14th
INTERNATIONAL
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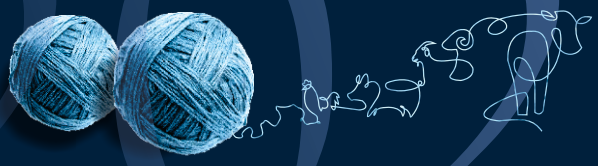
MODERN TRENDS IN LIVESTOCK PRODUCTION

2023



PROCEEDINGS

4 - 6 October 2023, Belgrade, Serbia

Institute for Animal Husbandry

Belgrade - Zemun, SERBIA

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MEDICINAL AND AROMATIC PLANTS IN LIVESTOCK FARMING: A PROMISING APPROACH FOR BOOSTING HEALTH AND PERFORMANCE

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Abstract: In recent times, there has been a revived interest in utilizing medicinal and aromatic plants (MAPs) for the treatment of diseases and enhancing the productivity of farm animals. Thanks to their bioactive compounds, MAPs can enhance the immune system, reduce the risk of disease and improve overall health and welfare. This is especially important in the post-antibiotic era, where the search for alternative options is becoming increasingly urgent. Although the mode of their action is still unclear, today it is known that MAPs can modulate the microbiota and promote gut health, leading to improved digestion and nutrient absorption. Some components of MAPs act against viruses, bacteria and parasites. Additionaly, the use of MAPs in livestock farming can also have environmental benefits. Livestock methane emissions are a significant contributor to greenhouse gas levels. Recent studies have shown that certain bioactive compounds found in MAPs could inhibit methanogenesis and reduce the number of methanogenic microbes in animal gastrointestinal tracts. As a result, researchers are exploring the potential of MAPs in methane reduction strategies. Plants could also play a prominent role in obtaining functional and enriched foods to contribute to animal product quality and human health in general. This review highlights the importance and potential of using medicinal plants in farm animal breeding, particularly in the context of the One Health concept, which acknowledges the interconnectedness of human, animal, and environmental health.

Key words: medicinal plants, livestock, health, performance, phyto additives, ethnoveterinary medicine

Introduction

Throughout history, herbs have been utilized for their medicinal properties and have played a significant role in promoting health and well-being. Furtheremore, they have always been a primary source of drugs and treatment strategies in various traditional medicinal systems. Determining the exact time when herbs were first used for medicinal purposes is challenging, but carbon dating from ancient Babylon (Iraq) suggests that they were being cultivated for medicinal purposes as far back as 60,000 years ago *(Qazi and Molvi, 2016).* A Sumerian clay tablet discovered in Nippur, dating back nearly 5000 years, holds the earliest recorded evidence of using medicinal plants for creating medicines and for treatment purposes. This tablet includes 12 recipes for making medicines and mentions over 250 different plants, including notable alkaloid-containing plants such as poppy, and mandrake *(Wong, 1971).* This finding provides valuable insight into the rich tradition and utilization of medicinal plants in ancient civilizations, shedding light on how people utilized plants for improving health and treating ailments thousands of years ago. Today, the term Medicinal and Aromatic plants (MAPs) is most often used for all plants used for this purpose.

The objective of this review is to present the latest knowledge about the importance and potential of using medicinal plants in the breeding of farm animals with a particular focus on preserving their health, suppressing diseases, improving production performance, and reducing methane emissions. In addition, the potential and effects of their use in supporting the One Health concept and the enrichment of foods of animal origin were discussed.

Translating tradition into modern livestock farming

For many medicines of plant origin, which were known by the oldest human civilizations and which were used throughout the millennia until today, modern science has confirmed their active action and included them in pharmacotherapy. Recognizing the importance of traditional medicine, the World Health Organization (WHO) acknowledges the need to explore and utilize ancient medicinal practices to meet the primary healthcare requirements of animals. The WHO also acknowledges that traditional medicine can play a crucial role in the advancement of livestock in third-world countries *(WHO, 2008).*

The use of medicinal plants in animal husbandry has so far been most widely used in organic production. Although, the EC Regulation for Organic Farming states that organic livestock should be treated preferably with phytotherapeutic products, only few registered herbal veterinary medicinal products currently exist on the European market *(Mayer et al., 2014).* In addition to

the growing need for natural products, there are other indications that encourage the use of medicinal plants. First of all, these are national and international efforts to combat antimicrobial resistance and promote the One Health approach. Nowadays promoting "clean, green, and ethical" animal production that limits the use of drugs, chemicals, and hormones while considering animal welfare and reducing the environmental impact of food production presents challenges to livestock production systems *(Ostojić Andrić et al., 2018).*

Antibiotic growth promoters have been banned in livestock production in the European Union since 2006. due to concerns about the transmission and spread of resistant bacteria in the food chain. Therefore, alternative feed strategies using botanicals, such as aromatic plant extracts, have been investigated. These plant products have advantages over commercial antibiotics because they are residue-free and generally considered safe. Furthermore, they can be used as alternatives to synthetic drugs, because of their potent properties and more complex bioactivity *(Kuralkar and Kuralkar, 2021).* Bioactive plants and botanicals have also gained attention in recent years as potential growth promoters for animals. They may be helpful in some aspects of the proposed approach because they are often inexpensive and considered environmentally safe *(Hashemi and Davoodi, 2011).* Although the use of medicinal plants has a long tradition in Serbia, the works of the 19th-century folk educator and pedagogue Vasa Pelagić (1839-1899) are considered the first important reading in which traditional and scientific knowledge was collected and presented on the appearance, purpose and method of use in the treatment of people as well as in the breeding of farm animals. Recently, with the increased studies on this topic around the world, the interest of researchers in Serbia has also increased.

Summarized data from different studies have shown that about 700 wild growing species have been used as medicinal plants in Serbia *(Zlatković et al., 2014).* Research on the use of medicinal plants in farm animals is not so common in Serbia and is predominantly reliant on information gathered from surveyed respondents who possess knowledge of traditional phytotherapy practices. From the recent literature, we can single out studies that investigated the knowledge of the practice and tradition of healing with medicinal plants in the area of Pirot *(Matejić et al., 2020; Marković et al., 2021),* Negotin *(Janaćković et al., 2019),* Suva mountain *(Jarić et al., 2015),* Kopaonik *(Jarić et al., 2007),* Rtanj *(Zlatković et al., 2014).* Until recently, the use of medicinal plants in veterinary medicine was mostly based on results obtained in human medicine. However, it is encouraging that the number of clinical studies on the effects of using medicinal plants in veterinary medicine is gradually increasing. Some of the studies investigated the effects of application of plants and their preparations on health and production performance of farm animals *(Runjaic-Antic et al., 2010; Davidović et al., 2011;*

Kostadinović and Lević, 2018; Pajić et al., 2019; Drašković et al., 2020; Petričević et al. , 2021; Kurčubić et al., 2019; 2023).

MAPs and their bioactive compounds

According to the State of the World's Plants report *(Royal Botanic Gardens, 2016)*, there are approximately 391,000 plant species on Earth. Out of this vast number, it is believed that 35,000 to 70,000 plant species have been utilized for medicinal purposes, as reported by the World Health Organization (WHO) in 1998. The use of herbal products has grown significantly worldwide.

Herbs have an inherent ability to generate a diverse range of chemical substances through their regular metabolic activities and each herb has its own distinct combination and characteristics. These substances can be categorized into two main groups: primary metabolites, including sugars and fats, which are present in all plants, and secondary metabolites (PSMs), also referred to as phytobiotics or phytochemicals, which are specific to certain plant species *(Hashemi and Davoodi, 2011).* PSMs are bioactive compounds that may have beneficial or adverse effects but in comparison to inorganic chemicals, products derived from plants exhibit natural characteristics, lower toxicity levels, absence of residues, and have found extensive applications in traditional as well as alternative veterinary medicine. Furthermore, investigation of medicinal plants has led to the isolation of many PSMs which have become well-known pharmaceuticals (acetylsalicylic acid, morphine, digitoxin, quinine etc.).

The most important bioactive compounds present in herbs include alkaloids, glycosides, flavonoids, phenolic acids, saponin, tannins, terpenes, anthraquinones, essential oils and steroids. They act as antibacterial, antioxidant, anticarcinogenic, antifungal, analgesic, insecticidal, anticoccidial and growth promoters *(Kostadinović and Lević, 2018).*

Utilization of MAPs-most frequent form of use and mode of action

The MAPs can be utilize in various forms. Sometimes the plants are used fresh or made into poultices. Far more common is the use of their extracts combined with other substances and administration in the form of drinks, through feed, or applied to the skin. The most important forms in the narrower sense include the use of whole plants or parts of plants (botanicals), essential oils, and phytoadditives.

Botanicals refer to the different parts of plants that are processed or used in their entirety. When herbs are used in their entirety, including the leaves and other

parts, and combined with other herbs, their active ingredients work together in harmony, resulting in the desired effects being achieved naturally *(Kuralkar and Kuralkar, 2021).* Botanicals work by disrupting the cell membrane of microbes, interfering with their virulence properties, and stimulating the growth of beneficial bacteria in the gut. They also act as immunostimulants, protect the intestine from microbial attack, and enhance the production and activity of digestive enzymes. Additionally, botanicals stimulate the growth of absorptive cells in the gastrointestinal tract *(Jamroz et al., 2003; Vidanarachchi et al., 2010).*

Essential oils are liquids that have a strong scent and are extracted from different parts of plants such as leaves, flowers, and seeds. They possess various properties such as antimicrobial, anti-inflammatory, antioxidative, and coccidiostatic that can benefit health. Essential oils can improve digestion and immunity, prevent the growth of harmful bacteria in the gut, and reduce odour and ammonia *(Omonijo et al., 2018; Diniz do Nascimento et al., 2020).* They work by increasing the release of digestive enzymes and decreasing the availability of nutrients for bacteria in the gut *(Omonijo et al., 2018; Reyer et al., 2017).*

The ban on the use of antibiotic growth promoters (AGP), applied in the European Union since 2006, has stimulated interest in the use of plant extracts, known as *phytogenic additives - PFA* (phyto additives, phytobiotics). PFAs is used to improve production outcomes and health in livestock farming. These additives act as antioxidants, metabolism enhancers, and regulators of the growth of pathogenic microorganisms such as bacteria and fungi *(Stevanović et al., 2018).* Moreover, their use supports the concept of sustainable agriculture and the production of healthier food. In order to be a viable alternative additive to antibiotic growth promoters, PFAs must provide similar advantages which means they should act like them: increase growth, improve feed efficiency, and reduce the occurrence of certain diseases.

MAPs for boosting livestock performance

The use of herbal and plant-based remedies has become more prevalent in livestock production. This shift can be attributed to various reasons, such as the negative effects of conventional synthetic drugs, the increasing expenses of traditional treatments, worries about harmful residues in food, the growth of microbial resistance, and the establishment of organic livestock production systems.

In terms of boosting livestock performance phytogenic additives -PFAs are the most common form of MAPs utilization. Research on the effect of phytoadditives in the nutrition of farm animals is most numerous in poultry. PFAs are shown to enhance feed efficiency and increase weight gain *(Zhang et al., 2009;*

Khattak et al., 2014), reduce pathogenic load *(Engida et al., 2023),* booster immune system and enhance meat quality characteristics in poultry *(Mnisi et al., 2023).*

There is an extensive collection of literature available on the impact of herbal feed supplements on the growth and meat quality of broiler chickens and pigs *(Jamroz et al., 2003; Vidanarachchi et al., 2010; Pajić et al., 2019; Petričević et al., 2021).* On the other hand, research on the effects of natural feed supplements on growth, immunity, and antioxidant status of ruminants is limited, possibly due to their complex digestive system.

Livestock production heavily relies on nutrient digestibility for optimal results. The addition of PFAs to livestock feed may improve digestibility through various mechanisms *(Reyer et al., 2017; Stevanović et al., 2018).* These mechanisms include increasing appetite, promoting saliva and intestinal mucus production, enhancing bile acid secretion, and boosting the activity of digestive enzymes like trypsin and amylase *(Oso et al., 2019).* PFAs may also have positive effects on intestinal morphology and exert local effects at the intestinal border, as well as induce systemic changes in macronutrient metabolism. The combination of these different actions leads to the observed improvement in nutrient digestibility when PFAs are added to feed.

The performance of farm animals is commonly understood to be closely associated with the health and function of their gut, which is influenced by various factors including diet, intestinal integrity, gut microbiome, and immune system of animals. In order to promote the growth of beneficial bacteria, and stimulate digestion and absorption, numerous feed additives have been developed *(Ghasemi et al., 2014; Abdelli et al., 2021).*

As mentioned previously, many experimental findings suggest that using traditional herbal medicines as supplements can improve feed to gain ratio and benefit animal health. However, conflicting research findings highlight the necessity for further investigation to ascertain optimal dosage and mechanisms of action. The biological effects of phytogenic feed additives can vary significantly depending on the experimental methods used to evaluate their suitability as growth-promoting feed additives for animals. To test the effectiveness of herbal feed additives on animal production, it is crucial to carefully select the appropriate traditional medicinal plants with bioactive compounds and determine the appropriate dietary doses *(Bostami et al., 2021).*

MAPs for curing, health promotion, disease prevention and management

The utilization of medicinal plants extends beyond human disease treatment and is also widely employed for addressing animal ailments. In fact, as revealed by *Marković et al. (2021)*, most of the herbal species are used to treat both veterinary and human diseases. Extracts and other natural substances in MAPs (plant derived bioactive compounds including lycopene, carotenoids, L-theanine, fucoidan, humic acid etc.), are used to treat various health conditions such as anxiety, depression, insomnia, pain, and inflammation *(Arain et al., 2018; Arif et al., 2019).* This type of complementary and alternative medicine is known as phytotherapy (also herbal medicine or botanical medicine) *(Nabi et al., 2023).* Nowadays, knowledge of phytotherapy is incorporated into ethnoveterinary medicine which encompasses the understanding, techniques, practices, and beliefs surrounding traditional health treatments. According to *Viegi et al. (2003)*, approximately 70% of animals treated with herbal remedies are cattle, horses, sheep, goats, and pigs, followed by poultry (9.1%), dogs (5.3%), and rabbits (4.3%). Although not the subject of this study, it is worth mentioning that animals possess a natural ability to self-medicate using herbs, which is referred to as zoo pharmacognosy.

Although the repertoire mechanisms of action of bioactive compounds in MAPs is not fully elucidated, one of their primary mode of action is related to their antimicrobial effects which allow controlling potential pathogens *(Mohammadi et al., 2018).*

Some studies have indicated that specific phytotherapeutic compounds may have antiviral properties, and could potentially be used as alternative or complementary treatments for viral infections in animals. For instance, certain compounds such as flavonoids, terpenes, and alkaloids found in different plants have demonstrated antiviral activity against various viruses, including influenza, herpes simplex virus, HIV, and coronavirus *(Setayesh et al., 2022).*

In the study conducted by *Pajic et al. (2019)*, the herbal preparation, which included essential oils derived from *Thymus vulgaris, Origanum vulgare, and Coriandrum sativum*, exhibited a potent anticoccidial effect and had a significant impact on oxidative stress parameters. Aromatic plants and their essential oils contain phenolic compounds that act as powerful natural antioxidants. These compounds, which include flavonoids, have the ability to efficiently eliminate free radicals and stop oxidative reactions, making them highly effective antioxidants.

Medicinal plants can serve as both, health promoters and remedies for various diseases. They are utilized in addressing a range of conditions, including infections like anthelmintic and acaricidal treatments, as well as in surgical,

gynecological interventions, and bovine mastitis management *(Chakraborty and Pal, 2012).*

A study by *Schmid et al. (2012)* showed that breeders from 21 organic farms were in general satisfied with the outcome of MAPs usage in their animals (mostly cattle). Skin alterations and sores, gastrointestinal and metabolic diseases as well as infertility and diseases of the female genitalia were treated with homemade mono-species herbal remedies. The single most applied species were *Matricaria recutita L., Calendula officinalis L., Symphytum officinale L., and Coffea arabica L.*

Herbal products have the potential to improve the overall health and well-being of livestock, in addition to treating illnesses. They can enhance the immune system, aid in digestion, and supply necessary nutrients, which can reduce the likelihood of disease and promote optimal growth and performance. For instance, certain studies have demonstrated that compounds present in plants like echinacea, elderberry, and garlic possess antiviral properties and can enhance the immune response *(Nabi et al., 2023).*

More and more research has demonstrated that phytochemicals can enhance the body's ability to fight off microbial infections, leading to better health. Through interactions with immune system, PFAs can modulate immune responses through various mechanisms. One way is through dietary immunomodulation. This involves modulating the expression of cytokines, which are essential for both the adaptive and innate immune systems. Another way is through effects of some substances that can help combat antigenic challenges. The active components in black cumin for example, including thymol, nigellidine, nigellimine, thymoquinone, dithymoquinone, and thymohydroquinone have such pharmacological effects *(Ghasemi et al., 2014).*

Another type of potentially beneficial action of MAPs is the positive influence on the microbiota of the gastrointestinal tract (GIT). Many studies showed that the composition and metabolic activity of the GIT microbiota are key factors in enhancing immune response, reducing pathogen load in the GIT and promoting the growth of beneficial bacteria *(Ghasemi et al., 2014; Abdelli et al., 2021).* In this way, by including MAPs in the diet of farm animals, long-term benefits can be achieved in ensuring their health and well-being in general.

As a rational approach to livestock management, preventing diseases should be the primary focus, and maintaining animal health is crucial. Medicinal plants can also play a role in achieving this goal. Numerous herbal products have antimicrobial, antiparasitic, and antiviral properties, which can aid in preventing and managing various diseases in livestock. By incorporating herbal remedies into healthcare practices, farmers can decrease their reliance on antibiotics and other pharmaceutical interventions, minimizing the risks associated with drug resistance.

Some of the most important MAPs in Serbian ethnoveterinary medicine

The Serbia and Balkans region in general is renowned for its abundant biodiversity and traditional ecological knowledge within the broader context of Europe *(Shabih et al., 2022).* As mentioned earlier, studies on the use of MAPs in farm animals is not so common in Serbia and is predominantly reliant on information gathered from questionaries. The literature highlights studies on the use of medicinal plants for healing in various areas of Serbia, including Pirot, Negotin, Suva mountain, Kopaonik, and Rtanj *(Marković et al., 2021; Matejić et al., 2020; Janaćković et al., 2019; Jarić et al., 2015; 2007; Zlatković et al., 2014).*

Until recently, the use of medicinal plants in veterinary medicine was mostly based on results obtained in human medicine. However, it is encouraging that the number of clinical studies on the effects of using medicinal plants in veterinary medicine is gradually increasing *(Runjaic-Antic et al., 2010; Davidović et al., 2011; Kostadinović and Lević, 2018; Pajić et al., 2019; Drašković et al., 2020; Petričević et al., 2021; Kurčubić et al., 2019; 2023).*

According to the reviewed literature, one of the most commonly used plants for livestock in Serbia is *Hypericum perforatum L.* It has a very wide range of indications and is used for infectious diseases, digestive intoxications, diarrhea, skin diseases (wounds and burns) and many other animal diseases. Depending on the disease, this plant can be used fresh, but also in the form of water extract or oil.

The water extract of *Helleborus odorus* has antiseptic properties, so it is used as a disinfectant, while its specific effect is also reflected in lowering the temperature when applied externally in the ear.

Some herbs have shown their usefulness in relieving udder edema in cows: *Alium sativum L., Cichorium intybus L., Agrimonia eupatoria Ledeb. and, Potentila reptans L.* are mainly applied topically in the form of lining. *Calendula officinalis L. and Celosia argentea* are used in the treatment of dermatological changes in pigs.

MAPs for reducing methane emissions

Global warming is a major environmental problem and methane produced by ruminants contributes significantly to it. A feeding strategy that involves adding plant secondary metabolites is one way to reduce methane emissions in ruminants. They have the potential to affect ruminal fermentation and reduce the population of methanogenic bacteria and protozoa which are the main CH_4 –producing microbes.

Protozoa in the rumen are directly proportional to methane production, and reducing their population can decrease methane emissions.

Considering saponins can act as protozoan defaunators, while tannins can inhibit methanogen growth by reducing H_2 production during fibre digestion, some research has addressed the effects of these plant compounds on methanogenesis in ruminants. Study by *Antonius et al. (2023)* showed that supplementation of *M. oleifera, C. longa Linn., and P. timoriana* in ruminant diet effectively increased total gas production, dry matter and organic matter digestibility, and reduced CH_4 gas emissions and protozoa populations during rumen fermentation.

Some other bioactive compounds from plants, such as polyphenols and flavonoids also could be useful in strategy against ruminal methanogenesis. In vitro study by *Jo et al. (2022)* showed that the addition of extracts (containing polyphenols and flavonoids) from oriental MAPs *(Vitis vinifera L. and Rhus succedanea L.)* to ruminant diets can decrease methane production and the presence of methanogenic archaea.

While many studies have shown the potential benefits of using MAPs in methane emission reduction strategies, further research is needed to validate and implement their use in ruminant diets, as the current studies are primarily based on in vitro analysis. Additionally, a more precise selection of MAPs potentially inhibiting methanogenesis is necessary.

MAPs for functional and enriched foods

Functional food is a type of food that has been changed or created to offer extra health benefits beyond its basic nutritional value. These foods are often intended to improve specific functions in the body or enhance overall health. They may contain bioactive compounds like antioxidants, prebiotics, phytochemicals, or probiotics that can potentially benefit health. Enriched food, on the other hand, refers to products that have had certain nutrients added to increase their nutrient content beyond what is naturally present *(Castillo et al., 2018).*

Despite the new trends that reject the consumption of meat, milk and their derivatives, it is clear that their consumption provides multiple benefits in terms of nutrition and health. The benefits provided by foods of animal origin could be further enhanced by changes in the design of farm animal rations, including supplementation with natural plant extracts. Manipulation of the process of ruminal biohydrogenation through natural supplements could in the future be the basis of nutritional enrichment of milk and meat of ruminant origin. In this way, the antioxidant effect on the final products would be ensured, and the modern demands of consumers related to the quality and safety of foodstuffs would additionally be met.

Conclusion

The use of MAP in improving the health and performance of farm animals could have an increasing application. It fits into the modern one health concept and supports a holistic approach for the overall well-being of humanity. By embracing this approach, we can move towards a more sustainable model of livestock farming that benefits animals, humans, and the environment.

The advantages of using MAPs compared to conventional preparations in animal husbandry can be briefly described in the following words: availability, cost-effectiveness, harmlessness and efficiency. However, despite the legacy of tradition and new knowledge, this promising field of research has only just begun. The number of potentially medicinal plant species around the world is large, folk knowledge about the medicinal properties of plants is mostly preserved in less developed parts of the world or those that have traditionally relied on ethnomedicine such as India and China. However, in some regions, traditional plant-based treatments have been overlooked due to the rise of modern medicine and pharmacology. Despite this, there is an opportunity to revitalize and optimize the use of MAPs in animal husbandry worldwide, combining traditional principles with modern scientific knowledge and trends. Collecting traditional knowledge about medicinal plants from around the world is crucial to prevent it from being lost. Subsequent research should prioritize analyzing selected plants, detecting their active ingredients, and determining their effectiveness and dosage based on scientific principles.

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