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Review article

Plant-food by-products to improve farm-animal health

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ABSTRACT

Livestock health is a worldwide issue because of the expected rise in meat demand in the coming years, with a consequent intensification of animal-production systems. As these systems extensively administer antibiotics, use is expected to increase sharply in the near future. Such use leads to resistance to these treatments, posing a serious threat to animal health throughout the world. This problem of farm-animal health can be alleviated by the use of natural alternatives, such as providing plant by-products as feed complements, which contain suitable concentrations of antimicrobial and health-promoting agents. This review describes and analyses the still limited research on the use of plant-food by-products to feed farm animals to bolster health. Future actions needed to improve knowledge for avoiding antibiotic resistance in animal rearing are also outlined. The by-products reviewed influence microbiological changes, reducing ileal coliform counts and improving small-intestinal indicator microbes, as well as having positive effects on the farm-animal immunology. Also, blood glucose, urea, creatinine, triglycerides, cholesterol, and cortisol concentrations usually decrease after the intake of plant-food by-products. Furthermore, some of these by-products cause significant up-regulation of several genes, while the antioxidant activity in muscle increase. Cottonseed meal, green tea, apple- and red-wine pomace have been the most thoroughly tested plant-food by-products.

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1. Introduction

Livestock health is a fundamental issue worldwide. Today, the world population is predicted to become gradually more urbanized (Gerland et al., 2014), and thus the demand of meat is expected to rise in the coming years. This will place a heavier strain on livestock systems, demanding an intensification of animal raising and thereby resulting in denser animal populations in those systems. This in turn will require animal diets using concentrated feeds, indoor housing, and the use of more or less specialized breeds. Such animals will be grown in areas having easy access to transport and processing systems (Rushton, 2015). Even today, due to the extreme crowded conditions and consequent poor hygiene, the health and growth of animals is promoted by the extensive use of antibiotics and this practice is expected to expand rapidly in the near future (Van Boeckel et al., 2015).

The abusive application of antibiotics leads to resistance, which is a critical public-health challenge, and thus this general trend towards excessive use of antimicrobial agents in food animals needs greater regulatory efforts (Landers et al., 2012; WHO, 2012). An integrated way of addressing this problem is by emphasizing the connections between the health of humans, animals, and the environment, thus, fomenting the collaboration across multiple professionals, including doctors, veterinarians, food-safety professionals, and environmental-health experts (So Ad Shah et al., 2015).

Animals fed plant-food by-products (PFBP) or freely grazing in the field do not require this improper use of antibiotics. This result has two important reasons: i) free-range animals have better hygiene conditions and the transmission of pathogens is not favoured by overcrowding; ii) such animals consume plant foods or PFBP, which are rich in bioactive compounds and thus help prevent and protect against various diseases.

In most cases, livestock feed is formulated using nutrients to provide an adequate profile at minimum cost. Such formulations are designed from previous research and field experience in order to avoid deficiency symptoms and to be cost effective. Feed formulation is usually intended to improve body weight, feed-conversion efficiency, protein accretion, milk production or egg production, all these features being inherent to healthy animals. However, the criteria used to formulate animal feeds are focused on the productivity, rather than in maintaining animal health (Makkar and Ankers, 2014). Therefore, reasonable strategies to improve farm-animal health lies with the use of natural products from PFBP, which contain suitable concentrations of plant-derived compounds with antimicrobial and health enhancing properties.

2. Occurrence of health-promoting agents in PFBPs

Several secondary metabolites are usually present in PFBPs, which have been shown to offer specific health benefits, for instance alkaloids, essential oils, glycosides, phenolics, tannins, peptides and saponins.

2.1. Alkaloids

Highly aromatic planar quaternary alkaloids have action mechanisms attributed to their ability to intercalate with DNA (Cowan, 1999), and alkaloids from pepper (*Capsicum annuum*) have been successfully tested against pathogenic bacteria, such as *Staphylococcus aureus*, *Bacillus subtilis*, and *Escherichia coli* (Wei et al., 2006). However, the bitter taste of alkaloids leads to a negative selection by animals when such compounds exceed a threshold concentration.

2.2. Essential oils

These display high activity for food-borne pathogen inhibition. Mango peels, a typical by-product from mango crops, contain these oils at high concentrations. The essential oil of this PFBP is rich in terpene hydrocarbons, which are not only active against Gram-positive and Gram-negative bacteria, but also display significant antifungal properties (El-Hawary and Rabeh, 2014). These compounds display high antibacterial activity against pathogens, and contain mainly phenolic compounds such as carvacrol, eugenol, and thymol (Lambert et al., 2001; Burt, 2004).

2.3. Glycosides

Glycosides are a class of molecules in which a sugar molecule is bonded to a non-sugar molecule. Among these, the hydrolysis products of glucosinolates have been evaluated as antimicrobial agents in Gram-positive and Gram-negative