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Phytogenics in livestock feeding- a potential alternative to antibiotics in promoting good health and production

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ABSTRACT

Phytogenics are bioactive compounds having natural growth promoters or non-antibiotic growth promoters derived from herbs, spices or other plants. With the ban of use of antibiotics in animal feed as growth promoters, there is a need to have alternative strategy to promote growth and health of animals. Plant derived feed additives can facilitate digestibility and in turn positively influence feed efficiency and growth. Also, the antimicrobial and antioxidant properties of phytogenics from essential oils, saponins, flavonoids, tannins etc. promote health thereby enhancing its beneficial effects.

1. Introduction

In livestock production, antibiotics are generally used as growth promoters to ensure good animal health, productivity and profitability. But with the realisation of increasing antimicrobial resistance by pathogens leading to the limitation in the treatment of infectious diseases, the use of antibiotics as growth promoters or prophylactics in healthy animals need to be restricted. According to the World Health Organization (WHO), overuse and misuse of antibiotics in animals contribute to the rising threat of antibiotic resistance (Carolien, 2019). In 2006, the EU imposed a ban on their use as antimicrobial growth promoters (Anadon, 2006) and in 2015, the World Health Assembly endorsed a global action plan to tackle antimicrobial resistance including systematic misuse and overuse of these drugs and released guidelines in 2017 to end giving antibiotics routinely to healthy animals (WHO, 2015 and 2017). Numerous alternative strategies have since been tested to control and reduce disease incidence. One such strategy is the use of phytogenic feed additives (PFAs). These natural plant-derived actives have proven antioxidant, anti-inflammatory and antibacterial effects.

The term phytogenic feed additive was coined by Delacon, an Austrian multinational feed additives company and was first introduced to the market in the 1980s (Sandra, 2019). The spectrum of phytogenic feed additives is vast and includes essential oils, pungent substances, bitter substances, saponins, flavonoids, mucilages and tannins obtained from spices, herbs and other plants (Industry Voice, 2017; Delacon, 2020). This review presents some of the research findings concerning the potential of phytogenic feed additives to promote growth and health in livestock and poultry.

2. Phytogenic in growth promotion

Phytogenic compounds have the potential to increase feed intake by improving the palatability of diet resulting from the enhanced flavour and odour, especially with the use of essential oils (Kroismay *et al.,* 2006). However improving feed palatability is not applied to poultry because the birds are not sensitive to odour, although phytogenic compounds have been widely used in poultry diets with positive results in growth performance (Bernes and Roura 2010; Cerisuelo *et al.,* 2014; Khattak *et al.,* 2014) and phytogenic feed additives can be substituted for antibiotic growth promoters in poultry diet (Murugesan *et al.,* 2015). Adding phytogenic feed additives to animal diets at recommended levels improved animal nutrition and growth (Zentek *et al.,* 2011; Biomin, 2018). It increased body weight gain while lowering the feed conversion ratio in broilers and improved feed efficiency (Agostini *et al.*, 2012).

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Though in pig, the reported effect of supplemented essential oils in diets on feed intake is highly variable (Neill *et al.,* 2006; Stelter *et al.,* 2013; Zeng *et al.,* 2015), compounds such as caraway oil, lemon oil, dried herbs and spices have the potential to improve the growth rate of weaned piglet (EFSA, 2011). The benefits of PFAs in piglet diets to alleviate negative consequences in weaned piglets were shown with caraway and lemon essential oils as key ingredients. The result demonstrated an increased body weight at the end of the nursery period by 3.4% and average daily weight gain by 5.3% while feed efficiency was improved by 2% (Kostas *et al.,* 2016). It has been suggested that the observed increase in feed palatability associated with the addition of essential oils could be due to their antioxidative effects, which contribute to preserving the qualities of feed and preventing the release of unfavourable odours (Franz *et al.*, 2010; Sola-Oriol *et al.,* 2011).

3. Digestibility enhancement and effect on ammonia emissions

Some PFAs can increase sensorial stimulation and feed palatability and enhance piglet feed intake by 4% (Kostas *et al.,* 2016) but in addition to adequate feed intake, feed digestion and nutrient absorption is vital to support a piglet's growth. Several studies with the additives showed an improved crude protein digestibility between 3% and 9% during the post-weaning period (Kostas *et al.,* 2016; Sandra, 2019). Intestinal permeability of nutrients depends on the activity of specific transporters. Increasing the activity of those transporters enhances the capacity of the intestine to absorb nutrients. It was shown that intestinal epithelium of piglets fed with the phytogenic product had increased glucose transport capacity by 28% as compared to a control diet (Kostas *et al.,* 2016). Feeding the weaned piglet with capsicum oleoresin, garlic botanical and turmeric oleoresin enhances the gut mucosa health (Liu *et al.,* 2014). Certain compounds, such as saponins, have shown potential to reduce ammonia emissions of animals by inhibiting urease activity that converts urea in ammonia and carbon dioxide (Veit *et al.,* 2011). The addition of saponin containing Yucca schidigera extract to the diet of nursery pigs reduced the aerial ammonia concentration in the room (Colina *et al.,* 2001). The use of phytogenic products with additional saponins reduce ammonia emissions up to 26% throughout the pig's life cycle (Delacon, 2018) thereby turning beneficial to both the pigs and farmers. This is important in ecohealth aspect as well since it will help in reducing greenhouse gas emissions.

4. Antimicrobial effects

Many essential oils like rosemary, sage, oregano, thyme, clove, and lemongrass have shown antimicrobial properties, by directly killing the bacteria such as E. coli, Salmonella Typhimurium, Staphylococcus aureus and Listeria monocytogenes (Burt, 2004). However, the required concentrations are fairly high. On the other hand, much lower concentrations are effective to disturb the bacterial communication or quorum sensing which is responsible for expression of virulence factors, adhesion, and toxin and biofilm production in pathogenic bacteria. (Khan *et al.,* 2009; Mith *et al.*, 2015). It was also demonstrated that E. coli adhesion to intestinal cells in piglets fed with the phytogenic product was reduced by 50% compared to the control (Gartner *et al.,* 2010). Quorum sensing inhibition is used as a possible method to treat bacterial disorders in farm animals (Aumiller *et al.,* 2017). Oregano essential oil and carvacrol inhibit the expression of virulence associated genes (ler, fliC and shiga toxin) in enterohaemorrhagic Escherichia coli O157:H7. It also decreases luxS gene transcription involved in quorum sensing (Mith *et al.,* 2015) and thus having the potential to mitigate adverse health effects through the use of these substances.

5. Antioxidant activity

Many different PFAs have antioxidant and or anti-inflammatory properties to support the immune system of the host, either directly by radical scavenging activity or indirectly by upregulating antioxidant gene expression and anti-inflammatory enzymes. It has been shown to manipulate the Nrf2 and NF-κB transcription factors to provide oxidative stress defense and suppress inflammation (Gessner *et al.,* 2013; Fiesel *et al.,* 2014). Several studies have demonstrated that phytochemicals including curcumin (Shehzad *et al.,* 2011), caffeic acid (Lee *et al.,* 2010), epicatechin (Bahia et al., 2008), grape seed extract (Gessner *et al.,* 2013), cinnamaldehyde (Wondrak *et al.,* 2010) and anthocyanins (Hwang *et al.,* 2011) increased the expression or translocation of Nrf2 and reduced or inhibited the activation of NF-κB, suggesting that phytogenic compounds can protect against oxidative stress and reduce inflammation, and eventually lead to the improvement of animal health and growth performance (Yang *et al.,* 2015). Limonene, the main active substance of lemon oil was shown to reduce leukocytes and pro-inflammatory cytokines such as tumour necrosis factor α (TNF-a) after an induced acute inflammation (Kostas *et al.*, 2015). Feed

Supple-mentation with essential oils from oregano, rosemary and thyme increased the antioxidant capacity in the jejunum

and liver of piglets and that PFA can improve the defense against microbial and feed derived toxic substances (Aumiller *et al.,* 2017). Feeding the weaned piglets with caraway and lemon essential oils revealed an increase of the antioxidant enzymes glutathione peroxidase and superoxide dismutase and decreased lipid peroxidation in blood plasma when compared to an unsupplemented control feed (Kostas *et al.,* 2016).

6. Conclusion

To have healthy animals performing at their best, phytogenics are likely to be a valuable alternative to antibiotic based growth promoters. The feedback of 758 agribusiness professionals surveyed within the framework of the Phytogenic Feed Additives Survey by Biomin indicated the antimicrobial effect, digestibility enhancement and growth promotion as their reasons for applying phytogenic feed additives to farm animal diets. As the feed costs of the grower-finisher phase account for up to 70% of the total production costs, improving feed digestibility and feed conversion ratio will increase profitability. Phytogenics can increase feed digestibility. Moreover, the antioxidant and anti-microbial properties of phytogenics support the animal to combat some common stressful situations. Some phytogenics have shown the ability to reduce ammonia formation Thus, the negative impact of ammonia emissions on the environment and the noxious effect on animals and workers can also be reduced. It is also imperative to work on screening and evaluation of the locally available spices, herbs and other plants having the potential to be use as feed additives in livestock production that benefit the farmers in producing healthy animals

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