Use of Phyto-Additives in Poultry Nutrition

Teodor Gavris, Untea Arabela, Mihaela Saracila

National Research and Development Institute for Animal Biology and Nutrition, 077015-Balotest, Calea Bucuresti, 1 ,Ilfov, Romania

Abstract

This article presents experimental data on the properties, efficacy and modes of action of phyto-additives that can be used in poultry nutrition. Phyto-additives are a great variety of herbs, spices and products derived from them, as well as essential oils. The content of active substances in these products can vary greatly depending on what part of the plant is used (grains, leaves, roots, bark, flowers, or buds), the harvest season and geographical origin and technique of treatment (cold, steam distillation, extraction or maceration with non-aqueous solvents, etc.). The uses of phyto-additives are still limited in relation to their mode of action and aspects of application in poultry nutrition. Phyto-additives are supposed to improve the palatability of feed and hence improve performance. Although many studies have demonstrated antioxidant and antimicrobial efficacy *in vitro*, this still remains to be checked *in vivo*. It is also assumed that phyto-additives improve nutrient absorption and enzymatic activity of poultry digestive tract. However, the limited number of comparative studies between phyto-additives and antibiotics suggests that they can have beneficial effects on the digestive tract by reducing the number of implicit bacteria and metabolites produced by them. Other studies show that phyto-additive use in animal feed improves the secretion of intestinal mucus. Also, a systematic approach to the effectiveness, dose, mode of action and safety of phyto-additives in poultry feed is not yet well established.

Keywords: broiler chickens, phyto-additives, plants extracts

1. Introduction

Since ancient times, people have explored nature, especially plants looking for new drugs. Medicinal plants since ancient times have been used to treat or ameliorate various diseases, the only existing remedy for a long time, and now basic remedies in some cases. According to chemical analyses carried out on plants, they have been shown to contain substances belonging to classes of compounds such as steroids, anthocyanins, terpenoids, coumarins, tannins, fatty acids, polyphenols. The results, suggest that these plants have an antioxidant and curative role in treating certain diseases [1].

In the last decades, plants have come back to people's attention for various reasons, one of them being getting new treatments for incurable diseases right now. Another reason why plants have returned to the attention of man would be that classical, suture medications cannot definitively treat a disease or come with an intake of undesirable chemicals. As a result of these observations, both medicine and the pharmaceutical industry, several plants could be used for curative purposes [2].

Medicinal herbs and herbal products are a wide range of nutraceuticals, a term defined as "any non-toxic food component that has scientifically proven benefits, including the prevention or treatment of diseases." It has been shown that many classes of plant products have antimicrobial activity, including phenols, quinones, flavones, tannins, etc. An advantage of these vegetable sources is that active substances come in complex mixtures, not just unique compounds such as synthetic ones, which is why the increase in microorganism resistance is lower [3].

* Corresponding author: Teodor Gavris
Email: gavris_teodor@yahoo.com

Phyto-additives are secondary products of plants used in animal feed to improve production performances, health status and environmental protection. Assistants came to the attention of researchers after banning antibiotics in 2006 in the European Union [4].

2. The importance of phyto-additives

Antibiotics have been used as growth promoters to improve the daily average gain due to a combination of better conversion of food and voluntary ingestion of a larger amount of food. The simple removal of growth promoters in farm animal feed would result in low food intake, animal health damage, increased mortality, decreased daily average feed and feed conversion, thus reduced profitability [5].

Currently, their plants and extracts are increasingly used, especially for the purpose of improving animal feed conversion and increasing meat quality. According to technical and economic indicators, the use of phyto-additives will continue to grow, with growth promoters as well as antibiotic substitutes.

In the last three decades, there has been a significant increase in the use of plants and their extracts, not only as medicaments and dietary supplements, but also in the field of animal nutrition. The use of herbal food additives, including essential oils and herbal mixtures (exotic), is widely promoted by the producers, but the scientific background underlying them is often limited.

Alternatives to antibiotics as growth promoters are very diverse, especially botanical mixtures, organic acids, probiotics, prebiotics, symbiotics, plant extracts, essential oils, enzymes [6]. The market for fodder additives is on the rise, intensive plant-based substances are a real alternative to using antibiotics as growth promoters. Plant herbs act on the digestive system, stimulating appetite, modifying intestinal flora, and also improving the palatability of feed [7]. Depending on the amount used, plant extracts may have a bacteriostatic or bactericidal effect [8].

Plants and plant extracts have been used in traditional medicine for centuries. After banning the antibiotics, the plants and their extracts were used as replacements in pigs and broilers feed [9, 10]. It has been found that some natural substances have a prophylactic effect, which improves the action against enteric disorders.

The antibacterial effect of essential oils depends on their chemical composition and the amount administered. Existing studies show that the effects of essential oils are due to the type of plant from which they are extracted, the appropriate mixture and the quantities used [11]. Synergistic effects of essential oils and organic acids have been demonstrated by Namkung et al., (2004) [12]. The garlic extract appears to have the best antimicrobial effect of all plant extracts in vivo [13], and in vitro the best effects were observed on thyme [14], oregano, cinnamon [15].

3. Anti-oxidative effects

The antioxidant properties of the plant have attracted the attention of the researchers, being considered of interest, for example, volatile oil extracted from plants of the Labitaceae family, especially rosemary. [16]. The antioxidant activity of rosemary comes from phenolic terpenes, such as rosmarinic acid and rosmarol [17].

Plant species of the Zingiberaceae family (e.g., ginger, turmeric), or the family of Umbelliferae (eg anise, coriander) are described as plants rich in antioxidants, flavonoids (eg green tea) and anthocyanins [18, 19]. The antioxidant potential of phytoadiatives containing phenolic components of the Lamiaceae family in order to increase the oxidative stability of animal products has been studied on poultry meat [20], pig meat [21] and eggs [22].

A mixture of plants can improve the oxidative stability of the piglet liver [23]. Also, grape seed powder improves oxidative stability of eggs enriched in linolenic acid [24].

However, plant antioxidants should be studied in order to make a decision regarding the replacement of synthetic antioxidants with those derived from plants.

4. Digestive effects

Phyto-additives are often used to improve the palatability of feed, resulting in increased production performance. However, the number of studies in which phytoadiative specific effects on palatability have been tested are quite limited, with studies in which, for example, pigs have not ingested feed containing certain doses of essential oil of fennel and cumin as well and oregano [25, 26]. On the other hand, several studies show an increase in the amount of ingested food through phyto-additives [27].

It is also supposed that their plants, spices and extracts improve the food quality of the feed. A wide variety of spices, plants and extracts are known in medicine for their beneficial effects on the digestive tract, as laxatives and spasmolytic effects as well as for the prevention of flatulence [28]. Moreover, it is proposed that stimulation of digestive secretions (e.g., saliva), bile and mucus as well as enhancing enzyme activity be a central mode of nutritional action [29].

It has also been reported that phyto-additives stimulate the secretion of gastric mucus in broilers, an effect that is supposed to affect the adherence of pathogens and thus contribute to the stabilization of the microbiota in the intestine of the animals [30]. The use of Chinese cinnamon essential oil (*Cinnamomum zeylanicum*), Chilean boldo leaves (*Peumus boldus*), and fenugreek seeds (*Trigonella foenum-graecum*) shows that it increases the intestinal length and increases the pH of the jejunum. It can also be observed that the use of this mixture reduces the lipid oxidation of the intestinal content.

5. Antimicrobial Effects

Plants and spices are well known for their antimicrobial effect demonstrated in vitro [31, 32]. The active substances are largely the same as those mentioned above for antioxidant properties, such as for example phenolic compounds. Again, the Lamiaceae family is of high interest, in this case the thyme, oregano and salvia are representative [33]. Oregano powder and oil improves the intestinal micro-flora of chicks under heat stress [34].

The main mode of action is based on the properties of oils to destroy cell membranes of pathogenic organisms. Strong antibacterial activities are also produced by other non-phenolic substances, for example limonene and compounds of *Canadian macadamia* (*Sanguinaria canadensis*) [35, 33]. The microbiological analysis of the minimum inhibitory concentrations of plant and herb extracts as well as pure active substances show levels that considerably exceeded the doses that can be used in feed when used as plant additives [33]. This may indicate that the antimicrobial action of phytogenic additives should not contribute significantly to the overall efficacy of this category of additives in animal nutrition. On the other hand, some broiler studies have shown in vivo that essential oils are effective against *E. coli* and *Clostridium perfringens* [36]. The willow bark extract (*Salix Alba*) contributes to the improvement of the intestinal microbial of broiler chickens by reducing the number of Enterobacteriaceae and Staphylococci [37].

6. Effects of phytogenics on broiler chicken

With respect to broiler chickens, a decrease in blood glucose, triglycerides and cholesterol in the blood has been observed following the administration of grape seeds and sea buckthorn [38].

Inclusion of mulberry leaves up to 5% in broiler feed does not affect growth performance but improves meat quality by lowering cholesterol in meat [39]. Supplementing feed of broiler chickens with oregano and roseship helps to improve the health of the digestive system [40]. After use of plant extracts can be observed an reduction of lipid intestinal oxidation, caused by intestinal pathogens, resulting a better intestinal nutrient absorption, and increased the activity of antioxidant enzymes that helped to enhance the birds' immune response. Also the gut length was higher at the birds supplemented with plants extracts [41].

Grape seed meal used in the feed of broiler chickens influences meat quality by enriching it unsaturated fatty acids [42]. Under the action of heating stress productive performance and digestive health are affected. To combat these effects in the chicken diet can be added polyphenols derived from plants such as *Artemisia annua*. The use of this plant and the oil extracted from it results in increased carcass size and

implicit consumption of feed. After the use of *Artemisia annua* in chicken diets, there was also a decrease in the number of Enterobacteriaceae and the increase in the number of Lactobacilli [43].

7. Effects of phytogenics on laying hens

Following the use of fenugreek in the feeding of laying hens, it has been observed that it improves the digestibility of the fibers, but also the enrichment of the egg in linolenic acid [44]. Following the administration of roots Chicory of and *Jerusalem artichokein* the feeding of laying hens as organic sources of manganese, iron and inulin, it was observed that their bioavailability is higher than inorganic sources [44]. The use of grape seed in the laying hens egg feed reduces the amount of cholesterol in the egg up to 16% [45]. The use of marigold leaves and pumpkin pulp in laying hens helps to improve the organoleptic quality of eggs, size of the yolk and feed conversion rate [44]. Using of grape seed meal in feed of laying hens leads to improve the amount of flavonoids and polyphenols in the eggs. There is also a change in the ω-6/ω-3 PUFA ratio in the egg composition and the increase in antioxidant capacity [46].

8. Conclusions

Currently, phytogenic additives are considered as a valuable alternative to antibiotics, with supposed antioxidant, antimicrobial effects and improved animal performance, which are partly associated with increased feed consumption, presumably due to improved palatability.

In monogastric animals, the use of phyto-additives in food has led to: increased productive performance; increasing oxidative stability of meat; improving intestinal microflora; Improving the performance of the carcass; lowering cholesterol in the blood; improving the fatty acid profile in meat.

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References

1. Temelie, M., Enciclopedia plantelor medicinale spontane din Romania, Editura Rovimed Publishers, Bucuresti, 2005.
2. Muntean, L. S., Tămaş, M., Muntean, S., Muntean, L., Duda, M., Vârban, D., Florian, S., Tratat de plante medicinale cultivate şi spontane, Ed. Risoprint, Cluj-Napoca, 2017.
3. EFSA, Assessment of plants/herbs, plant/herb extracts and their naturally or synthetically produced components as "additives" for use in animal nutrition, 2005.
4. Windisch, W., Schedle, K., Plitzner, C., Kroismayr, A., Use of phytogenic products as feed additives for swine and poultry 1. Journal of animal science, 2008, 86(14_suppl), E140-E148.
5. Criste, R. proiect cercetare FITOMIN, raport cercetare, 2009.
6. Huyghebaert, G., Ducatelle, R., Van Immerseel, F., An update on alternatives to antimicrobial growth promoters for broilers. The Veterinary Journal, 2011, 187(2), 182-188.
7. Frankič, T., Voljč, M., Salobir, J., Rezar, V., Use of herbs and spices and their extracts in animal nutrition, Acta Agric Slov, 2009, 94(94), 95-102.
8. Tosi, E. A., Ré, E., Ortega, M. E., Cazzoli, A. F., Food preservative based on propolis: Bacteriostatic activity of propolis polyphenols and flavonoids upon *Escherichia coli*, Food chemistry, 2007, 104(3), 1025-1029.
9. Borovan, L., Plant alkaloids enhance performance of animals and improve the utilizability of amino acids, Krmivarstvi, 2004, 6, 36-37.
10. Hernandez, F., J. Madrid, V., Garcia, J., Orengo, Megias, M. D., Influence of two plant extracts on broilers performance, digestibility, and digestive organ size, Poult. Sci., 2004, 83, 169-174.
11. Oetting, L. L., Utiyama, C. E., Giani, P. A., Ruiz, U. D., Miyada, V. S., Effects of herbal extracts and antimicrobials on apparent digestibility, performance, organs morphometry and intestinal histology of weanling pigs, Braz. J. Anim. Sci., 2006, 35, 1389-1397.
12. Namkung, H., Li, M., Gong, J., Yu, H., Cottrill, M., de Lange C. F. M., Impact of feeding blends of organic acids and herbal extracts on growth performance, gut microbiota and digestive function in newly weaned pigs, Can. J. Anim. Sci., 2004, 84, 697-704.
13. Arnault, I., Christidès, J. P., Mandon, N., Haffner, T., Kahane, R., Auger, J., High-performance ion-pair chromatography method for simultaneous analysis of alliin, deoxyalliin, allicin and dipeptide precursors in garlic products using multiple mass spectrometry and UV detection, Journal of Chromatography, 2003, 991(1), 69-75.

14. Azaz, A. D, Irtem, H. A, Kurkcuoglu, M., Baser, K. H. C., Composition and the in vitro antimicrobial activities of the essential oils of some Thymus species, Journal of Biosciences, 2004, 59, 75–80.
15. Carson, C. F., Hammer K. A, Riley T. V, *Melaleuca alternifolia* (tea tree) oil: a review of antimicrobial and other medicinal properties, Clinical Microbiology Reviews, 2006, 19, 50–62.
16. Ognik, K., Cholewińska, E., Sembratowicz, I., Grela, E., Czech, A., The potential of using plant antioxidants to stimulate antioxidant mechanisms in poultry, World's Poultry Science Journal, 2016, 72(2), 291-298.
17. Cuppett, S. L., Hall, C. A., Antioxidant activity of the Labiatae, Advances in food and nutrition research,1998, 42, 245-272.
18. Nakatani, N., Phenolic antioxidants from herbs and spices, BioFactors, 2000, 13, 141-146.
19. Wei, A., Shibamoto, T., Antioxidant Activities and Volatile Constituents of Various Essential oils, J. Agric. Food Chem, 2007, 55, 737-1742.
47.
20. Florou-Paneri, P., Giannenas, I., Christaki, E., Govaris, A., & Botsoglou, N., Performance of chickens and oxidative stability of the produced meat as affected by feed supplementation with oregano, vitamin C, vitamin E and their combinations, Archiv fur Geflugelkunde, 2006, 70(5), 232-239.
Janz, J. A. M., Morel, P.C.H., Wilkinson, B. H. P., 21Purchas, R. W., Preliminary investigation of the effects of low-level dietary inclusion of fragrant essential oils and oleoresins on pig performance and pork quality, Meat Sci., 2007, 75, 350-355.
22. Botsoglou, N. A., Florou-Paneri, P., Botsoglou, E., Dotas, V., Giannenas, I. Koidis, A., Mitrakos. P., The effect of feeding rosemary, oregano, saffron and alpha-tocopheryl acetate on hen performance and oxidative stability of eggs, S. Afr. J. Anim. Sci., 2005, 35, 143-151.
23. Untea, A. E., Cornescu, M. G., Panaite, T. D., Olteanu, M., Gavris, T., Lupu, A., Effect of dietary antioxidant plant mixture on the oxidative stability of liver in piglets, Archiva Zootechnica, 2018, 21(1), 19-26.
24. Saracila, M., Panaite, T. D., Untea, A., Ropotă, M., Vlaicu, P. A., Șoica, C., Mitoi, M., Evaluation of oxidation stability and antioxidant activity in eggs enriched in ω-3 polyunsaturated fatty acids, Archiva Zootechnica, 2017, 20(1).
25. Jugl-Chizzola, M., Ungerhofer, E., Gabler, C., Hagmuller, W., Chizzola, R., Zitterl-Eglseer K., and Franz, C., Testing of the palatability of *Thymus vulgaris* L. and *Origanum vulgare* L. as flavouring feed additive for weaner pigs on the basis of a choice experiment, Berl. Munch. Tierarztl, 2006, 119, 238-243.
26. Schöne, F., Vetter, A., Hartung, H., Bergmann, H., Biertumpfel A., Richter G., Müller S., Breitschuh G.,. Effects of essential oils from fennel (*Foeniculi aetheroleum*) and caraway (*Carvi aetheroleum*) in pigs, J. Anim. Physiol. Anim. Nutr., 2006, 90, 500-510.
27. Freitag, M., Hensche, H. U., Schulte-Sienbeck, H., Reichelt B., Kritische Betrachtung des Einsatzes von Leistungsförderern in der Tierernährung. Forschungsbericht des Fachbereichs Agrarwirtschaft Soest. ISBN 3-00-003331-9. Universität 439 Gesamthochschule Paderborn, Germany, 1998.
28. Chrubasik, S., Pittler, M. H., Roufogalis, B. D., Zingiberis rhizome: A comprehensive review on the ginger effect and efficacy profiles, Phytomedicine, 2005, 12, 684-701.
29. Platel, K., Srinivasan, K., Digestive stimulant action of spices: A myth or reality?, Indian J. Med. Res., 2004, 119, 167-179.
30. Jamroz, D., Wertelecki, T., Houszka, M., Kamel. C., Influence of diet type on the inclusion of plant origin active substances on morphological and histochemical characteristics of the stomach and jejunum walls in chicken, J. Anim. Physiol. Anim. Nutr., 2006, 90, 255-268.
31. Si, W., Gong, J., Tsao, R., Zhou, T., Yu, H., Poppe, C., Johnson R., Du. Z., Antimicrobial activity of essential oils and structurally related synthetic food additives towards selected pathogenic and beneficial gut bacteria, J. Appl. Microbiol., 2006, 100, 296-305.
32. Özer, H., Sökmen, M., Güllüce, M., Adigüzel, A., Sahin, F., Sökmen, A., Kilic, H., Baris. Ö., Chemical Composition and Antimicrobial and Antioxidant Activities of the Essential Oil and Methanol Extract of *Hippomarathum microcarpum* (Bieb.) from Turkey, J. Agric. Food Chem., 2007, 55, 937.942.
33. Burt, S., Essential oils: their antibacterial properties and potential applications in food – a review, Int. J. Food Microbiol, 2004, 94, 223-253.
34. Turcu, R. P., Tabuc, C., Vlaicu, P. A., Panaite, T. D., Buleandra, M., Saracila, M., Effect of the dietary oregano (*Origanum vulgare* L.) powder and oil on the balance of the intestinal microflora of broilers reared under heat stress (32°C), Scientific Papers: Series D, Animal Science-The International Session of Scientific Communications of the Faculty of Animal Science, 2018, 61.
35. Newton, S. M., Lau, C., Gurcha, S. S., Besra, G. S., Wright, C.W., The evaluation of forty three plant species for in vitro antimycobacterial activities; isolation of active constituents from *Psoralea corylifolia* and *Sanguinaria Canadensis*, J. Ethnopharmacol, 2002, 79, 57-67.
36. Jamroz, D., A. Wiliczkiewicz, T. Wertelecki, J. Orda, and J. Skorupinska. Use of active substances of plant origin in chicken diets based on maize and locally grown cereals, Br. Poult. Sci., 2005, 46, 485-493.

37. Saracila, M., Criste, R. D., Panaite, T. D., Vlaicu, P. A., Tabuc, C., Turcu, R. P., Olteanu, M., *Artemisia Annua* as Phytogenic Feed Additive in the Diet of Broilers (14-35 Days) Reared under Heat Stress (32ºC), Brazilian Journal of Poultry Science, 2018, 20(4), 825-832.
38. Vlaicu, P. A., Panaite, T. D., Olteanu, M., Ropota, M., Criste, V., Vasile, G., Grosu, I., Production parameters, carcass development and blood parameters of the broiler chicks fed diets which include rapeseed, flax, grape and buckthorn meals, 2017.
39. Olteanu, M., Criste, R., Cornescu, G., Ropota, M., Panaite, T., Varzaru, I., Effect of dietary mulberry (*Morus alba*) leaves on performance parameters and quality of breast meat of broilers, Indian Journal of Animal Sciences, 2015, 85(3), 291-295.
40. Criste, R. D., Panaite, T. D., Tabuc, C., Sărăcilă, M., Șoica, C., Olteanu, M. Effect of oregano and rosehip supplements on broiler (14-35 days) performance, carcass and internal organs development and gut health, AgroLife Scientific Journal, 2017, 6(1), 75-83.
41. Fascina, V. B., et al., Effects of phytogenic additives and organic acids, alone or in combination, on the performance, intestinal quality and immune responses of broiler chickens, Brazilian Journal of Poultry Science, 2017, 19.3, 497-508.
42. Turcu, R. P., Olteanu, M., Criste, R. D., Panaite, D, T., Ropota, M., Alexandru, V. P. Soica C., The use of flaxseed meal and grape seed flour (2% and 3%) as natural antioxidant in broiler diets. Scientific Papers-Animal Science Series: Lucrări Ştiinţifice-Seria Zootehnie, USAMV Iasi, 2018, 69(23), 200-206.
43. Saracila, M., Criste, R. D., Panaite, T. D., Vlaicu, P. A., Tabuc, C., Turcu, R. P., Olteanu, M., Artemisia Annua as Phytogenic Feed Additive in the Diet of Broilers (14-35 Days) Reared under Heat Stress (32ºC), Brazilian Journal of Poultry Science,2018, 20(4), 825-832.
44. Panaite, T. D., Varzaru, I., Criste, R. D., Papuc, C., Cornescu, G. M., Ropota, M., Predescu, C. (2015). Effect of the dietary fenugreek (*Trigonella foenum-graecum*), used as antioxidant in layer diets, on the nutritional quality of the eggs, Archiva Zootechnica, 8(2).
45. Olteanu, M., Criste, R. D., Panaite, T. D., Ropotă, M., Mitoi, M., Vlaicu, P. A., Șoica, C., Quality of the eggs obtained from hens fed diet formulations rich in polyunsaturated fatty acids and with grape seeds meal as antioxidant, Archiva Zootechnica, 2017, 20(1).
46. Olteanu, M., Criste, R. D., Panaite, T. D., Bunduc, V., Panaite, C. V., Ropota, M., Mitoi, M., Study on the efficiency of grape seed meals used as antioxidants in layer diets enriched with polyunsaturated fatty acids compared with vitamin E, Brazilian Journal of Poultry Science, 2016, 18(4), 655-662.