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NATURAL ANTIMICROBIALS IN ORGANIC LIVESTOCK

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SUMMARY

Antimicrobials represent one of the most important discoveries, to both human and animal health. However, the spread of multi-resistant microorganisms and the development of alternative livestock farming systems such as organic farming has led to the need to exploit new alternative and natural compounds from plants, minimally processed, to replace synthetic molecules. Among these, the wide group of phytochemicals has been recently investigated, mostly in order to replace the use of antimicrobial-growth promoters in swine and poultry. These compounds are called phytobiotics by some authors. Among them, essential oils have shown very interesting antimicrobial properties against several pathogenic bacteria. Many *in vitro* studies have been published on essential oils and other plant extracts. However, greater information is still needed before allowing the use of these alternatives on a daily basis at farm level. They appear to be very promising tools in contributing to the reduction of antimicrobial-resistance and at the same time, to meet food safety requirements without compromising animal health and welfare. This document briefly summarises the results available for this topic.

INTRODUCTION

Phytochemicals are non-nutritive plant-derived compounds which have an important role in plants defence[1]. Phytochemicals are considered, along with other compounds and additives, as possible alternatives to antibiotics with the advantage of being from natural sources. Because they are derived from plants, they are sometimes called phytobiotics. Some of the preferred characteristics of natural antimicrobials are listed in **Table 1**.

Table 1. Characteristics that natural antimicrobials should meet:

Properties for natural antimicrobials
non-toxic, with no side effects on animals
short term presence of residues
be stable in the feed and animal gastrointestinal tract
low environmental impact
without influences on palatability
without disturbing physiological intestinal flora
efficacious against pathogenic bacteria
enhance the body resistance to diseases
ameliorate feed efficiency and enhance animal growth
good compatibility
without contributing the development of antimicrobial-resistance

What does the European legislation say?

Organic livestock production is regulated by Regulation (EU) 2018/848 of May 30th 2018, which indicates that

chemically synthesised veterinary medicinal products are prohibited for preventive treatment. Moreover, when they are prescribed the withdrawal period is twice that for conventional farming; and if animals receive more than 3 courses of treatment within a year (or more than 1 course if the productive lifecycle is <1 year), they should undergo a conversion period to be considered organic again.

PHYTOBIOTICS IN LIVESTOCK

Several *in vitro* and *in vivo* studies have been conducted to investigate the antimicrobial properties of plant-derived compounds. Great attention has been paid to **thyme**, **oregano**, **rosemary**, **marjoram**, **yarrow**, **garlic**, **ginger**, **green tea**, **black cumin**, **coriander** and **cinnamon**, especially in the poultry sector for their potential application as growth promoter alternatives[2].

Plants and plant products with high concentrations of phytochemical compounds can be used in solid, dried and ground form or as extracts (crude or concentrated), and also as essential oils and oleoresins, depending on the process used to derive the active ingredients. Among essential oils, two major classes have been identified: terpenes (e.g. carvacrol and thymol) and phenylpropenes (e.g. cinnamaldehyde and eugenol).

In vitro trials on phytobiotics

Minimum inhibitory concentration, pharmacokinetic and quorum sensing studies have been employed to evaluate phytobiotics (e.g., **tannins**, **Quebraco extract**) against bacterial pathogens in swine, ***Salmonella*** and other bacteria responsible for **diarrhoea** in animals, and bacteria responsible for **mastitis** in dairy cattle, including ***Staphilococcus*** spp., ***Streptococcus*** spp. and ***E. coli***. Essential oils from **thymol**, **eugenol** and **carvacrol** have also been tested against ***E. coli*** and ***Salmonella*** spp. (**Figure 1**).

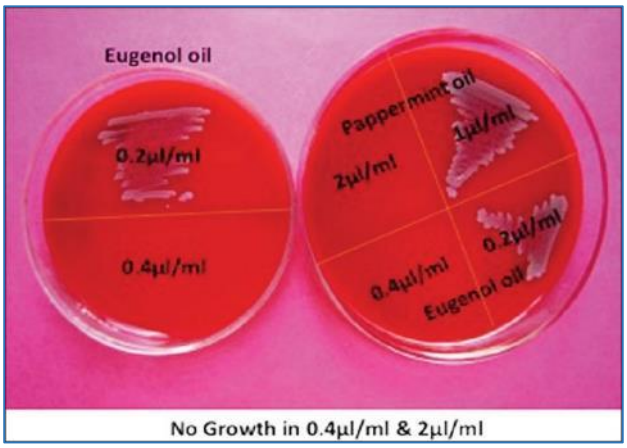

Figure 1. An example of MIC determination, from Thosar et al.[3].

In vivo trials of phytobiotics in

Swine. Several experiments have been conducted to evaluate the use of essential oils in swine, including **oregano**, **cinnamon**, **mexican pepper** alone or blended, **capsaicin**, **carvacrol**, and **thymol** to counteract **diarrhoea** and other diseases.

Poultry. Herbs, spices, other plant extracts and essential oils are used as feed additives in the poultry industry, where they are perceived to be growth promoters. They have been used to control pathogenic bacteria,

including ***Clostridium perfringens*** and ***E. coli***, and to stabilise the ecosystem of gastrointestinal micro-biota[4].

Cattle. Very few researchers have investigated the use of herbs in the treatment and prevention of diseases in cows. Studies have focused on specific bacterial species like *Staphylococcus aureus* that causes **mastitis** in dairy cattle[5]. An example is ***Morinda citrifolia*** juice, that when fed to cattle, has been demonstrated to be effective in reducing the total bacterial count in milk.

Rabbits. Multiherbal products have been shown to increase growth performance in rabbit, while other plant products (e.g. **cumin seed**) increased immune response against ***Pasteurella multocida*** and ***Staphylococcus aureus***; and **spirulina** and **thyme** reduced the count of ***Clostridium coccoides*** and ***Clostridium leptum*** in cecal content.

Aquaculture. Phytochemicals have been shown to act in aquaculture in terms of growth promotion, appetite stimulation, immunomodulation and as antioxidants, as well as being antiparasitic, anaesthetic and reducing tress[6]. Supplementations with essential oils have shown potential in promoting the health of the gastrointestinal tract in fish. For example, **thymol** and **carvacrol** appeared to positively affect the gut microbiome.

ANTIMICROBIAL CAPACITY OF FOOD INDUSTRY BY-PRODUCTS

Several studies have confirmed the antimicrobial activity of some bioactive compounds contained in plant by-products[7]. Phenolics and flavonoids of **pomegranate fruit skins** have shown antimicrobial properties against ***L. monocytogenes***, ***S. aureus***, ***E. coli***, ***Yersinia enterocolitica***, ***Pseudomonas fluorescens***. Extract of **grape pomace** at 10% has been shown to inhibit the growth of ***Enterobacteriaceae***, ***S. aureus***, ***Salmonella***, **yeasts** and **moulds** in beef patties during 48 hours of storage at 4 °C. **Grape seed** and **Yerba Mate** extracts promoted the growth of gastrointestinal beneficial bacteria in poultry. The antimicrobial properties of **olive pomace** and **olive juice powder** have also been confirmed.

Conclusions

Most studies on alternatives to antimicrobials in livestock have been focused on bioactive compounds from plants, such as essential oils. Several positive effects on animal health and productivity of these secondary metabolites have been shown in different species of food-producing animals and could contribute to reduce the use of antimicrobials at farm level. Nevertheless, it is important to overcome some limitations in

experimental studies such as diet and essential oil composition, which can influence experiments outcomes. There is still a shortage of knowledge about essential oil metabolism, and scientific evidence showing the potential link between feeding essential oil and animal health is not solid yet. The mechanisms by which essential oils affect gut microflora and the gut-associated immune system are not yet fully understood. Research on this topic should contribute to the strategy to fight antimicrobial-resistance, but also to find new solutions for a more effective organic farming.

TAKE HOME MESSAGES

- An enormous variety of plant products with antimicrobial properties is available.
- Specie-specific studies have been conducted to assess their effects on the main diseases of farm animals.
- *In vitro* studies have been conducted on a wide range of bacteria.
- More information is needed on the impact on animal performance and their products.

For further information, please contact those responsible for the Livestock work of Organic-PLUS, massimo.demarchi@unipd.it

PROJECT WEBSITE

www.organic-plus.net

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