

# FARMERS' ECONOMIC INTEREST IN *DERMANYSSUS GALLINAE* CONTROL

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Review paper

**Abstract:** Poultry red mite or *Dermanyssus gallinae* (De Geer, 1778) is the most significant poultry ectoparasite with regards to health and economy. It is a widely accepted opinion that *D. gallinae* can only be suppressed, with the current annual expenditure of 60 eurocents per layer. However, research indicates that *D. gallinae* can be controlled in other ways and eradicated from the production facilities and farms, and subsequent reinfestation can be prevented by implementing biosafety measures. This provides a long-term or permanent effect of *D. gallinae* control. From the aspect of economy, this means that after decades of increasing expenditures, farmers can first decrease, and then completely eliminate expenditures incurred by *D. gallinae*. Therefore, economic calculations should be based on an expert and comprehensive approach, which should itself be based on rational control, preventive veterinary medicine, i.e. *D. gallinae* control program. This would result in long-term savings. In 10 years' time, 0.5 million euros would be saved per 100.000 layers. There are an estimated 4 billion infested layers worldwide.

**Key words:** *Dermanyssus gallinae*, control, economic interest

## Introduction

Poultry production is the field of animal husbandry which provides the largest portion of animal source foods for human consumption. Last decades have been marked by an intensive increase in egg production. Over the period from 1970 to 2007, the production of table eggs tripled and rose from 20 million to 60 million tons. According to FAO, the number of layers reached 4.93 billion in 2009 (FAO, 2010).

Poultry red mite is the most significant poultry ectoparasite with regards to

health and economy (Nordenfors, 2000). Control of red poultry mites in the current situation, not paying enough attention to the choice of acaricidal products for control and methods, i.e. rational pharmacotherapy (suppression), professional application and the principle of preventive veterinary medicine. Therefore, simultaneously with the increase in egg production, the problem of prevalence and harmful effect of poultry red mite has also increased, together with the damage caused by inefficient, partly efficient, or illegal control (Giangaspero et al., 2011, 2017; Marangi et al., 2012)

## Poultry red mite

Poultry red mite, *Dermanyssus gallinae* (De Geer, 1778) is an invasive arthropod, successfully adapted to the conditions of modern poultry production (figure 1). Over 80% of commercial layer flocks, as well as parent and breeding flocks are affected by the invasion of this ectoparasite (Sparagano et al., 2009). Its small size (about 1 mm), mobility, ability to feed on a large number of species of birds and mammals, resistance to temperature conditions and starvation (Pavličević et al., 2007b), extreme adaptability and development of resistance, large numbers and high reproductive potential, hidden way of life and night activity (Simić and Živković, 1958) are the traits of this parasite which enable its invasiveness. Poultry red mite is a problem of the flock, but also of the environment, thus jeopardising not just current, but also future flocks (Pavličević et al., 2018b).

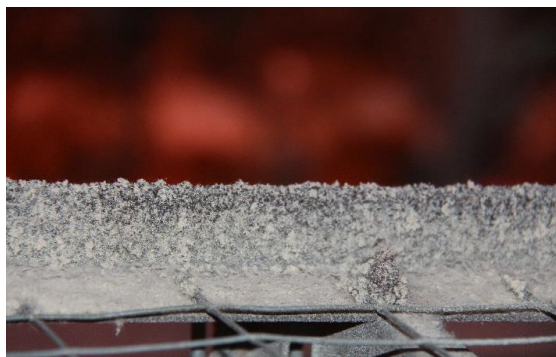


**Figure 1.** Microscopic image of *D. gallinae*. The mites get their red colour from freshly consumed blood (Photo: Zeković Miljan & Pavličević Aleksandar)

In addition to biological traits of the parasites, the basis of this health and economic problem is a long-term wrong approach to *D. gallinae* control, which has been additionally exacerbated by the new changes (EU 1999/74/EC) in the technological conditions of housing layers (Pavličević *et al.*, 2016a, 2016c, 2019; Flochlay *et al.*, 2017).



**Figure 2.** *D. gallinae* invasion in the clinical conditions of commercial egg production, cage system. Hundreds of thousands of these parasites can parasitise on one laying hen  
(Photo: Pavličević Aleksandar)



**Figure 3.** *D. gallinae* invasion in the clinical conditions, a detail of the upper, inner edge of the cage with massive clusters (Photo: Pavličević Aleksandar)

## Harmful effects

The harm caused by *D. gallinae* can be direct and indirect. Direct harm is caused by immediate parasitic action of *D. gallinae*: crawling on the body, stinging and bloodsucking. This results in poultry being afflicted by stress, anaemia due to blood loss, deteriorated general health state and immune status, aggravation and transmission of infectious diseases. Clinical manifestations in the flock are nervousness, pronounced health problems, increased mortality rates, reduced egg quality, and increased feed consumption (Emous 2005, 2017; Flochlay *et al.*, 2017).

*D. gallinae* is a zoonosis and occupational disease (Caferio *et al.*, 2019). It also afflicts people, causing nervousness, itching, and changes on the skin. These problems can result in workers leaving their jobs or asking for compensation due to aggravated working conditions.

Further, indirect harm caused by *D. gallinae* occurs due to transmission and incorrect approach.

1. A young flock can be invaded in the rearing facility, and it can further transmit the infestation to a previously uninfested production facility, thus

causing further damage. The disease caused by *D. gallinae* (*Dermanyssosis*) is a hidden flaw, but it can be detected if properly looked for. The condition necessary to avoid the damage is a correct forensic assessment and definition of legal relations (Pavličević et al., 2003, 2018c).

2. Used cages and equipment are some of the key vectors of *D. gallinae* in intensive poultry production. When purchasing used cages and equipment, it is necessary to pay attention to possible invasion. Invaded cages and equipment should cost less, because they will incur unplanned sanitation expenditures for farmers (Pavličević et al., 2016b, 2018c).
3. Transport cages for poultry transmit *D. gallinae* and thus cause damage (Pavličević and Pavlović 2016b).
4. Incorrect work organisation on farms enables the transmission of invasion within the farm, from one house to another.
5. Incorrect choice of products and methods of control and/or their unprofessional application cannot provide efficient control of *D. gallinae* invasion, and it can cause damage.
6. Untimely *D. gallinae* control increases the damage by maximising direct harm, as well as making control more expensive, usually through higher consumption and lower efficacy of products. The production in highly infested flocks (++++) is not cost-effective.
7. Uncritical control is reflected in the application of illegal acaricides or inadequate application of registered products, which is harmful to human health, poultry and the environment.
8. The presence of *D. gallinae* on table eggs causes customers' disgust and aversion.
9. Highly infested flocks can result in abattoirs' refusal to accept the flock after the production period is finished.

## Calculation

Expenditures incurred by the damage are added to the cost of products and implementation of control measures and they represent the farmers' total economic loss. In some cases, these expenditures can include the cost of preparation and sanitation of the consequences of application, such as the eggs which must be safely disposed of due to the withdrawal period (harmful chemical residue in eggs). Farmers' true economic loss is visible after one year, which is the duration of the production period, or over a longer period.

Farmers' economic loss is caused by the increased parasitic prevalence, intensity and extensity of the invasion, difficulty level of *D. gallinae* control, and cost of products and methods. Estimated cost per hen in the period from 2005 to

2017 increased by 40%, and it is 231 million euros annually for the whole of Europe. Annual expenditure caused by *D. gallinae* per hen is 60 euro cents, 15 of which are spent on the control and 45 on damage (1:3) (Emous, 2005, 2017).

Less successful, and especially unsuccessful control includes both types of expenditures. The less successful *D. gallinae* control measures are, the bigger total expenditure is for farmers. However, expenditures caused by *D. gallinae* and its control do not have to nor ought to occur simultaneously. Successful *D. gallinae* control implies only control expenditures for farmers, and, in time, even those are eliminated. For example, in 10 years' time, over 0.5 million euros would be saved per 100.000 layers (capacity of a medium size farm). If we apply the infestation rate to the number of layers (FAO, 2007), we get the figure of about 4 billion layers infested with *D. gallinae* worldwide. This is an approximate figure, since both the numbers of layers and infested flocks have risen in the meantime. For example, reports for Germany, the Netherlands, and Belgium put *D. gallinae* infestation in layer flocks at 94% (Mul et al., 2016).

## Current control

Current *D. gallinae* control offers a large selection of products. In the purpose of clarity, we have selected just two most important groups of products.

Since the beginning of modern intensive poultry production, *D. gallinae* control has predominantly been based on acaricides, synthetic neurotoxic compounds. Its purpose is *D. gallinae* suppression and its effects last for several months, or in some cases for over six months (Pavličević, 2005; Pavličević et al., 2016, 2018d).

Over the past 10 years, with the development of SiO<sub>2</sub> formulations, a technology which can compete with acaricides has been developed for the first time. However, the progress achieved with SiO<sub>2</sub> has not been properly utilised, but has also been employed just in the purpose of *D. gallinae* suppression.

No developmental steps taken so far indicate any future change in the widely accepted approach to *D. gallinae* control. The control program for *D. gallinae* has been developed in contrast to the predominant approach. However, for over 20 years, it has remained marginalised and without any significant impact on the mainstream red mite control in the poultry industry.

## Program

The problem of *D. gallinae* control can be solved and it does not have to exist in the poultry industry. The solution is a program, a comprehensive approach which would be based on preventive veterinary medicine and rational pharmacotherapy (control). The primary goal of the program in intensive poultry

production is to prevent *D. gallinae* infestation in uninfested poultry houses, i.e. farms. Safety risks need to be excluded in infested houses, rational control needs to be introduced, and then efficacy and cost-effectiveness will be increased. After the necessary conditions have been met, *D. gallinae* is eradicated from the production facilities on the farm, and biosafety measures are introduced (Pavličević et al., 2018a, 2018b).

For example, if a highly effective suppression of *D. gallinae* is achieved by two treatments (during housing preparation, before the population) with P 547/17 (project ID 1115), in the partial absence of adequate conditions, mites will appear in small numbers only in the final three months. A small mite infestation (from + to ++ ) has no significant (measurable) health impact and it does not cause economic loss. If there are adequate conditions (hygienic conditions and housing downtime), the procedure of housing preparation with P 547/17 technology results in *D. gallinae* eradication from production facilities. In this case, the flock is not exposed even to minimal *D. gallinae* presence, i.e. its harmful effect, and therefore these harmful consequences do not exist anymore. If there is continued implementation of biosafety measures, the expenditures caused by harmful effect or further control are excluded in the future.

During its development, the program has relied on the current, available products and methods. Initially, it was based on acaricides. However, contrary to the widely accepted method of control (which required more frequent use of acaricides), a correct acaricide application in the poultry house (eradication and introduction of biosafety measures) eliminates the need for further acaricide use (Pavličević et al., 2016).

The first practically applicable distancing from acaricide control was enabled by SiO<sub>2</sub>-based formulations. By exploring the possibilities of mechanical control, an original program was developed, based on the combination of powdered and liquid forms. Eradication was possible again, this time based on a mechanical method. However, an expensive and complex technological procedure, highly demanding regarding the necessary conditions, hindered its wider implementation.

Main disadvantages of SiO<sub>2</sub>-based product application have been successfully overcome first by developing a specialised formulation based on inert oils (P 547/17, Pulcap), and then by developing an original technology of its application (Project ID 1115). The new formulation and technology has been tested in laboratory (Pavličević et al., 2017a, 2017c) and clinical conditions. In this way, we have eliminated any safety risks and devised a more functional and efficient and less complex application procedure which requires fewer conditions. There is no possibility for *D. gallinae* to develop resistance to P 547/17 or to significantly adapt its behaviour. Therefore, the current program will not lose its efficacy over time. Its results are permanent. In comparison to other programs and methods for poultry red mite control, we have concluded that P 547/17 formulation and application technology is an example of rational *D. gallinae* control (Pavličević et

*al.*, 2017b, 2019b). Moreover, it provides all the conditions necessary to completely exclude the application of neurotoxic synthetic compounds from poultry meat and egg production. P 547/17 formulation and application technology has its requirements: professional application, hygienic conditions, housing downtime. Furthermore, despite its undisputed quality, it has certain disadvantages, thus leaving more space to further improve this type of control. This program is permanently open for all new contributions to *D. gallinae* control, which would help it to function better and more adequately respond to various practical challenges of modern poultry industry.

A systematic approach to the implementation of *D. gallinae* control would be an adequate step towards intensive vertical and horizontal integration of poultry industry. Systematic program implementation would additionally contribute to functional and rational product application, protection of human and animal health and environment, and improved control of diseases transmitted by *D. gallinae*; improving the flock's general health status and increasing production results would result in farmers' economic gain.

The situation for *D. gallinae* control in extensive poultry production is different from the one in the intensive production, and consequently, the approach of the program is different. In extensive poultry production, there is an open system, contact with other domestic and wild animals, large area per layer, and complex environment. It is advised to correctly build and set up the perches and nests, together with the barriers which successfully divide them from the rest of the environment. In this way, farmers can control *D. gallinae* problem easily and without significant expenses (P 2017/ 0762).

The necessary conditions have been met to first stop the unfavourable trend in *D. gallinae* control, then mitigate the problem, and eventually eliminate it completely. All this cannot be achieved immediately, since the procedure is technologically demanding and complex.

## Veterinary medicine

Insufficient efficacy of veterinary medicine in *D. gallinae* control effected the size and extent of economic loss suffered by farmers. Veterinary medicine could have contributed more to the mitigation and prevention of loss caused by *D. gallinae* in the following ways:

1. The primary role of veterinary medicine should have been to provide timely and correct information to farmers. In this way, the disease could have been stopped in its initial phase, and most farms would have been protected by biosafety measures, while the rest would have been easily treated. Well-informed farmers would have taken an active role in the solution of the problem, otherwise they make wrong decisions and become

- a part of the problem (Pavličević et al., 2016);
2. Defining eradication as the objective of the control in intensive poultry production is the premise for a real solution. The generally accepted opinion in veterinary medicine that *D. gallinae* can only be suppressed puts the farmers in a hopeless position of constant, increasing expenditures (Pavličević et al., 2018, 2018b);
  3. Improved detection and standardised laboratory and clinical testing of efficacy of products and methods for *D. gallinae* control (Pavličević et al., 2007a, 2017b, 2019c);
  4. Warning about technological flaws and negative effects of complex cages and equipment, which would contribute to the improvement of conditions for *D. gallinae* control (Pavličević et al., 2016a);
  5. Timely utilisation of the legislation change in the EU regarding cages and equipment (EU 1999/74/EC) could have easily eliminated the problem. However, the omission to do so had the opposite effect and actually contributed to the spread of the disease (Pavličević and Pavlović 2016a);
  6. Insisting on rational control, advising the farmers about the optimal choice of current products and methods, based on verified data;
  7. Ensuring professional application of products and methods, which is crucial for efficient control;
  8. Insisting on preventive veterinary medicine and maximising the efficacy of control relative to the cost;
  9. Regular tests of resistance and timely elimination of unjustified use of acaricides which have already caused resistance (Pavličević et al., 2016);
  10. Promoting integrated health care, especially with regards to the control of infectious diseases transmitted by *D. gallinae*, which would additionally improve the general health status of poultry and contribute to the general welfare and cost-effectiveness of poultry production (Pavličević et al., 2017b);
  11. Improving the efficacy of *D. gallinae* control and residue monitoring and minimise or completely exclude the toxicological risk caused by uncritical control (Pavličević et al., 2005, 2018c);
  12. Introduction of the control program would cover all the above said requirements (Pavličević et al., 2018a, 2018b, 2019d).

We are facing an open question – to what extent does veterinary medicine fulfil its role in *D. gallinae* control? Farmers' economic interest is currently not in accordance with the generally accepted opinion in veterinary medicine regarding *D. gallinae* control. The future will provide the answer to the question to what extent it is possible to critically review and improve the above-mentioned positions of veterinary medicine in accordance with the basic medical principles and in the interest of general welfare and economic interest of farmers.



## Conclusion

The economic interest of poultry producers can be significantly improved. Farmers' expenditures incurred by *D. gallinae* can be reduced (time necessary to meet the conditions), and subsequently completely eliminated. Improving farmers' economic interest from the aspect of *D. gallinae* control is in correlation with the general welfare (interest). The requirements necessary in order to achieve the said interest depend on the role of veterinary medicine, which should reconsider the current procedure of *D. gallinae* control and introduce the principles of rational control and preventive veterinary medicine, i.e. the control program.

## Ekonomski interes farmera u kontroli *Dermanyssus gallinae*

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### Rezime

Tekut ili crvena kokošija grinja *Dermanyssus gallinae* (*De Geer, 1778*) je zdravstveno i ekonomski najznačajniji spoljašnji parazit u živinarstvu. Opšte je prihvaćeno mišljenje, da je *D. gallinae* moguće samo suzbijati, i da je pri tome aktuelni godišnji trošak po nosilji 60 eruo centi. Međutim, istraživanja ukazuju na to da postoje i druge mogućnosti kontrole *D. gallinae*, te da je iskorenjavanje (eradikacija iz proizvodnih objekata i farmi) moguće, a zatim, i da je moguće sprečiti njihovo naknadno unošenje (reinfestaciju) biosigurnosnim merama. Time se omogućava dugotrajan ili trajan efekat kontrole *D. gallinae*. Sa ekonomskog aspekta, to znači da nasuprot višedecenijske tendencije povećavanja troškova, farmeri mogu smanjiti, a zatim potpuno isključiti troškove koje im stvara *D. gallinae*. Prema tome, ekonomski proračun svoje uporište bi trebao da temelji na stručnoj osnovi i sveobuhvatnosti, a stručna osnova bi trebalo da bude zasnovana na racionalnoj kontroli, preventivnoj veterinarskoj medicini, odnosno programskom prilazu kontrole *D. gallinae*. Na ovaj način stvorile bi se dugoročne uštede. Za deset godina, za svakih 100.000 nosilja ušteda je preko 0,5 miliona eura. Na svetu se procenjuje da je infestirano oko 4 milijardi nosilja.

**Ključne reči:** *Dermanyssus gallinae*, kontrola, ekonomski interes

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