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# Some of thyme *(Thymus vulgaris)* properties in ruminant's nutrition

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## ABSTRACT

*Thyme (Thymus vulgaris) is a medicinal herb in the Lamiaceae family, cultivated worldwide for culinary, cosmetic perennial and medical purposes. Beneficial effects of herbal extracts or active substances in animal nutrition may include the stimulation of appetite and feed intake, the improvement of endogenous digestive enzyme secretion, activation of immune response and antibacterial, antiviral, antioxidant and antihelminthic actions. Isoprene derivatives, flavonoids, glucosinolates and other plant metabolites may affect the physiological and chemical function of the digestive tract. The pharmacological action of active plant substances or herbal extracts in humans is well known, but in animal nutrition the number of precise experiments is relatively low. However, objective of this review discussing some of thyme (Thymus vulgaris) properties including antimicrobial, antioxidant, effect on digestion process and* process of methanogenesis in the rumen.

**Key words:** Medical herbs, thyme, herbal extracts, antibacterial, antiviral, antioxidant, digestive tract, ruminant, flavonoids.

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## INTRODUCTION

Feeding ruminants in intensive production systems, especially for dairy production, requires supplies of high levels of energy and protein. Animals are thus fed on rations rich in starch and high quality protein, which are fermented very rapidly. It is well known that the rapid degradation of starch tends to cause ruminal acidosis. The rapid breakdown of dietary protein to ammonia increases nitrogenous excretions rather than contributing directly to the animals´ nutrient requirements. In order to delay ruminal protein degradation, dietary proteins were denatured by treatment with formaldehyde or more controversially, antibiotics were used to suppress the bacterial populations responsible for the rapid protein fermentation. But the use of such compounds has been criticized, as they may leave harmful residues in the food chain and promote the spreading of resistance genes. Antibiotics which had been used as growth promoters in animal feeds, has been banned by European Union's Agricultural ministry since the first of January 2006. It has been considered that, those additives will be replaced by natural

compounds. Plant extracts form dietary protein complexes that also protect them from microbial fermentation. Once they bypass the rumen, the complexes dissociate under the acidic conditions in the abomasum and proteins become available to the host animal. Plant extracts destroy rumen fungi along with the protozoa and have foam-stabilizing properties that may enhance bloat, especially under high protein feeding regimes [1].

It is estimated that there are 250,000 to 500,000 species of plants on Earth. A relatively small percentage (1 to 10%) of these is used as foods by both humans and other animal species [2]. Herbs normally used are picorhiza, garlic, cloves, slippery elm, neem fruit and leaves, sophora flavescens, nutmeg, cinnamon, ginger, peppermint, sage, thyme, mustard and fenugreek [3]. Thyme *(Thymus vulgaris)* is a medicinal herb in the *Lamiaceae* family, cultivated worldwide for culinary, cosmetic perennial and medical purposes. This species has special functions such as antispasmodic, expectorant, antiseptic, antimicrobial and antioxidant [4]. The products of thyme extraction are thyme oil extract which contain approximately 15% essential oil (soluble in alcohol) and the thyme water extract (soluble in water). Essential oil is also extracted from fresh or partially dried flowering tops and the leaves of the plant by water or steam distillation providing a yield of 1.0%. The compounds which comprise the essential oil of *T. vulgaris* have been identified as phenoylic compounds such as tymol (44.4-58.1%), carvacrol (2.4-4.2%) and γ-terpipene (6.9-18.9%). These compounds have strong antibacterial effects and are also found in the extracted water soluble fraction of thyme [5]. The concentrations of two predominant components of thyme essential oils, i.e. thymol and carvacrol have been reported to range from as low as 3% to as high as 60% of total essential oils (Lawrence and Reynolds, 1984) [6]. Volatile oil from thyme (*Thymus vulgaris*) was assessed for antibacterial and antiviral activity as inhibitors of microbial growth [7]. Ground thyme has been shown to inhibit the growth of *S. typhimurium* when added to media. The essential oil of the thyme has been shown to inhibit the growth of the *E. coli* in media [8].

**Predominant components of thyme essential oils**

***Thymol***

Thymol is a monoterpene [5-methyl-2-(1-methyleth-yl) phenol; $C_{10}H_{14}O$] with strong antimicrobial activity against a wide range of gram positive and negative bacteria and is one of the well-researched active components of essential oils. Researchers reported that thymol affected the energy metabolism of two relevant rumen bacteria grown in pure culture: Streptococcus bovis and Selenomonas ruminantium. It reduced methane and lactate concentrations, although at higher doses it also reduced overall nutrient digestion and total VFA production, a clear indication that microbial metabolism was inhibited. Compounds with phenolic structures, such as thymol, are more effective as antimicrobials in comparison with other non-phenolic secondary plant metabolites because of the presence of a hydroxyl group in the phenolic structure. Furthermore, the small molecular weight of thymol allows it to gain access to the cell membrane through the pores of the external wall. The strong and wide spectrum activity against gram positive and gram negative bacteria, the narrow margin of security between an optimal and a toxic dose and the effects reported, which were not always in the desired direction [9]. Evans and Martin (2000) observed that thymol, a primary component of some essential oils, modified the concentration of volatile fatty acids (VFA) *in vitro* incubations of ruminal fluid. When thymol was added to ruminal fluid at the level of 400μg/ml, final pH and acetate to propionate ratio increased but the concentration of methane, acetate, propionate and lactate were decreased [10]. Newbold et al., (2004) investigated the effects of specific blend of essential oil compounds (BEO, Crina Ruminants); (the major components are thymol, guajacol and limonene) on rumen fermentation in sheep. Deamination of amino acids measured *in vitro* in rumen fluid removed from the sheep decreased by 25% ($P<0.05$). However, total VFA and

ammonia concentrations were unaffected [11]. Similarly, other researchers supplemented ruminally fistulated sheep with 100 mg/d of the same BEO and did not observe effects on total VFA concentrations [4]. Thymol is also used as flavoring agents in foods [12].

### *Carvacrol*

Carvacrol, an isomer [2-methyl-5-(1-methylethyl) phenol; $C_6H_3CH_3(OH)(C_3H_7)$] of thymol, is found in essential oils isolated from oregano, thyme, marjoram, and summer savory [9,12].

### Antimicrobial properties

Minimum inhibitory concentration (MIC, ppm) of carvacrol, cinnamaldehyde and thymol has shown in Table 1. Some of the simplest bioactive phytochemicals consist of a single substituted phenolic ring. Cinnamic and caffeic acids are common representatives of a wide group of phenylpropane-derived compounds which are in the highest oxidation state. The common herb thyme contains caffeic acid, which is effective against viruses, bacteria, and fungi [2]. Carvacrol kills pathogenic microorganism by disintegrating their cytoplasms, and also prevents an increase in plasma triglyceride and cholesterol [5].

**Table 1: Minimum inhibitory concentration (MIC, ppm) of carvacrol, cinnamaldehyde and thymol [12]**

| *Microorganisms* | Carvacrol | Cinnama-ldehyde | Thymol |
|---|---|---|---|
| *Escherichia coli* | 450 | 396 | 450 |
| *Escherichia coli* | 225 | NT | 225 |
| *Staphylococcus aureus* | 450 | NT | 225 |
| *Candida albicans* | 150 | NT | 150 |
| *Candida albicans* | 113 | NT | 113 |
| *Candida albicans* | 200 | 200 | NT |
| *Pseudomonas aeruginosa* | 500 | NT | 500 |
| *Pseudomonas aeruginosa* | >900 | NT | >900 |
| *Salmonella typhimurium* | 150 | 396 | 150 |
| *Salmonella typhimurium* | 225 | NT | 56 |
| *Streptococcus mutans* | 125 | 250 | 250 |
| *Streptococcus mitis* | 125 | 125 | 125 |

NT: not tested.

### Antioxidant properties

Oxygen is one of the most important elements for life, growth and metabolism of living organisms. Autooxidation process results in the destruction of important molecules in diet formulations and also damages cellular tissues in living organisms. Therefore, autooxidation results in the formation of reactive oxygen species and causes different kinds of diseases. Flavonoids and phenoic acids are widely present in higher plants. These compounds are effective against the deleterious effect of reactive oxygent species. Some compounds found in Thyme plant have been reported to possess strong antioxidant activity [13]. Tymol is the antioxidant component in thyme. It has been reported that the essential oil extracted from thyme, and in particular the phenolic components (carvacrol and thymol), are responsible for the antioxidant activity observed in the lipid system [5].

The antioxidative properties of the extracts of oregano, dittany, thyme, marjoram, spearmint, lavender and basil have been evaluated when added to lard kept at 75 $^{\circ}$C. Oregano extract was found to be most effective in stabilizing lard, followed by thyme, dittany, marjoram and lavender. It was reported that thymol and carvacrol which are found in thyme showed strong antioxidant properties [12]. Farag et al. (1989) discussed the relationship between the antioxidant property and the chemical composition of the essential oils. It was suggested that the high antioxidant activity of thymol is due to the presence of phenolic OH groups which act as

hydrogen donors to the peroxy radicals produced during the first step in lipid oxidation, thus retarding the hydroxyperoxide formation [14]. Teissedre and Waterhouse (2000) reported a high correlation (r = 0.75) between the total phenol content of essential oils and human low-density-lipoprotein oxidation in vitro [15].

**Effect on digestion process**

There are suggestions that dietary essential oils from thyme can improve digestion. It might be reasoned that spices and herbs, from which essential oils are derived, have been shown to positively affect food digestion. A number of studies have reported the effect of spices or their active components on bile salt secretion [12,16].

**Effect on the process of methanogenesis in the rumen**

Information on the effect of essential oils from *Thymus* on the process of methanogenesis in ruminants is ambiguous. The rumen ecosystem, due to various interactions within it, can differently react to the used factors modulating fermentation, including the process of methanogenesis. It has been proved by both the current studies and the studies from the 1950s and the 1960s [17,18]. The results obtained by Newbold et al. (1988) demonstrated that the increasing level of essential oils may be a direct reason for reduction of the population of the microorganisms participating in methane formation in the rumen (*Methanobrevibacter smithii* PS; ATCC 35061) [19]. However, according to some authors, it is mainly the used amount and the source of essential oils that are responsible for the result of reduction or lack of reduction of methane production [10,17]. Other studies similarly revealed that the highest used addition (400 μg/l) of the essential oil from *Thymus vulgaris* and *Origanum vulgare* (thymol) strongly inhibited the process of methanogenesis in the *in vitro* conditions, resulting in the 93% reduction of the amount of produced methane [10]. However, it should be emphasized that lower thymol doses of 50, 100 and 200 μg/l did not result in any changes in methane production. Similar tendencies have been observed by Macheboeuf et al. (2008), who analysed the effect of the essential oils extracted from *Thymus vulgaris*, *Origanum vulgare*, *Cinnamomum verum* and *Anethum graveolens* [20].

## CONCLUSION

Medicinal plants compete with the synthetic drugs. As the world is becoming more advanced, new diseases are emerging in animals and human beings by irrational use of antibiotics and antimicrobial growth promoters. The main scope of animal production is to ensure the high productivity, healthy animals and quality animal products, which are stable and appropriate for further processing. In this aspect, thyme is not just appetite and digestion stimulants, but can, with impact on other physiological functions, help to sustain good health and welfare of the animals and improve their performance.

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