

THE USE OF HERBS IN ANIMAL NUTRITION

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ABSTRACT

The withdrawal of antibiotic growth promoters (AGP) from the list of allowed feed additives forced livestock producers to look for legal and safe substitutes. These included probiotics, synbiotics, enzymes and proenzymes, minerals, organic and inorganic acids, as well as phytobiotics, i.e. plant extracts and substances derived from herbs. Medicinal plants contain a range of biologically active compounds in various combinations, thus they may have a varied effect on the animal body. Here we review the properties of a number of medicinal plants used in the feeding of livestock animals, such as cattle, poultry and swine. The research has confirmed the effectiveness of herbal substances as natural growth promoters and proved they represent an alternative for banned antibiotics. Phytobiotics also prove to be a positive factor in relation to both animal health and productivity in terms of quality and quantity, in cattle (milk and beef), pigs (pork yield and reproductive performance) and poultry (egg laying yield in laying hens and broiler chickens). Health improvement is the most pronounced outcome of an application of herbs and herbal feed additives, which has been reflected in blood tests. The interest in phytobiotics as a natural food component will continue to grow, along with the consumers' awareness and the growing demand for healthy food products. To achieve the desired effects, it is not enough to replace the antibiotics with herbs or to add them to the feed. In the first place, it is a balanced feed ration, animal welfare and appropriate veterinary prophylaxis that should be taken care of.

Key words: herbs, medicinal plants, health, animal nutrition, farm animals.

INTRODUCTION AND OBJECTIVES

Following the ban of antibiotic growth promoters (AGP), the market began to offer numerous different feed additives which were to represent a substitutes for AGPs. Some of them are plant extracts with a positive effect on the health and condition of animals. Medicinal plants contain a number of compounds that give them their specific properties, thanks to which farmers can achieve the desired effects without the necessity of using antibiotics or other synthetic veterinary medicines. It is important to remember that not every animal will be eager to take the herbs chosen by us; this depends on the species, age, sex, and even individual preferences.

The percentage of farmers who decide to drastically limit the usage of antibiotics and other synthetic medications on their herds is constantly growing. Natural herbal additives contain antiviral, antioxidant and antibacterial substances [Siminska et al. 2009, Kumar et al. 2014].

The aim of this paper is to present herbs and medicinal plants as additives in the nutrition of various livestock animals. We describe selected plants and their properties, as well as the effects they exert on the bodies of such farm animals, as cattle, poultry or swine.

HERBS AS FARM ANIMALS FEED ADDITIVES

Besides the basic nutrients, minerals and vitamins, animal nutrition involves feed additives. According to the regulation of the European Parliament and of the Council [Regulation (EC) No 1831/2003], an additive is defined as a substance, micro-organism, or chemical purposefully added to the feedingstuff in order to improve the properties of the feed, meet the nutritional demands of the animals, positively influence the genetics, production traits and welfare of the animals, and in order to enhance livestock production. In respect to their properties and function, feed additives have been allocated to one or

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more groups, namely technological additives, sensory additives, nutritional additives, zootechnical additives and coccidiostats and histomonostats [Regulation (EC) No 1831/2003].

Feed additives include feed enzymes, flavor improvers, organic acids, coloring, detoxicants, preservatives, antioxidants, herbs [Hashemi and Davoodi 2011]. Bioactive substances that occur in herbs (alkaloids, glycosides, tannins, essential oils, phenolic compounds and others) affect the animal bodies in a specific way: they have antibacterial properties, improve the functioning of the immune system, regulate feed intake and appetite in animals by improving the flavor, and regulate the functioning of the digestive system [Mirzaei-Aghsaghali 2012], inhibit or enhance metabolism, and also shape the sensory and dietary properties of the animal products [Grela et al. 1998, Meineri et al. 2010].

The therapeutic properties of plants result from the interaction of compounds contained and stored any parts of the plant: seeds, flowers, fruits, stems, roots, rhizomes and leaves. Active compounds in medicinal plants are present in very small quantities; it is rare that their content exceeds 1%, rather, it is a tenth or even a hundredth of a percent [Sadowska 2003].

Animals have had a contact with herbs in their natural habitats ever since. They tend to select herbs which are most favorable for them in terms of stability and health. Free-living herbivorous animals selectively pick medical plants or their parts. The selection depends on their taste and smell and meet the needs resulting from the ailments of health condition of the animal. This is referred to as self-treatment [Grabowicz 2007, Huffman and Wrangham 1996].

SELECTING HERBS FOR LIVESTOCK ANIMALS

When selecting herbs to add to the feed, not only the properties of the plants, but also the preferences of the animals should be taken into account. It has been noticed that, for example, that pigs are more likely to eat the feed with an addition of rosemary or garlic rather than ginger or oregano [Janz et al. 2007, Kowalczyk et al. 2013]. Cows, on the other hand, willingly take common yarrow, thyme, willow bark, the rootstock of coach grass, chamomile, centaury, lemon balm, St. Benedict's thistle or plantain leaves. When it comes to napeta, birch leaves, ruptureworts, linden leaves, lemon thyme, sweet flag rhizomes, dandelion root or coltsfoot leaves, cows are more fussy [Grela 2003].

Herbal plants can be selected depending on the expected effects and requirements. It should be kept in mind that not all of them will be willingly eaten by the animals, and that not every plant should be offered. Some herbs are antagonistic against one another and they should never be

offered together. The plants may be fed in various forms: dried, fresh, as a decoction, infusion, extract or essential oils.

Table 1 presents the preferences of cattle, swine and poultry in relation to various herbs. It can be noticed that the animals differ in preferences.

If we look at cattle and poultry, many herbs have not been tested yet and data on the preferences for a given type of herb are lacking. Also, ruminants much more frequently avoid a given plant compared to other groups of animals.

In order to create a good herbal preparation mixtures, one should take into account the active substances of the plants, physiological requirements of the animals, and the expectations of the consumers towards the quality of eggs, milk, or meat. Table 2 illustrates the effects of herbs applied to selected animals.

As presented in Table 2, there are multiple available forms of feeding herbs to animals, including the most efficient ones. The data leads to conclusion that all the forms of herbs fed to dairy cattle are of desired efficiency. When it comes to calves, best are dry extracts and oils. In sows the most efficient herb preparations are dry extracts and fresh plants; in piglets and porkers, however, fresh plants do not bring about the desired effect, neither do dry extracts and oils in laying hens and broiler chickens.

HERBS IN POULTRY NUTRITION

Poultry production is now occupying a significant part of the agricultural sector in Poland. The production volume of poultry meat is growing by year. The increasing scale of production requires the farmer to seek nutritional additives which will positively affect both production performance and the health status of the animals. Herbs are applied to poultry diet in the form of various mixes [Choraży 2010].

The most popular herbal plants in poultry nutrition include garlic, St. John's wort, lemon balm, common yarrow, caraway, peppermint, nettle, chamomile, medical rut, and sage.

The effects and quality of herbal plant products depend on a number of factors, such as plant species, part of the plant (roots, rhizomes, leaves, fruit, stalks, seeds, flowers), the ealth of the habitat the plant had grown, way and stage of harvest, processing, and the dose. Due to the great diversity and abundance of bioactive components of these plants, the spectrum of herbal preparations effects is multiple and wide. Considering this, it can be concluded that multi-component extracts or herbal mixtures are more effective than application of single plants.

A situation may be that herbal mixtures exhibit poor performance of their active substances caused, for example, by the environmental factors (rainfall, soil, drying

Table 1. Herb preferences in livestock animals (data by Grell et al. 2013)

Tabela 1. Preferencje zwierząt pobierania ziół (na podstawie Grell i wsp. 2013)

Herbs – Zioła	Scientific name – Nazwa łacińska	Cattle – Bydło	Pigs – Świnie	Poultry – Drób
Anise – Biedrzynek anyż	<i>Pimpinella anisum</i>	+	+	+
Boadleaf plantain – Babka zwyczajna	<i>Plantago major</i>	++	++	++
Calendula – Nagietek lekarski	<i>Calendula officinalis</i>	+	+	++
Caraway – Kminek zwyczajny	<i>Carum carvi</i>	+	–	+++
Centaury – Tysiącznik	<i>Centaureum erythraea</i>	++	NA	NA
Chamomile – Rumianek pospolity	<i>Matricaria chamomilla</i>	++	+	+++
Cinquefoil – Pięciornik gęsi	<i>Argentina anserina</i>	–	+	+
Coach grass – Perz właściwy	<i>Elymus repens</i>	++	+++	+
Common agrimony – Rzępik pospolity	<i>Agrimonia eupatoria</i>	NA	+	+
Common flax – Len zwyczajny	<i>Linum usitatissimum</i>	++	+++	++
Common juniper – Jałowiec pospolity	<i>Juniperus communis</i>	NA	+	+
Common yarrow – Krwawnik pospolity	<i>Achillea millefolium</i>	+++	++	+++
Coriander – Kolendra	<i>Coriandrum sativum</i>	+++	+	++
Dandelion – Mniszek lekarski	<i>Taraxacum officinale</i>	–	++	++
Dill – Koper ogrodowy	<i>Anethum graveolens</i>	–	+	+
Fenugreek – Kozieradka pospolita	<i>Trigonella foenum-graecum</i>	NA	+	+
Field horsetail – Skrzyż polny	<i>Equisetum arvense</i>	NA	–	++
Garden angelica – Arcydzięgiel	<i>Angelica archangelica</i>	++	+	+
Garlic – Czosnek pospolity	<i>Allium sativum</i>	+	++	++
Heartsease – Fiołek trójbarwny	<i>Viola tricolor</i>	NA	+	+++
Hops – Chmiel zwyczajny	<i>Humulus lupulus</i>	NA	+	+
Knotgrass – Rdest ptasi	<i>Polygonum aviculare</i>	–	++	++
Lemon balm – Melisa lekarska	<i>Melissa officinalis</i>	++	++	++
Lemon thyme – Macierzanka	<i>Thymus pulegioides</i>	+	++	+
Licorice – Lukrecja	<i>Glycyrrhiza sp.</i>	++	++	+
Lovage – Lubczyk ogrodowy	<i>Levisticum officinale</i>	+	+	+
Marshmallow – Prawoślaz lekarski	<i>Althaea officinalis</i>	+	+	+
Napeta – Kocimiętka	<i>Napeta sp.</i>	+	+	NA
Nettle – Pokrzywa zwyczajna	<i>Urtica dioica</i>	–	+++	+++
Oregano – Lebiodka pospolita	<i>Origanum vulgare</i>	++	+++	+++
Pepper mint – Mięta pieprzowa	<i>Mentha × piperita</i>	++	++	–
Purple coneflower – Jeżówka purpurowa	<i>Echinacea purpurea</i>	++	++	+
Sage – Szalwia lekarska	<i>Salvia officinalis</i>	+	++	+++
Shepherd’s purse – Tasznik pospolity	<i>Capsella bursa-pastoris</i>	++	+	NA
St. Benedict’s thistle – Drapacz lekarski	<i>Cnicus benedictus</i>	++	+	NA
St. John’s wort – Dziurawiec zwyczajny	<i>Hypericum perforatum</i>	–	+	+
Summer savory – Cząber ogrodowy	<i>Satureja hortensis</i>	NA	+	++
Sweet flag – Tatarak	<i>Acorus calamus</i>	–	+	+
Thyme – Tymianek pospolity	<i>Thymus vulgaris</i>	+++	++	++
Valerian – Kozłek lekarski	<i>Valeriana officinalis</i>	NA	–	–
White mustard – Gorczyca jasna	<i>Sinapis alba</i>	NA	–	+
Willow – Wierzba	<i>Salix sp.</i>	+++	++	+
Wormwood – Piołun	<i>Artemisia absinthium</i>	–	–	NA

+++ favored, ++ preferable, + tolerated, – avoided, NA no data available.

+++ bardzo chętnie, ++ chętnie, + niewielkie zainteresowanie, – unikają, NA brak danych.

Table 2. Efficiency of herbal supplementation in selected animals (data by Grell et al. 2013)

Tabela 2. Efektywność stosowania ziół u wybranych zwierząt (na podstawie Grell i wsp. 2013)

Species or livestock group Gatunek lub grupa produkcyjna	Form fed – Forma skarmiania			
	Fresh Świeże	Dry Suszone	Dried extracts Wyciągi suszone	Oils Olejki
Dairy cows – Krowy mleczne	++	++	++	++
Calves – Cielęta	+	+	+++	++
Sows – Lochy	++	+	++	0
Piglets, porkers – Prosięta, tuczniki	+	++	++	++
Laying hens – Nioski	+	++	+	++
Broiler chickens – Brojlery kurze	0	++	++	++

+ low efficiency (0–2% improvement), ++ acceptable efficiency (2.1–5%), +++ high efficiency (more than 5%), 0 lack of effects or no data available.

+ niska skuteczność (0–2% poprawy), ++ pożądana skuteczność (2,1–5%), +++ wysoka skuteczność (powyżej 5%), 0 brak skuteczności lub informacji.

processes, etc.). For these reasons, if various herbal compositions are used, a variety of results can be expected. The best is to harvest the plants in their growing phase. Under natural conditions, poultry eagerly eat many of the herbs that have been mentioned above. These plants stimulate intestinal peristalsis, improve appetite, improve the palatability of the feed, and stimulate the pancreas and liver. They have astringent properties, show anti-inflammatory and antibacterial effects, enhance the immunological system, but also positively affect the smell and taste of eggs and meat [Korytkowska 2013].

Laying hens

Laying hens belong to the group of livestock animals with the highest productivity in relation to body weight. With such a huge load on the body, it is necessary to accurately balance complete feeds and ensure optimal housing conditions for the birds. If hens have free access to the runs, they can choose the food items they prefer and that are right for them. They often eat herbaceous plants, which have a positive effect on health. The results of studies on the applicability and efficiency of herbal additives for laying hens are presented below.

1. Some meadow herbs, such as dandelion, nettle, cress, sorrel, yarrow or parsnip, act positively on the growth, laying performance, improve egg yolks and color and flavor [Grela et al. 2013].
2. Researchers have been recently focused on garlic, due to its antiviral, antibacterial and antifungal properties [Ognik et al. 2016]. It also has anti-inflammatory and antioxidant, immunomodelling and antiseptic properties. According to some authors, an addition of garlic extract to drinking water may improve animals health and the functioning of the immune system, resulting in lower mortality and higher body weights, and a better feed conversion [Grela et al. 2013]. Supplementing drinking water with garlic can have a positive effect due to the presence of antioxidants in the blood. Garlic lowers cholesterol levels in meat, eggs and blood. Hens kept in areas contaminated with lead should also receive an addition of garlic, which limits its accumulation in meat [Mirowski 2015].
3. Garlic in laying hens diet may increase the weight of eggs by as much as 2 g, however, the supplementation may affect the flavor of the products [Mirowski 2015].
4. Bölükbaşı et al. [2008] have shown that oils from thyme, sage and rosemary also have a positive effect on egg weight and better use of laying hen feed.
5. It has also been found that the addition of 1 to 1% of black caraway (*Nigella sativa*, L.) to feed has a significant effect on weight gain or improves laying performance [El-Bagir et al. 2006].
6. The extract of *Echinacea* may increase blood immunoglobulins in laying hens, reducing mortality and improving the health in hens [Świątkiewicz and Koreleski 2007].
7. The addition of thymol oil and the oil of sage, thyme and rosemary to feed significantly reduces blood triglycerides and cholesterol in laying hens [Skomorucha and Sosnowka-Czajka 2012].

Broiler chickens

Since antibiotics have been forbidden in animal feed, farmers try to replace them with herbs, which in the following studies have a specific effect on the health and development of birds.

1. Studies on meat chickens indicate that the highest finishing body weights are attained by broilers that receive nettle addition to feed. An addition of hops, on the other hand, significantly deteriorated this parameter. Less effective were other plants, such as pansy, mint or lemon balm [Kapica et al. 2006].
2. It has been demonstrated that antibiotics can be successfully replaced with herbal preparations based on the interaction of biologically active substances from several herbs. Such extracts, acting as immunomodulators, stimulate, regenerate, improve feed conversion, increase healthiness, improve meat production [Grela et al. 2013].
3. Herbs also alleviate stress thus improving the welfare of industrially farmed animals [Grela et al. 2013, Dmoch et al. 2014]. The research, in which broiler chickens were given water extracts from herbs showed that their addition reduced the level of corticosterone in the animal blood. The lower level of corticosterone in the blood means a lower susceptibility of the body to stress factors [Skomorucha and Sosnowka-Czajka 2013].
4. Some plants may have a soothing effect on the body during the pre-slaughter handling. This has been demonstrated on chickens administered sage, lemon balm and nettle [Mirowski 2015].
5. Some herbs have the ability to inhibit lipid oxidation. They influence chemical composition and organoleptic characteristics of poultry meat [Basmacioglu et al. 2004, Giannenas et al. 2005].
6. An addition to feed of the flowers of *Calendula* and *Tagetes* will improve the color of broiler carcass, adding some yellow tint to the skin [Grela et al. 2013].
7. Herbal supplementation of animal feed may alter the fatty acid profile. In this area, studies on chickens focused on many herbs, such as hops, pansy, lemon balm, nettle and mint. On this basis, it was found that due to such combination, the share of saturated fatty acids increased, which is undesirable in intramuscular fat. These acids have decreased in quantity. The

content and size of polyunsaturated fatty acids were influenced by various types of herbs. The best changes in fatty acids were found after the addition of mint and pansy [Kapica et al. 2006].

8. Garlic fed to broiler chickens may improve the color of meat and reduce the changes in lipids [Mirowski 2015].
9. Feeding chickens with the addition of alfalfa showed an increase in lymphocytes and a higher mass of lymphatic organs [Skomorucha and Sosnowka-Czajka 2012].

Coccidiostatic plants

Coccidiosis is a serious poultry disease. Caused by *Eimeria* unicellular protozoans, the condition leads to intestinal epithelium damages. The development of the disease depends on the protozoan species, its pathogens and the amount of coccidia swallowed by the bird. The subclinical form, which is often imperceptible, is manifested by the deterioration of the production performance and impaired absorption of nutrients. In its clinical form, it is a very common cause of deaths, the mortality rate reaching up to several dozen percent.

One of the first plants used as an inhibitor of coccidiosis was *Artemisia annua*. Administered in the form of dried fruit, it reduced intestinal damage in chickens infected with *E. tenella* oocysts. The artemisinin contained in the plant proved to be very effective; it causes oxidative stress, which inhibits the development of the disease [Świątkiewicz et al. 2009].

In organic farming, where antibiotics and other pharmacological agents cannot be used in the prevention of coccidiosis, the best medication is oregano (*Origanum vulgare*), which contains many compounds, such as carvacrol, thymol, flavonoids, phytosterols and caffeic, ursolic and rosmarinic acids. The above mentioned active components of the oregano action is antibacterial, antioxidant, disinfecting, detoxifying and digestion stimulating. The addition of oregano to the feed of chickens infected with coccidia reduced the degree of intestinal damage and the amount of *E. tenella* oocysts in the feces. In addition, it was found that oregano extract had a positive effect on weight gain also in uninfected chickens [Waldenstedt 2003].

In the prevention of this disease, one can also use *Echinacea*, which contains caffeic acid derivatives, non-starch polysaccharides, alkaloids, flavonoids and essential oils. It has been confirmed that the addition of purple coneflower to feed increases the effectiveness of bird preventive vaccination, reduces disease changes and increases the body mass of affected chickens [Allen 2003].

The use of dried Japanese plum (*Prunus salicina*), which contains immunostimulating components - flavanols, phenolic acids, and anthocyanins, has also proved

beneficial. There was a protective effect on the body during coccidiosis, better weight gains and reduction of excreted oocytes [Świątkiewicz et al. 2009].

Hops cones, Indian saffron (which mitigates the course of coccidiosis), herbs of Chinese medicine, *Capsicum annuum* peppers and shitake mushrooms, also had a positive effect on the immunity. Yucca extract in non-infected birds had a positive effect on the effectiveness of vaccination against coccidiosis. It is also expressed in an increasing length of intestinal villi and improved production performance [Arczewska-Włosek and Świątkiewicz 2013].

Meat quality of boiler chickens and herbal supplementation

The use of herbs in broiler feeding has a positive effect not only on rearing but also on the quality and color of the carcass. The practical application of such additives depends on bird's age, type of feed, production type and housing conditions. In the Institute of Animal Production, Poland, tests were carried out aimed at determining the effect of herbal mixtures on water-holding capacity (WHC) and chemical composition of the muscles in Ross chickens. The starter, grower and finisher feeds were prepared in the powdered form, differing in the content of herbs, which were mixed in the respective proportions: *Calendula* 15%, St. John's wort 10%, marshmallow 5%, chamomile 20%, peppermint 20%, common yarrow 10%, and nettle 20% [Czaja and Gornowicz 2004].

Chicken breast and leg muscles had a lower WHC if the birds had been fed on herbal supplementation. The differences, however, have not been confirmed statistically, so it is impossible to unambiguously conclude whether feeding birds with the addition of herbs had an effect on water absorption in the muscles.

The influence of the addition of herbs on the chemical composition of poultry muscles is slightly marked. Higher fat content was characteristic of chicken muscles, which received a herbal mix, while the water content leveled at an even level. A low ash content was observed in both control groups. In these cases, we can not clearly say that chickens feeding with an addition of herbs had an impact on water-holding capacity. One could notice only a tendency which indicated that there was an influence of herbs on the chemical composition of muscles, especially an increased level of fat and protein [Czaja and Gornowicz 2004].

Studies on the influence of herbs on proteolytic enzymes (peptidases) revealed that herbs in feeds for broilers positively influenced the animal body weight. They can therefore be a good alternative to antibiotic growth promoters and synthetic drugs [Kapica et al. 2006].

HERBS IN CATTLE NUTRITION

Herbs visibly improve the quality of products: milk and meat, and have a positive effect on animal health. The desired effect appears after regular and long-terms use. Medicinal plants contain valuable ingredients: fats, protein, starch, vitamins, mineral salts, pectin, cellulose and biologically active substances.

The evaluation of the nutritional value of feedstuffs most often focuses on the production performance indicators, such as body weight gains, feed intake and conversion, and milk or meat yields. In high-yielding cows there is often a reduced immunity and, as a consequence, an increased susceptibility to diseases [Maksymiec 2012].

Some authors have demonstrated that the administration of 2% herbal mixture containing common yarrow, chamomile, nettle, *Agrimonia*, *Alchemilla* and English plantain positively affects the quality of milk (the cytological and microbiological image). It was shown that milk obtained from cows fed with the mixture was characterized by significantly lower counts of somatic cells (from 437.3 thousand · cm⁻³ to 205.6 thousand · cm⁻³), lower bacteria counts, and reduced contamination with mold and yeast, as compared to milk from cows in the control group. There was an increase in acidifying bacteria from 62% to 88%. Significantly lower was also the frequency of pathogenic bacteria that contaminate milk. A reduction was noted in *Staphylococcus aureus*, from 57% to 3%, and *Streptococcus agalactiae*, from 14% to 2%. This means that the udder health improved and the nutritional value of the milk improved too [Kraszewski et al. 2008].

Herbs also increase the appetite, which means that the cattle take more feed, which in turn causes better conversion. Tests carried out with the addition of 2.0% and 1.0% herbs (fenugreek, pansy, fennel, sage, thyme, chamomile, nettle, mint) to the feed increased the intake of solid feed, resulted in higher body weight, higher daily gains and better conversion of feed. The use of feed with 2% of herbs produced the best results were obtained in bull-calves and heifers. During the tests, no diseases were found in the animals. The average daily gains were 707 g in the control group, 760 g in the group receiving 1% herb addition, and 782 g with 2% herb addition [Kraszewski et al. 2008].

Other studies showing positive effects were obtained using a mineral and herbal mixture in 2.5% to 6%, in which the herbs constituted from 1.0% to 4.0%. The mixture contained yarrow flower, horsetail herb, English plantain, St. John's wort, lemon balm and nettle. The following minerals were used: dicalcium phosphate, dolomite fodder, salts of J, Co, Se, Zn, Cu and fodder chalk. The highest gains were obtained between 127 and 190 days with an increased amount of medicinal plants used in the diet [Saba et al. 2000, after Maksymiec 2012].

Studies on 3-month-old calves showed that an addition of herbs to the feed had beneficial effects on weight gains. The animals were divided into two groups: treatment and control. The treatment group animals were fed 10% decoction of elderberry, *Calendula*, and lemon balm. These animals had significantly better average daily gains compared to the control group (experimental group 716 g and control group 563 g) [Gupta et al. 2005, after Maksymiec 2012].

The aqueous extract from the stems of *Tinospora cardifolia* and the leaves of *Ocimum sanctum* positively influenced the immune system. This was reflected in the decrease in granulocytes and increased number of lymphocytes or increased phagocytic activity [Mukherjee 2005, after Maksymiec 2012].

Application of mineral and herbal supplements containing St. John's wort, nettle, sage and chamomile in the first six months of life of calves resulted in an increase in blood serum inorganic phosphorus, magnesium and calcium [Saba et al. 2000, after Maksymiec 2012].

In other studies, the effect of 20% herbal extract on the level of minerals in the coat was evaluated. Calves who received a mixture of marigold, chamomile, plantain, lemon balm, nettle and St. John's wort received a favorable increase in the content of magnesium, phosphorus and calcium in the calf's hairs. It was also observed that the use of herbal extract in calves positively affects the concentration of iron, zinc and copper in the blood serum [Bombik et al. 2002].

In dairy cattle, feeding with herbal mixtures containing dandelion, nettle, caraway, *Agrimonia*, chamomile, sage, yarrow, lemon balm, lilac and St. John's wort improved chemical composition of milk and enhanced milk yields. The milk of cows that received herbal mixtures had better technological quality compared to that from the control group (without herbs) [Kraszewski 2003].

Studies were also carried out on hematological indicators in calves. Mixes containing licorice, lemon balm, yarrow, clover, marjoram, chamomile, sage, St. John's wort, and nettle caused an increase in red blood cells and raised the level of hemoglobin. This means a very good metabolic effect [Saba et al. 2000, after Maksymiec 2012]. The authors stated that administering herbal mixtures to 7-month-old heifers before the first service positively influenced their reproduction, growth and development. It also had a positive effect on the heat, services per conception rates and higher body weight.

Nowak et al. [2005] determined, based on their research, that the addition of lingonberry and purple coneflower extract positively affects the level of immunoglobulins in the blood serum and the level of total protein as well as the results of breeding Black-and-White calves. 24 animals took part in the experiment, which were divided into 3 groups (8 animals each: 3 calf bulls and 5

heifers). The calves of group I did not receive herbs in the food. The second group took the extract of coneflower (600 mg per head per day), and the third group extract of bilberry (90 mg per head per day). The feeding trial took 8 weeks. Blood was collected from the calves twice, at the beginning and on the completion of the experiment. In group II, increased daily body weight gains were noted, compared to the control group and group III. The most pronounced differences were seen in the first month of administering herbal extracts. In group II and III, higher concentration of total protein in the serum and immunoglobulins in the blood of calves was found. In addition, increased calving feed intake was noted in calves that received mixes with herb addition [Nowak et al. 2005].

HERBS IN SWINE NUTRITION

The beneficial effect of herbs on the health of animals is also used in pork production. In this case, immunostimulating preparations play an important role in the neonatal and postnatal periods in piglets. During these periods, piglets are particularly exposed to numerous diseases and disorders caused by microorganisms. This is important from an economic point of view, since the prevention of diseases is expensive and at the same time limited. For these reasons, it is important to maintain the appropriate housing conditions of individual piggeries (hygiene, ventilation, temperature), nutrition (administration of milk and colostrum), behavior of the staff, and health of the piglets [Pejsak et al. 2003].

Lack of resistance and environmental factors is the cause of high mortality and morbidity of newborn piglets during the period from birth to weaning. For this reason, many studies are carried out on the immunity of juvenile livestock animals. Many medications based on medicinal herbs have been created that have immunomodelling, anti-stress or adaptogenic effects [Markowska-Daniel et al. 2010].

A study aimed at determining the effect of a herbal preparation on piglet rearing results and their immunity showed its beneficial effect on body weight at birth, viability, growth rate during rearing and serum immunoglobulin concentration. There was an increase in serum IgG concentration in piglets at weaning on day 28. In all animals fed the herbal preparation (experimental group), the concentration of immunoglobulins IgA and IgG was higher by an average of 21% than in the control group (fed without the addition of herbs). The mean body weight of piglets from the weaning experimental group was higher by 3.9% and 6.7% compared to the control group [Markowska-Daniel et al. 2010].

An addition of herbs has a positive effect on swine reproduction. Fennel, cumin, juniper or nettle improve milk yields of lactating sows and their reproduction parame-

ters. There is better appetite and increased metabolism in sows during the periparturient period. Herbs reduce the duration of labor [Rekiel et al. 2011] and ease the removal of the placenta, which greatly affects young piglets and increases their survival [Hanczakowska 2007]. Anti-inflammatory activity of chamomile improve the condition of the litter [Paschma 2007]. Administration of cumin to high-yielding sows effectively prevents agalactia, which often is the case following a difficult parturition [Sadowska 2003].

Coach grass, nettle and garlic increase feed intake, which is especially important during the weaning of piglets. As a result, the digestibility of the feed and its components increased. An improvement of metabolic processes was also demonstrated, which resulted in the protein deposition in the carcass [Turyk and Osek 2010].

Studies were carried out on birth-hypotrophic piglets. They were characterized by poor immunity as a result of lactation disfunction in dam sows. The herbal preparation prepared from basil, fenugreek, marigold, dill and chamomile improved phagocytic activity and increased weight gains of the piglets [Kończak et al. 1997].

Administration of herbal mixtures, which include lady's mantle, nettle and dill, shortens the labor and the newborn piglets are more viable and have more weight [Fritz and Grela, 1995].

Dry extracts of lemon balm, sage and coneflower resulted in better daily gains in porkers. Lemon balm as a feed additive also improved carcass lean percentage by more than 2%, whereas sage and coneflower increased the loin eye area by 3% [Hanczakowska 2007].

Krusiski [2004] stated that along with the increase in the content of herbs in feed (1%, 2.5%, and 5%) the body weight gains in pigs were increasing too. The herbs used (nettle, coneflower, yarrow and garlic) did not affect the conversion of the feed. Studies conducted by Peris and Asensio [2002] proved, however, that the use of essential oils extracted from herbs, in combination with propionic, formic and lactic acids, increases feed conversion rate by 8% and improves animal growth by 10%.

To test the effect of herbal extracts on sows during lactation and pregnancy, oregano, cinnamon and Mexican chili peppers were added to the diet. The influence of these herbs on the thickness of backfat in lactating sows, composition of milk and piglet rearing success was evaluated. The research was carried out on 40 sows (Polish Landrace x Polish Large White). During the experiment, the maintenance conditions were the same. From the 3rd month of pregnancy to the 28th day of life of piglets, the sows of the experimental group were given a mixture with XTRACT. This preparation contained 2.2% Mexican chili (capsaicin), 3.2% cinnamon (cinnamaldehyde) and 5.4% oregano (carvacrol). Milk was also ta-

ken from the sows and its composition was analysed [Matysiak et al. 2014].

The offspring of sow that received a herbal preparation at the 28th day of life had a bolder bacon at points P4 and P2 than piglets from the control group. The analysis showed that the sow's milk, which received the preparation contained a greater concentration of lactose. Significant differences were not found in the protein, dry matter and fat content in the milk of sows of both groups. The number of animals in the litter was similar in both groups. Mortality from day 1 to day 28 was lower by 4.1% in the experimental group. It can therefore be concluded that the use of oregano, chili and cinnamon has a positive effect on the viability, weight and growth of piglets [Matysiak et al. 2014].

Urbańczyk et al. [2002], who studied possibilities of substituting antibiotic growth promoters with a herbal mixture in swine feeding, confirmed the beneficial effect of herbs on the fattening process. The mixture called Ziolośan T contained: milk thistle, dandelion, coriander, marjoram, turkish pepper, garlic, chamomile, nettle, peppermint and lemon balm. The trial was carried out on 3 groups of animals. Group I was fed with no supplement, the second group was given a blend with the addition of Ziolośan T, and the third group was fed on mix containing flavanicin (an antibiotic).

The effects of using the herbal mixture were already visible at the beginning of fattening. Animals fed with Ziolośan T gained on average 90 grams more per day than those in the control group and by 66 grams more compared to group III of pigs [Urbańczyk et al. 2002].

In addition, in post-slaughter carcass evaluation, pigs receiving Ziolośan T outdid the animals of the other two groups. They were characterized by the largest loin eye area, the thinnest backfat layer, the greater lean content in the prime cuts (about 6.5% more meat in the carcass compared to the other groups). In conclusion, these studies have found that the selection of appropriate herbs for feed positively influences pig fattening and may represent an alternative to a growth-promoting antibiotics [Urbańczyk et al. 2002].

The effect of herbal supplements on blood profile and piglets growth was also analyzed. In the study by Kasprowicz-Potocka [2011], the following herbal mix was used: (group II) nettle, English plantain, rosemary, thyme, thyme, lemon thyme, and (group III) nettle, knotgrass, garlic, anise, and coneflower. The initial body mass in all groups was very similar, but after the time of using the mixtures, the group II and III animals which received herbs in their diet had the best gains. The piglets from these groups were also characterized by a better viability and were found to have the best profiles of erythrocytes, hemoglobin and hematocrit. Herbs also contributed to an increase in the content of iron, sodium, copper and potas-

sium in the blood serum. In the animals receiving herbs, changes in the content of magnesium, potassium, sodium and zinc in the blood serum were also observed. This indicates a better absorption of mineral substances from food. The B-safe preparation also had a positive effect on piglet rearing. The animals fed with the preparation had a greater body weight, and thus better weight gains. This addition also improved daily feed intake and significantly reduced mortality of piglet. Young animals that received B-safe went through diarrheas much better, and the disease lasted shorter when compared to animals that did not receive the preparation [Grela and Kowalczyk-Vasilev 2009].

Feeding pigs with preparations containing essential oils results in a positive effect. Studies on the use of oregano oil showed that an addition of 1 gram per 1 kg of feed improved sows reproduction parameters, litter performance and piglets health, whereas an addition of half a gram of this oil per one kilogram of feed positively influenced the growth of porkers and piglets [Kasprowicz-Potocka 2011].

CONCLUSIONS

The review characterizes selected herbs that are used in feeding farm animals. After the withdrawal of antibiotics growth promoters, breeders began to look for new preparations and agents that would provide a good substitution for the previously used drugs. An important substitute was found in the form of herbal plants. Due to a higher content of biologically active substances compared to other plants, herbs exert very positive effects on the functioning of the body.

Based on the published documented studies, it should be stated that adding herbs to the feed in various forms usually has a positive effect on health, growth and production performance of livestock animals. This applies to all animal groups described in the review, namely cattle, pigs and poultry (laying hens and broiler chickens).

It is worth mentioning that applying herbs as antibiotic replacements is not enough if we want to improve the performance of the animals. Farmers must also ensure an appropriate management system, good environment in which they live, and a high level of animal welfare. Herbal supplementation of animal nutrition aimed to improve rearing performance should be treated comprehensively.

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WYKORZYSTANIE ZIOŁ W ŻYWIENIU ZWIERZĄT GOSPODARSKICH

STRESZCZENIE

Wycofanie antybiotykowych stymulatorów wzrostu (ASW) z listy dozwolonych dodatków paszowych zmusiło hodowców do poszukiwania alternatywnych, a zarazem bezpiecznych zamienników. W grupie tej znalazły się między innymi probiotyki, synbiotyki, enzymy i proenzymy, związki mineralne, kwasy organiczne i nieorganiczne, a także fitobiotyki, czyli preparaty pochodzenia roślinnego pozyskiwane z ziół. Zioła lecznicze zawierają w swoim składzie wiele związków biologicznie czynnych i w różnych kombinacjach, dzięki czemu mają szeroki zakres oddziaływania w organizmie zwierząt. W pracy dokonano charakterystyki ziół leczniczych wykorzystywanych w żywieniu zwierząt gospodarskich: bydła, drobiu i trzody chlewnej. Badania naukowe potwierdziły skuteczność preparatów ziołowych i dowiodły, że można zastąpić nimi antybiotyki. Fitobiotyki miały pozytywny wpływ na zdrowie zwierząt, jakość i ilość pozyskiwanych surowców od zwierząt gospodarskich: bydła (użytkowość mleczna i mięsna), trzody chlewnej (użytkowość mięsna i użytkowość rozplodowa) i drobiu (użytkowość nieśna u kur i brojlerów kurzych). Szczególnie zauważalny był lepszy stan zdrowia zwierząt po zastosowaniu ziół i preparatów ziołowych. Oceniano to na podstawie analizy morfologicznej krwi, jej składu porównując ze zwierzętami, które nie otrzymywały w dawce pokarmowej ziół. Zainteresowanie stosowaniem fitobiotyków będzie wzrastało ze względu na ich naturalne pochodzenie, wyższą świadomość konsumentów i wzrastający popyt na żywność ekologiczną. Dla osiągnięcia pożądanego efektów nie wystarczy zastępowanie antybiotyków ziołami czy dodawanie ich do pasz. Należy zadbać o właściwie skomponowaną dawkę pokarmową, dobrostan zwierząt i odpowiednią profilaktykę weterynaryjną.

Słowa kluczowe: zioła, rośliny lecznicze, zdrowie, żywienie, zwierzęta gospodarskie

