THE OPPORTUNITY OF VETIVER GRASS AS A FEED ADDITIVE

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Abstract

Most of the antimicrobial drugs have several limitations such as low potency, poor solubility, emergence of resistant strains, and drug toxicity and as such have to be phased out with time. Antibiotic growth promoters in the poultry industry have been banned because of harmful effects on human health that were observed by the development of microbial resistance to these products. Several alternatives to antibiotic growth promoters have been proposed such as herbs and herbal products. The detection of an antioxidant property in *Chrysopogon zizanioides* indicates that it could be used in feed supplements as well. Use of these additive supplements in the diet of broilers enhanced nutrient utilization, growth and feed efficiency. Also essentials oils are generally recognized as safe when used as flavoring agents for consumption by human and animals. Vetiver oil has also been reported to high antibacterial activity against drug resistant strains of *E. coli.* There is increasing interest in using natural products including secondary plant metabolites or their nature-identical chemicals that do not pose a public health hazard as feed additives, to solve problems in animal nutrition and livestock production and in the future human diet. Young vetiver was found to have relatively higher structural carbohydrates as compared to native grass and rice straw. It is reported to have edible herbage of high quality for cattle and goats particularly in during the growing stage.Vetiver may be used as ruminant feed if it is mixed with other good quality feed and forages. Ensiling vetiver with cassava peel enhanced the acceptability by goats. Vetiver has good a potential as a feed additive and it seems potentially suitable for poultry and ruminants.

Keywords: Feed additive, Livestock feed, *Chrysopogon zizanioides*

Introduction

Vetiveria zizanioides (L.) Nash recently reclassified as *Chrysopogon zizanioides* L. Roberty has the common name vetiver grass and belong to the family *Poaceae.* It is a perennial grass with thick fibrous adventitious roots which are aromatic and highly valuable. The genus of vetiveria comprised of 11 species (Rahman *et al*. 1996), and one of them is *Chrysopogon zizanioides* occurs in Indonesia. The generic name, vetiver, is derived from a Tamil word, 'vettiver' which refers to root that is dug up. The specific epithet, *zizanioides*, means by the riverside, reflecting the fact that the plant is commonly found along the waterways (NRC, 1993). *Chrysopogon zizanioides* has some common names such as khas-khas grass (Africa), vetiver (Europe), khus-khus, khas, cus-cus (India), or usar, akar wangi, lara setu (Indonesia), nara wastu (the Malay name)(Skerman and Riveros, 1990; Peterson, 2014). Distribution of *Chrysopogon zizanioides* throughout Africa, India, Burma, Sri Lanka and Southeast Asia (Skerman and Riveros, 1990).

Vetiver has multiple uses, such as forage, thatch and material for roofing, fencing, shedding, firewood and medicinal herbs (Kirtikar and Basu, 1986), soil and water conservation and perfume industry (Bor, 1960). Cultivation of vetiver grass has ecological advantages as it decreases soil erosion and is recommended in conservation studies (Greenfield, 2002). The cultivation of vetiver grass in Garut (West Java, Indonesia) has contributed to 89% of the vetiver grass production in Indonesia (Jariyah and Supangat, 2008). Farmers in East Java, Central Java and West Java plant it as a monoculture or as in polyculture with vegetable, legume crops, etc. However, 87% of the income of vetiver's farmers came from the polyculture system since vetiver is perennial and needs a longer time before harvesting, while other crops are annual and need a shorter time before harvesting. (Rochdiani, 2008).

Vetiver grass has been used for hundred of years as the source of vetiver essential oil , It is found in tropical regions of India, China, Indonesia, Haiti and Reunion Island, who are the world's main vetiver oil producers (Arctander, 1960). A vetiver oil industry has been developed in Indonesia (Indrawanto *et al*., 2008), and the oil is used as a perfume ingredient, in cosmetics, fragnance soaps, an anti-inflammatory agent, as a repellent, and in insecticidal agents (Kadarohman *et al*., 2014). Indonesia is the second largest country in the world after Haiti as a vetiver oil exporter, is now the first exporting country after the earthquake in Haiti in 2010 (Kadarohman *et al*., 2014). Vetiver oil is one of the essential oils produced from the distilation of vetiver roots. In the world market Indonesia's oil is known as 'Java Vetiver Oil' has a strong aroma fixation capacity, and widely used in the perfume industry, cosmetics, aroma therapy and in fragnance soap (Mulyono *et al*. 2012).

It is also used as a relaxant for the nervous system, lowers heart rates, normalizes breathing, has an anti-inflammatory property, controls diabetes and cures certain skin diseases (Chia, 2002). There are bacteria present in the vetiver roots that are actually responsible for the complexity of vetiver essential oil. The plant itself produces compounds that are used as pheromones and hormones. The bacteria transform these compounds into the complex variety of constituents found in vetiver that have insecticidal, antimicrobial, and antioxidant properties (Peterson, 2014). There is increasing interest in the health and wellness benefits of herbs and botanicals. as they might offer natural safeguards against the development of certain conditions and be a putative treatment for some diseases (Martinez *et al*., 2004; Snigdha *et al*., 2013).

Vetiver as Livestock Feed

Vetiver can be used as fodder if it is managed correctly. When managed for a dual purpose - forage and hedgerows - the two uses are complementary since regular cutting of hedgerows encourages tillering producing more forage. The overall productivity of vetiver grass depends on the number of tillers. Considering its high survivability and its high tiller increment capacity a maximum number of tillers can be produced with double tiller planting of vetiver is better than that of single or triple tiller (Moula and Rahman, 2008).

Nutrient contents of vetiver grass correlated highly to growth phase and soil condition. The nutritive value of vetiver in the winter season is lower compared to other seasons. Vetiver grass that grew in on a pig farm was suitable as a ruminant feed resource, with high crude protein content (CP), carotene and lutein (Xu *et al*., 2003). The young vetiver leaves can be ground to feed livestock, but mature leaves cannot be used for such purposes. The older leaves are less palatable for use as fodder (Skerman and Riveros, 1990). In the State of Karnataka, India, vetiver is cut every two weeks for use as fodder (Balasankar *et al*., 2013). In China research showed that fresh and tender vetiver grass was suitable as fodder for cattle, sheep and goats. Vetiver was also reported to be high quality edible herbage for cattle and goats particularly while in the growing stage (Liu and Cheng, 2002). Dry matter (DM) and fiber content increase with age while crude protein (CP) (% N x 6.25), mineral content and non-nutritional components reduced with age (Falola *et al*., 2013a). Vetiver was found to have relatively higher structural carbohydrates as compared to native grass and rice straw. On the other hand, it also had optimal levels of CP, considered to be enough to maximize intake and digestion of vetiver as a forage. Vetiver grass can be used as ruminant feed if it is mixed with other good quality feed and forages (Balasankar *et al*., 2013). Vetiver can be used as livestock feed in fresh and preservative forage forms such as silage or hay. Digestibility of the nutrient content in vetiver grass is shown in Table 1 (Fan and Sauer, 1995). Other research results showed that young vetiver grass ensiled with cassava peels enhanced its acceptability by goats (Falola *et al*., 2013b).

Table 1. Digestibility of nutrient contents in vetiver grass (Fan and Sauer, 1995)

Items	Digestibility (%)
Dry matter	46.09
Energy	29.65
Crude protein	23.15
Ether Extract	28.79
Crude fiber	46.44
Calcium	61.00
Phosphorus	66.60
Nitrogen free extract	36.25

Vetiver grass may also be a promising feed resource because of its various advantages such as high quality, fast growth rate and easy adaptation to the environment as well as being able to bear repetitive mowing without occupying farmland. However, there has been little research done on the application of vetiver grass as feed for ruminants (Liu and Cheng, 2002).

Vetiver as Feed Additive

Most antimicrobial drugs have several limitations such as low potency, poor solubility, emergence of resistant strains, and drug toxicity and they have to be phased out with time (Bisignano *et al*., 1999). For several years, antibiotics (ANT) have been extensively used worldwide as growth promoters in animal feed, particularly in poultry and pig production. However, the use of growth-promoting ANT are decreasing as consumers fear that their use may lead to the emergence of ANT-resistant bacteria that are harmful to humans. Researchers have also demonstrated that the overuse and misuse of one antibiotic can actually lead to bacterial resistance to other antibiotics. Resistant bacteria can travel from the farm in the air or water. They can wind up in the soil when manure is applied to crops, which in turn can end up on fruits and vegetables, and they can be found in meat on retail shelves (Cordova and Kar, 2014). As a result, antibiotic growth promoters in animal feeds especially in the poultry industry have been banned in European countries because of harmful effects on human health due to the evolution of microbial resistance to these products (Knudsen, 2001; Hayes and Jensen, 2003; McCartney, 2002; Greathead, 2003). Several alternatives to antibiotic growth promoters have been proposed, such as organic acids, herbs and herbal products. Herbal and naturally-derived growth promoters from plant sources can be used as a potent replacement of antibiotic growth promoters if used at an optimum level (Banerjee *et al*. 2013).

Herbal feed additives, also called phytobiotics, are commonly defined as plant-derived compounds incorporated into diets to improve the productivity of livestock (Subha, 2013). Within plant-derived feed additives, the content of active subtances in products may vary widely, depending on the plant part used (e.g. seeds, leaf, root or bark), harvesting season, and geographical origin. Medicinal plants as natural feed additives are used in poultry diets to enhance the performance and the immune response of birds (Dibner and Buttin, 2002). The plant-derived and herbal growth promoters supplemented in the diet or added in the drinking water for poultry (broilers and layers) have a promising biological effect on their growth performance by reducing the pathogenic bacteriological load in different parts of the digestive tract and by increasing the villus height in different segments of the small intestine, mainly in the duodenum (Subha, 2013). The plant extracts exhibited considerable antimicrobial activity against tested bacterial and fungal strains (Prajna *et al*., 2013). Natural products play an important role in the pharmaceutical industry, and systematic investigation of natural resources for the discovery of new drug molecules is the primary objective for bioprospection program (Jones *et al*., 2006). These trends have created an industrial demand for ANT replacements such as herbal esential oils (Hertrampf, 2001).

Esential oils (EO) also called volatile or ethereal oils are aromatic oily liquids obtained from plant material (flowers, buds, seeds, leaves, twigs, bark, wood, fruits, and roots). Geranyl acetate, eugenyl acetate, trans-cinnamoldehyde, menthol, carvacrol, thymol, geraniol, eugenol, p-cymene, limonene, ¥-terpinene and carvone are the main components of EO comprising up to 85% of the chemical components (Burt, 2004). Esential oils from *Poaceae* (grass family) can be considered as promising future candidates for food or feed supplements and good sources of natural antioxidants. These properties are also very much needed by the food industry in order to find possible alternatives to synthetic antioxidant preservatives such as butylated hydroxytoluene (BHT) and phenolic compounds (Saleh *et al*., 2010). Vetiver oil has a quite complex chemical composition. Over 150 compounds have been isolated and characterized from vetiver oil so far. A major portion of vetiver oil consists of sesquiterpenoides, hydrocarbons and their oxygenated derivatives.,and screening of the powdered leaves shows the presence of alkaloids, flavonoids, tannins, phenols, terpenoids and saponins (Martinez *et al*., 2004; Snigda *et al*., 2013). Some EO also are known to have strong antimicrobial activity against a wide variety of foodborne pathogens. Essential oils help in the colonization and maintenance of balanced levels of beneficial microbial populations within the gastrointestinal system (Jang *et al*., 2007). Besides antibaterial properties, EO or their isolated components have antifungal (Chao *et al*. 2000), antiviral, antiparasitic, and insecticidal properties (Ramadan and Asker, 2009). Another study on vetiver oil also reported high antibacterial activity against drug resistant strains of *E. coli* (Luqman *et al*., 2005). Vetiver exhibited good antifungal activity at concentrations of about 200 ppm against *Aspergillus fumigatus, Microsporum canis, Trichophyton interdigitale, Trichophyton mentagrophytes, T. interdigitale, T. mentagrophytes, T. rubrum, and Candida albicans* (Peterson, 2014). The beneficial effects of essential oils on animal nutrition include appetite stimulation as well as improvement of endogenous digestive enzyme secretion and immune response activation (Jamroz *et al*., 2003). Supplementing diets with essential oils in poultry layer feed increased the body weight in laying hens (Cabuk *et al*., 2006). EOM (essential oil mixture) has beneficial effects as a dietary supplement on egg production and feed conversion ratio. These results also suggest that supplementing diets with herbal EOM is a viable alternative to growth-promoting ANT in poultry nutrition (Cabuk *et al*., 2014). The detection of an antioxidant property in *Chrysopogon zizanioides* also indicates that it could be used in food and feed supplements and nutraceuticals. There is increasing interest in using natural products including probiotics, prebiotics, enzymes, organic acids and secondary plant metabolites or their nature-identical chemicals, that do not pose a public health hazard, as feed additives to solve problems in animal nutrition and livestock production and in future human diet (Greathead, 2003). Essentials oils are generally recognized as safe in the United States as flavoring agents, for consumption by human and animals (Food and Drug Administration, 2006).

Phytogenic feed additives are plant-derived products used in animal feeding to improve the performance of agricultural livestock. The antioxidant property of many phytogenic compounds may be assumed to contribute to the protection of feed lipids from oxidative damage, such as the antioxidants usually added to diets (e.g., alpha-tocopheryl acetate or butylated hydroxyloluene). Phytogenic feed additives were also reported to stimulate intestinal secretion of mucus in poultry broilers, an effect that was assumed to impair adhesion of pathogens and thus to contribute to stabilizing the microbial eubiosis in the gut of the animals (Jamroz *et al*., 2006). This class of feed additives has recently gained increasing interest, especially for use in swine and poultry (Windisch *et al*., 2008). The principal potential of feed additives containing herbal phenolic compounds to improve the oxidative stability of animal-derived products has been demonstrated for poultry meat (Giannenas *et al*., 2005), rabbit meat (Botsoglou *et al*., 2004), and eggs (Botsoglou *et al*., 2005). Vetiver significantly showed anti-inflammatory and analgesic effects through its anti-oxidant potential (Rahul *et al*., 2013). However, application of phytogenic feed additives to livestock also has to be safe to the animal, the user, the consumer of the animal product, and the environment. There is still a need for a systematic approach to explain the efficacy and mode of action for each type and dose of active compound, as well as its possible interactions with other feed ingredients. Nevertheless, the current experience in feeding such compounds to livestock seems to justify the assumption that phytogenic feed additives may have the potential to promote production performance and productivity, and thus add to the set of nonantibiotic growth promoters, such as organic acids and probiotics.

Conclusion

Young vetiver grass can be used as a ruminant feed in fresh or preservated hay, if it is mixed with other good quality feed and forages. The screening of the vetiver powdered leaves shows the presence of alkaloids, flavonoids, tannins, phenols, terpenoids and saponins.

Vetiver grass also exhibited good antifungal and antibacterial activity. Vetiver oil has a complex chemical composition, and a major portion of the oil consist of sesquiterpenoides, hydrocarbons and their oxygenated derivatives and other phytochemicals. Essential oil from vetiver can be considered as a promising future candidate for feed supplements and a good source of natural antioxidants. Vetiver has a good opportunity to be a feed additive to solve problems in livestock nutrition and production. However, there is still a need for a systematic approach to explain the efficacy and mode of action for each of type and dose of active compounds, as well as its possible interactions with other feed ingredients.

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