/ regulatory practices which is not good from food safety point of views. Latter Fang et al. (2006) reported that the sulfonamides have been widely used as effective chemotherapeutics and growth promoters in animal feeding, but their residues could be a potential danger to human health due to their carcinogenic potency and possible antibiotic resistance. Development of a simple and sensitive method for the determination of sulfonamides residues in food of animal origin is of great significance. The method was applied to determine the trace sulfadiazine, sulfamerazine, sulfadimidine, sulfathiazole, sulfamoxol, sulfamethizole, sulfamethoxypyridazine, sulfachlorpyridazine, sulfadoxin, and sulfisoxazole, in eggs and pork. Thus continuous use of sulfonamides in animal feed could be hazardous to human as well as animal health because of their carcinogenic potency.

Antibiotic feeding

There is a worldwide concern about the quality of life and one of the most important requirements is to ingest safe and nutritious food. The administration of antibiotics in different kind of
livestocks are being used to treat several infectious diseases have contributed to contaminate the various types of animal products. For this purpose Martins et al. (2007) developed a simple and fast method to identify and quantify fourteen antibiotics from different classes in milk, including five beta-lactams, four sulfonamides, three tetracyclines, one macrolide and one cephalosporin, using reversed-phase liquid chromatography with electrospray ionization and triple quadrupole mass spectrometry (MS/MS). This technique used Multiple Reaction Monitoring (MRM) acquisition mode to allow the determination of the proposed compounds in the concentration range from 0.75 to 375 microg L-1, within coefficient of linearity (r) higher than 0.9960, selectivity, sensitivity, and speed, with analysis time less than 10 minutes. Dicloxacillin and erythromycin showed the lower and higher decision limits (cc alpha) results of 0.05 and 9.77 micro g L-1, respectively. Overall, the recoveries results ranged from 65 to 125%, with standard deviation values from 2.0 to 15%. This method was also applied to evaluate the quality of different fat milk brands offered in the Brazilian market. Further Watanabe et al. (2010) investigate that the use and occurrence of antibiotics in dairy concentrated animal feeding operations (CAFOs) and their potential transport into first-encountered groundwater. On two dairies they conducted four seasonal sampling campaigns, each across 13 animal production and waste management systems and associated environmental pathways; application to animals, excretion to surfaces, manure collection systems, soils, and shallow groundwater. Concentrations of antibiotics were determined using on line solid phase extraction (OLSPE) and liquid chromatography-tandem mass spectrometry (LC/MS/MS) with electrospray ionization (ESI) for water samples, and accelerated solvent extraction (ASE) LC/MS/MS with ESI for solid samples. A variety of antibiotics were applied at both farms leading to antibiotics excretion of several hundred grams per farm per day. Sulfonamides, tetracyclines, and their epimers/isomers, and lincomycin were most frequently detected. Yet, despite decades of use, antibiotic occurrence appeared constrained to within farm boundaries. The most frequent antibiotic 159 detections were associated with lagoons, hospital pens, and calf hutches. When detected below ground, tetracyclines were mainly found in soils, whereas sulfonamides were found in shallow groundwater reflecting key differences in their physicochemical properties. In manure lagoons, 10 compounds were detected including tetracyclines and trimethoprim. Of these 10, sulfadimethoxine, sulfamethazine, and lincomycin were found in shallow groundwater directly downgradient from the lagoons. Antibiotics were sporadically detected in field surface samples on fields with manure applications, but not in underlying sandy soils. Sulfadimethoxine and sulfamethazine were detected in shallow groundwater near field flood irrigation gates, but at highly attenuated levels. As such food and vegetable crops grown on such type of soil contaminated with antibiotics being used by the animal and mankind could be harmful.

**Coccidiostat Feeding**

European Commission asked the European Food Safety Authority to deliver an opinion on the safety and efficacy of AvatecReg.150G (containing 15 lasalocid sodium as active substance), a coccidiostat is being used in turkeys for fattening up to an age of 16 weeks, @ of 75-125 mg (lasalocid sodium) per kg of feed. Lasalocid sodium from AvatecReg. 150G was considered safe for turkeys for fattening at the maximum dose applied (125 mg/kg complete feed) up to 16 weeks of age. A margin of safety could not be determined. Lasalocid sodium may be dangerous for equine species and its simultaneous use with certain medicinal substances could be contra-indicated in turkeys, as it is in chickens for fattening. The additional data provided on the metabolic fate of lasalocid sodium in chickens and rats gave sufficient evidence to the Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) viewed on the similarity of metabolic pathways in chickens, turkeys and rats. Unchanged lasalocid A is the marker residue. In the absence of new data, the FEEDAP Panel reiterated its former views that lasalocid sodium is not genotoxic, carcinogenic or teratogenic. A lowest no-observed-adverse-effect-level (NOAEL) of 0.5 mg/kg BW/day was established from the two-year chronic oral toxicity study in rats and maternal toxicity study in rabbits. A toxicological ADI of 0.005 mg/kg/person/day (or 0.3 mg/60 kg person/day) was derived applying a safety factor of 100. Consumer
exposure after a one-day withdrawal period complied with the ADI. Considering the slower decline of residues in kidney and skin/fat compared to liver and the inherent variation of data, the FEEDAP Panel found that a five-day withdrawal period is appropriate to ensure compliance with the MRLs already in force in the EU. In the absence of new data, the FEEDAP Panel reiterated its former views that it is unlikely that lasalocid sodium from AvatecReg. 150G would pose a risk to the user/worker handling the additive. The FEEDAP Panel could not identify a safety concern for the environment resulting from the use of AvatecReg. 2 150G in turkeys, at the maximum recommended feed concentration. The FEEDAP Panel considered that AvatecReg. 150G is effective in controlling coccidiosis in turkeys at a minimum dose of 75 mg lasalocid A sodium/kg complete feed. The FEEDAP Panel made some recommendations concerning the antimicrobial and Eimeria resistance monitoring. Coccidiosis is a major threat to the poultry industry. It often manifests in the form of outbreaks in young birds, inspite of availability of a wide range of coccidiostats. The European Parliament has issued directives to phase out coccidiostats and histomonostats as feed additive from the market (ACAF, 2007). This has intensified search for safe coccidiostats worldwide. Further Waskar et al. (2011) has evaluated the effect of coccihar (Ayurved Ltd., India), a poly herbal coccidiostat feed additive on meat attributes of chicken broilers, which has been successfully tested earlier as a promoter of growth, survivability, and feed conversion efficiency in chicken. The meat attributes of 50 unsexed day old broiler chickens were studied in this experiment, under two feeding regimen viz., basal (control) and experimental (supplemented with coccihar @ 2 kg/tonne of feed) diets for a period of six weeks. The birds on coccihar supplemented diet had significantly (P<0.05) higher carcass yield, dressing percentage, fillet yield, tender yield, and giblet weight than the control. The sensory qualities of cooked meat (breast fillets and tenders) evaluated on an eight point hedonic scale revealed significant (P<0.05) improvement in appearance, colour, odour, juiciness, texture, tenderness, and palatability of meat in the experimental group over the control. The chemical composition (moisture, protein, fat) was similar in both the groups. Latter in said context Koffogran (containing 25% nicarbazin) is intended to be used as a coccidiostat for chickens for fattening up to an age of 28 days. Feeding 125 mg nicarbazin/kg feed was safe for chickens for fattening (margin of safety about 1.5) and effective in controlling coccidiosis. Ingested nicarbazin is rapidly split into its components 2-hydroxy-4, 6- dimethylpyrimidine (HDP) and 4,4’-dinitrocarbanilide (DNC). DNC is the marker residue and liver is the target tissue. HDP-related residues are much lower than those derived from DNC. Nicarbazin is not genotoxic. In sub-chronic rat studies, no NOAEL could be derived for nicarbazin, but a NOAEL of 709 mg/kg BW/day was identified for DNC. Those differences may be related to the higher systemic exposure of rats to DNC when administered as nicarbazin instead of DNC alone. No major concern appeared in multigeneration reproduction studies in rats at 300 mg DNC+100 mg HDP/kg BW/day and in developmental studies with rats and rabbits at 70 and 60 mg nicarbazin/kg BW, respectively. Nicarbazin was not an irritant or sensitisier to skin, but a slight irritant to eyes. Inhalatory exposure of users to nicarbazin was negligibly small. No safety concern for the soil compartment, groundwater or by secondary poisoning was identified, the risk for surface water could however not be assessed. The conventional coccidiostats, used as feed supplements, produce harmful side effects, and the drug residues are potential public health hazards. **Ionophores feeding** The therapeutic use of ionophores in veterinary medicine has grown in the last years, with resultant increase in the risk of poisoning in animals. Ionophores are used as food additives as coccidiostats in several animal species and growth promoter and bloat prevention in ruminants. The most often used ionophores are monensin, lasalocid, narasin and salinomycin. There is a great variation in the susceptibility to the toxic effect of ionophores in different animal species. Poisoning can occur when the dosage is too high or when not correct doses for a certain animal species are given. Cases of poisoning have been described in sheep, swine, horses, dogs and poultry. For horses ionophores are extremely toxic (Nogueira et al., 2009). The use of ionophores is only safe when used appropriately to the instructions of the manufacturer and especially for each animal species. Further Edrington et al.
(2003) had evaluated the effects of short-term feeding of ionophores on fecal shedding, intestinal concentrations, and antimicrobial susceptibility of *E. coli* O157:H7 and *S. typhimurium* in growing lambs. Sixteen lambs were used and divided in four groups (Monensin, Laidomycin Propionate, Bambermycin and control) in each experiment. Lambs were fed a grain and hay (50:50) diet with their respective ionophore for 12 d before experimental inoculation with *E. coli* O157:H7 or *S. typhimurium*. Animals were maintained on their respective diets an additional 12 d, and fecal shedding of inoculated pathogens was monitored daily. Lambs were killed and tissues and contents were sampled from the rumen, cecum, and rectum. No differences (P>0.05) in fecal shedding of *Salmonella* or *E. coli* O157:H7 were observed due to treatment. Occurrence of *Salmonella* or *E. coli* in luminal contents and tissue samples from the rumen, cecum, and rectum did not differ among treatments. Feeding monensin decreased (P<0.05) the incidence of occurs in sheep infected with *Salmonella* compared with the other treatments. No differences in antimicrobial susceptibility were found in any of *Salmonella* or *E. coli* O157:H7 isolates.

**Essential oils feeding**

Mixture of essential oils tested on cultures of rumen bacteria (*Clostridium aminophilum*, *Clostridium Sticklandii* and *Peptostreptococcus anaerobius*) which are known for their major role in the fermentation of amino acids into ammonia in the rumen. Reducing the degradation of amino acids by rumen bacteria is beneficial for ruminants as it increases the supply of amino acids to the small intestine, which has a positive impact on the production of milk and the secretion of milk proteins (Benchaar, 2005). It also causes a reduction in the amount of nitrogen excreted in cow urine, thus reducing environmental pollution. The significant antimicrobial effects of several essential oils and essential oil compounds against enteropathogenic organisms in farm animals. Proeien proliferative enteropathy caused by specific *Escherichia coli* strains could be controlled by carvacrol-rich essential oils, and the effect of some essential oil components against *Clostridium perfringens* and necrotic enteritis was confirmed in poultry. In ruminants, an improvement of the digestion was observed, resulting in reduced methanogenesis and nitrogen excretion (Franz et al., 2010). In addition, the antioxidative activity of aromatic plants and essential oil compounds contributes to the stability and palatability of animal feeds. Moreover, resulted in an improved shelf-life and quality of animal products, due to reduced oxidation. The 'growth promoting effect' of essential oils is not as evident, since a large number of publications are (commercial) product-driven, lacking data on the starting material.

**Saponins feeding**

Pen et al. (2008) studied the effects of *Quillaja saponaria* (QS) with or without *Yucca schidigera* extract (YS) on *in vitro* ruminal fermentation and methanogenesis. The culture media consisted of 400 ml of strained rumen fluid collected from two non-lactating Holstein cows and 400 ml of artificial saliva. The culture media was anaerobically incubated with 10 g of a mixture of concentrate and oat hay (1:1, w/w) at 39 degrees C for 24 h. The treatments were arranged as 2x3 factorial design experiment consisting of three levels of QS (0, 2 or 4 ml/litre) and two levels of YS (0 or 2 ml/litre). Treatment interactions between QS and YS were observed for pH and ammonia N concentration. CH4 production was not modified by addition of QS but decreased when added with YS. Addition of QS with YS increased propionate concentrations. Protozoa numbers were decreased by QS addition alone or with YS. Results show that QS and YS exhibited strong antiprotozoal effects and combinations of both plant extracts may have potential as safe manipulators of ruminal fermentation. Likewise Li Ting et al. (2010) observed the effects of food tannin and saponin on diet selection of mice (*Mus musculus domesticus*) by using natural seeds and artificial feed with different amount of tannin or saponin. They also investigated the effects of feeding experiences on diet selection. The results showed that; (1) regardless of feeding experiences, mice preferred to consume more seeds with lower tannin (i.e. *Castanea henryi*) or saponin (i.e. *Arachis hypogaea*) over those with high tannin (i.e. *Quercus variabilis*) or saponin (i.e. *Camelia oleifera*); (2) feeding experiences for mice could enhance its ability to identify tannin or saponin levels in seeds, resulting in less feed intake; and (3) feed
intake of mice significantly decreased with the increase of feed tannin or saponin level.

Mineral mixture and vitamins feeding

Plant and mineral feedstuffs contribute to the available P content of the diet depending on their respective availability. The P content in body weight gain is 5.0-5.5 g/kg in young ducks, and it probably decreases with age. The ratio of Ca to P in body weight gain is about 1.8:1. Inevitable P losses are not yet quantified and can only be estimated to account for 1 g/kg of feed intake. Availability of P from plant-based diets without P supplements and phytase ranged between 28 and 49%. Availability of P from different mineral sources ranged between 77 and 100%. Microbial phytases were efficient in improving the availability of P from plant-based diets. The most efficient tool for reducing the use of P sources is the frequent adjustment of the dietary P content during the growth period. Data from growth studies indicate that the suggestions made herein are sufficiently safe for application in Pekin duck feeding (Rodehutscord, 2006). Further Ashok and Chaudhary (2008) evaluated that the effect of supplementation of monensin @ of 25 mg/kg of concentrated mixture and tocopheryl acetate (Vitamin E) @ 160 mg/kg in ration of Barbari kids on body weight gain was studied for 170 days. Monensin supplementation tended to increase average daily weight gain (54.90+or-3.51 g/h/d) significantly and lowest recorded in Vitamin E supplemented group. Serum glucose levels were consistently increased significantly in monensin supplemented kids, exhibiting positive glucogenic effect. Other haemato-biochemical parameters in feeding trial were within normal limit. Monensin supplementation showed protein-sparing effect. None of the animal fed with mineral and vitamins supplements showed any untoward and adverse reaction; may be considered safe.

CONCLUSION

Lastly a conclusion has been reached prolonged use of various kinds of feed supplements like, Sulfonamides, Antibiotics, Coccidiostat, Ionophores, Essential Oils and Saponins, in animal feeding have shown adverse effect while Probiotics & prebiotics and Minerals & Vitamins shown beneficial effects on animals and animal products as well. Thus for safe food production form animals the prolonged use of synthetic feed supplements is deleterious to the animals and consumers as well.

REFERENCES

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