

POULTRY WELFARE IN TERMS OF POULTRY RED MITE (*DERMANYSSUS GALLINAE*) IMPACT AND CONTROL

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Review paper

Abstract: Technological solutions and environmental conditions have a significant impact on infestation intensity and the problems around *D. gallinae* control. Changes in keeping laying hens in EU, in terms of *D. gallinae* influence, have not led to the welfare of the layers. On the contrary, they have contributed to the spreading of disease, have worsened conditions for control and accentuated harmful consequences. Apart from the poultry, these changes have also had a negative impact on the welfare of humans, through a toxicological and zootonic risk, and economic damages. Conventional cages so far provide the most appropriate environment for *D. gallinae* control. Opportunities for improving, even solving the problem of *D. gallinae* control in egg production do exist, however they require a changing the entire approach hitherto.

Key words: Poultry welfare, *Dermanyssus gallinae* control

Introduction

EU has laid down the poultry welfare as a necessary condition in consumer egg production. By adopting the Directive 1999/74/EC a ban on using conventional cages has been put in place, which came into effect on 01.01.2012. Since then, keeping laying hens in EU is allowed only in alternative systems: enriched cages, aviaries, barns, free range and organic. The 2012-2015 EU Strategy is based on scientific indicators, transparency, reference centers and competencies of those handling the poultry (Van Emous, 2017).

Poultry red mite (*Dermanyssus gallinae*, De Geer) is a cosmopolitan, hematophagous ectoparasite. *Dermanyssosis* is considered as one of the most

important health and economic problem in egg production. *D. gallinae* is a temporary parasite, which stays on the poultry only during feeding time, and otherwise remains in appropriate hiding places in the housing system. This is why *D. gallinae* is a problem of both the flock and the environment. The new changes in rearing systems have also had an impact on *Dermanyssosis* manifestation.

The aim of our paper is to consider poultry welfare in terms of *D. gallinae* impact and control in different technological conditions.

Red mite control through legislative

In 1979 the UK Farm Animal Welfare Council defined animal welfare in terms of 5 freedoms: 1. from hunger and thirst; 2. from discomfort; 3. from pain, injury and disease; 4. to express normal behaviour; 5. from fear and distress. The European consortium defined welfare in terms of 4 categories and 12 subcategories. These are: 1. good feeding (absence of prolonged hunger and thirst); 2. good housing (comfort around resting, thermal comfort, ease of movement); 3. good health (absence of injuries, absence of disease, absence of pain induced by management procedures); 4. appropriate behaviour (expression of social behaviors, expression of other behaviors', good human-animal relationship, positive emotional state). There is a great number of varying interpretations of farm animal welfare, incompleteness, but also opposing claims. According to the aforementioned definitions, health in reference to the specific case of *Dermanyssosis* control, is an important factor in achieving animal welfare.

According to EU's commitment that each new legislation is to be based on the latest scientific knowledge and advice, the European Food Safety Authority (EFSA) was requested to provide an opinion for the purpose of assessing health and welfare effects on laying hens. EFSA Report (2004) has confirmed the scientific and economic foundation and justification for changing cage systems, claiming that there is crucial evidence which show that the ban on conventional battery cages for laying hens can make considerable improvements for the health and welfare of these birds. In addition to this, a research program called 'LayWel' was financed by the EU, which confirmed the accuracy of EFSA research results (IP/08/19). Economic foundation for technological changes was motivated by the fact that egg producers in the EU, based on the costs of production, can hardly be considered competitive. Since market research (CEAS) established a potential in increasing the price of eggs, the introduction of higher poultry welfare standards is also a way of creating economic prosperity of poultry keeping in the EU (preserving its competitiveness).

Already in 2000, the great problems around the complex situation of rearing systems conditions and the available options for *D. gallinae* control were evident (Nordenfors, 2000). Sparagano et al. (2009) have pointed out a high global prevalence of *D. gallinae*, but also the unfavorable expectations regarding the

manifestation of *Dermanyssosis* in alternative rearing systems of layers in the EU. Eight years later, *Flochlay et al. (2017)* have found this was precisely the case. A harmful effect of *D. gallinae* in Europe has increased in the last decades, with a tendency of the situation to get worse. The authors consider Directive 1999/74/EC and changes in poultry housing as the first factors of this negative development of events. Changes which were meant to improve poultry welfare, have created a more complex environment, which provides more favourable conditions for *D. gallinae*. Technological changes have also had a negative impact on farm staff, highlighting the zoonotic aspect of *Dermanyssosis* (COREMI, 2016). The report from 2016 suggested an infestation level of farms in Europe of 83%. The Netherlands, Germany and Belgium had a prevalence of 94%. *Nicole et al. (2017)* propose that the prevalence is lower in cage systems and that the complexity of housing in alternative solutions is unfavorable, as well as that *D. gallinae* control has not been resolved, and requires urgency in finding a solution. Along with prevalence and difficulty in *D. gallinae* control, economic losses have also increased. In the period between 2005 and 2017, economic losses have increased to 40% per hen, and at EU level have been estimated at 231 million annually (*Van Emous, 2005; 2017*).

D. gallinae control has additionally been placed in public focus due to the toxicological affair of consumer egg production in 2017 (*Pavličević et al., 2017c*). The situation is further made difficult by the lack of appropriate solution and generally a small number of efficient products and methods of *D. gallinae* control available. More recent reports find high levels of *D. gallinae* resistance (*Abbas et al., 2014; Pavlicevic et al., 2016a*). The foundation of all these problems (high prevalence; health effect on poultry; spreading of communicable diseases; toxicological risk for humans, poultry and environment; accentuated zoonotic impact; losses in productivity and high material damages; intense development of chemoresistance) is an incorrect approach to *D. gallinae* control across several decades, which is now further challenged by these new changes in technological conditions.

Challenges in red mite control in different rearing systems

The conditions of the rearing environment have a key influence on the inaccessibility and distribution of *D. gallinae*, but at the same time, also the distribution, accessibility and efficiency of products and methods used in its control. This means that environment and technology in egg production, have a significant role in determining the effects of *D. gallinae* control (*Pavlicevic et al., 2016b*). In earlier periods, intensive egg production was based exclusively on conventional cage systems. Quality and conditionality of certain types depended on the model that is cage manufacturer (*Pavlicevic et al., 2016c*). In relation to *D. gallinae* control, the development of conventional cages can in general be traced to

the stages described below.

Cages with static manure collection (“California type”, cages with scrapers and plates) were the most challenging hygienic conditions for *D. gallinae* control in caging systems, which were, apart from greater presence of static impurities, often followed by unfavorable constructions, for example, cylindrical constructions for adjoining sides.

The next were cages with mobile litter belts and a more complex construction. In this phase, hygienic conditions in the cages themselves were ensured, but were regularly followed by unfavorable construction. However, possibilities for *D. gallinae* control became much more favorable.

Cage manufacturers have gradually simplified cage construction for rearing layers and have thus improved the overall conditions. This way, these cages have ensured the best conditions for efficient *D. gallinae* control hitherto. At one point, the situation became more complicated by installing manure drying tunnels. These have to an extent challenged the conditions for *D. gallinae* control. For the rest of the cage and equipment there was a general tendency of simplifying constructions, and the general conditions were still good.

Isolated attempts to create cages for warming layers in intensive poultry farming which would control *D. gallinae*. The first documented idea comes from the USA, 1928 (Van Emous, 2006). We consider that the approach to solving is not rational in terms of the general problem of *D. gallinae* control in poultry farming. The efficiency of the thus far implemented models is questionable. Instead of the optimisation of conventional cages, the technological development of cages for layers was directed at alternative rearing methods, with the aim of poultry welfare.

At the moment, most intensive poultry farming in the EU is done in enriched cages. The construction of enriched cages has greatly diminished the efficacy of existing measures and products for *D. gallinae* control. The most harmful in this respect, has been the existence of appropriate hiding places in the immediate proximity of the hens, which are inaccessible or hardly accessible to external application. This situation requires more work in terms of application. This is due to the furnishings in the cages, constructions and perches, depending on the model of the cage. These environmental conditions (inconveniences) can have an immense capacity for a big *D. gallinae* infestation. Apart from providing hiding places, these areas cannot be protected though the residual effect of the product on external surfaces, due to immediate proximity and contact with the hens. Another negative effect is the blocking of surfaces for distribution, with external application (as the dominant application method) of the product. The third consideration is merely the increase of surface unit per hen, which has considerably raised the expenditure of materials and cost of control. Then, there was a tendency to minimize the number of hiding places by redesigning existing additions: new type of slatted floor, new type of laying nest floor (Van Emous, 2006). Creating unfavourable conditions has been somewhat masked by physical extermination or

disruptions created by the change in caging systems.

In aviaries, barn, free range and organic systems litter mats have been introduced, which provide a protective environment for *D. gallinae*; the construction of perches, nests, and equipment disrupts or prevents machine work; application by hand means bigger expenditures per hen of total capacity and greater risk from application mistakes; the distribution of infestation of the same intensity is greater; hiding places depend on the model of the cage and there are models which are difficult to control technically. We have thus far not been able to assess the importance of free range systems for *D. gallinae* control.

For comparison, the main characteristics of conventional cages, relate do *D. gallinae* control are the following:

- ideal hygienic conditions
- simple and efficient detection of even a small number of *D. gallinae* (included in the regular working process, without additional costs) with floor dust (Pavlicević *et al.*, 2007; 2017a,b);

- greatest applicability of products for external use;
- greatest efficacy;
- greatest rationality of costs;
- the possibility of additional optimization of the environment, which would greatly facilitate control measures and increase efficacy. These innovations are applicable even in alternative systems, but will be much more apparent in conventional systems.

- available innovative technology (P 547/17) which eliminates safety risks and offers efficient and economically advanced *D. gallinae* control, and if appropriate conditions are met, also the solution to the problem. It has a physical mode of action, by creating a long-lasting, inert layer with a prolonged effect on non-absorbent surfaces. Although it is possible to apply this technology in alternative systems, the maximal effect is provided in conventional systems.

Conventional cages with a simple construction and good hygienic conditions have so far ensured the best conditions for *D. gallinae* control in intensive poultry farming. Apart from that, there is also the possibility to further optimise conditions in cage systems for *D. gallinae* control. Alternative poultry rearing methods provide possibilities for improvement which could contribute to *D. gallinae* control, but the challenges of these conditions by far outweigh this.

However, the problem of environmental conditions can be approached by adapting the type of application. The concept of the new veterinary medicine, based on the insecticide fluralaner (isoxazolinic) is application through drinking water (*per os*), which means it can be effective in these conditions (Heckerroth *et al.*, 2015; Thomas and Flochlay-Sigognault, 2017). However, it is to be expected that the circumstances (infestation distribution and intensity) will decrease the efficacy of the medicine and contribute to development of quicker chemoresistance in alternative systems. Subsequent clinical experience will determine the possible

contribution of this veterinary medicine, the application of which is based on a curative approach.

Preventive veterinary medicine holds multiple advantages over the curative approach: safety, efficiency, rationality and longevity. Preventive veterinary medicine is the foundation of the program control of *D. gallinae*, which is focused on implementing measures for control before the new flock is housed. An example where this preventive mode of action was missing was the change of cage systems in the EU.

In regular technological conditions, the most complex and most problematic part of the environment, in terms of *D. gallinae* control are cages and equipment. In a situation when cages and equipment are disassembled and removed, the environment is simple and accessible for *D. gallinae* control. The scientific plan of the EU was obliged to prepare measures for changing rearing systems, which would be used in a planned and systematic manner to allow farmers a simple and economic way of conducting eradication and introducing security measures. The change in cages and equipment was a remarkable opportunity which, on its own, could improve welfare and change the prevalence of *D. gallinae* in EU (Pavlicević et al., 2016a). Instead, quite the opposite occurred. The changes in rearing systems have contributed to the spreading of disease, which had a negative effect on the neighbouring countries as well. What happened was that conditions have not been scientifically assessed and met with adequate measures of changing caging systems in the EU. With the export of second-hand cages and equipment, poultry red mite was also widely spread. In newly built facilities with new equipment, in most cases, proper biosafety measures for preventing *D. gallinae* entering were not introduced.

Red mite infestation impact on poultry and humans

Poultry in flocks highly infested with *D. gallinae* is exposed to stress, anemia and a disrupted immune response (Kaoud and El-Dahshan, 2010). It is more susceptible to infections and more exposed to communicable diseases, more susceptible to cannibalism, with a disrupted general health status. Stress is clinically visible through the distress of poultry, which can also resemble symptoms of mental illness if *D. gallinae* enters the outer ear canal (Simić and Živković, 1958). Somatic and psychogenic stress have also been diagnosed. Stress is also haematologically diagnosed. Corticosterones are also increased 1.5 times, and the level of adrenaline as much as doubled (Kowalski and Sokol, 2005). The manifestation of stress and anemia depends on the intensity of infestation of *D. gallinae*. It has been established that with medium infestation the number of mites per hen ranges from 25,000 to 50,000, but can reach as many as 500,000 (Kilpinen et al., 2005; Van Emous et al., 2005; Mul et al., 2013). In these situations, poultry is constantly exposed to *D. gallinae* at night, but also during daytime. A hen

infested with *D. gallinae* can lose 3% of its total blood every night, and as much as 5% at an extremely high number of *D. gallinae* (Van Emous, 2005). The blood analysis of infested poultry has established a dramatic decrease of erythrocytes, from 3.1 million to 1.2 million (Babić *et al.*, 1956), as well as the damage to humoral immunity (Kowalski and Sokol, 2015). The role of *D. gallinae* vector is complex: mechanic, transstadial and transovarian (Moro *et al.*, 2005), and relates to multiple causes of diseases: viruses, bacteria, protozoans and filarias (Moro *et al.*, 2007). We highlight *Salmonella gallinarum* and *S. enteritidis* (Moro *et al.*, 2009) and *A. influenza* virus (Sommer, 2011). Besides the basic definition of welfare, establishing the importance of categories is of vital importance. It is clear that animals which are under stress, with a disturbed general health status and increased mortality cannot fully make use of the benefits at their disposal in alternative housing. A complete elimination of all harmful consequences on poultry in intensive poultry farming is possible through *D. gallinae* eradication from production systems and introduction of biosafety measures (Pavlicević *et al.*, 2017b).

Apart from this, poultry welfare ought to be coordinated with human welfare. Burdening *D. gallinae* control, the challenges of an otherwise problematic *D. gallinae* control have been even further multiplied and raised, which has also increased the toxicological risk (level) to which consumers, poultry and the environment are exposed to (Giangaspero *et al.*, 2011; Marangi *et al.*, 2012). Here it is also important to consider that *D. gallinae* control is based on chemical synthetic neurotoxic compounds (acaricides, insecticides in a wider sense), which are often used in conjunction with illegal and products not registered for these particular purposes (Giangaspero *et al.*, 2017). The situation is especially worrying if we take into account the rate of frequency and concentration in application, which are motivated by the absence of expected effects and resistance of *D. gallinae*. Prohibitions and legal framework are necessary, but alone they are not sufficient to completely eliminate toxicological risk. To do this, it is necessary to eliminate the need for farmers to use poisons. Primarily, toxicological risk has come about as a consequence of the absence of a solution. Therefore, in order for the risk to be minimized, it is necessary to ensure a safe, efficient and rational control. To eliminate the toxicological risk completely, it is necessary to eliminate *D. gallinae* from production facilities. George *et al.* (2016) point to the zoonotic importance of *D. gallinae*. This way, the zoonotic influence of *D. gallinae* on farms will be also eliminated. Depending on the intensity of *D. gallinae* infestation, mortality is increased, egg laying and weight of eggs are reduced (Kaoud and El-Dahshan, 2010). Lowering of production results alongside additional costs affect the economic competitiveness of farmers. We have proved that eradication is possible and that the problem of poultry red mites, along with all its consequences should not exist in poultry farming (Pavlicević *et al.*, 2017a).

Environmental conditions have a manifold impact on poultry welfare. For

industrial poultry keeping they are alone not the solution to *D. gallinae* control. However, the role of environmental conditions in *D. gallinae* control is extremely significant and requires much greater scientific attention than it is given at present.

Conclusion

Technological changes in rearing methods for layer hens in the EU have not brought poultry welfare in terms of *D. gallinae* control, but have rather had a negative impact, even to human welfare. Possibilities of improving, even solving *D. gallinae* control in egg production do exist, but they require chaining the entire approach hitherto.

Prilog razmatranju dobrobiti živine sa aspekta uticaja i kontrole crvene kokošije grinje (*Dermanyssus gallinae*)

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Rezime

Tehnološka rešenja i ambijentalne prilike bitno utiču na intezitet infestacije i problematičnost kontrole *D. gallinae*. Promene u načinu držanja kokošaka nosilja u EU, sa aspekta uticaja *D. gallinae*, nisu dovele do dobrobiti nosilja. Naprotiv, doprinele su širenju bolesti, pogoršale uslove kontrole i naglasile štetne posledice. Osim na živinu, promene su nepovoljno uticale na dobrobit čoveka kroz toksikološki i zoonotski rizik, i ekonomske štete. Konvencionalni kavezi obezbeđuju do sad najprikladniji ambijent za kontrolu *D. gallinae*. Mogućnosti za unapređenje, pa i rešenje kontrole *D. gallinae* u proizvodnji jaja postoje, ali ona zahteva promenu celokupnog dosadašnjeg pristupa.

Ključne reči: dobrobit živine, kontrola *Dermanyssus gallinae*

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