



USE OF TOXICANTS BAITING FOR REDUCTION OF WILD BOAR POPULATIONS IN AFRICAN SWINE FEVER DISEASE MANAGEMENT – IMPLICATIONS FOR BIODIVERSITY AND LEGISLATION

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Summary

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Wild animals appear to be a key factor in the occurrence, transmission and prevalence of a myriad of contagious animal diseases, being natural reservoirs, vectors or both. This role is played by wild boars in the African swine fever (ASF) transmission to domestic pigs. ASF entered the European Union in 2014 and since then lots of measures have been implemented to bring the disease under control. Bulgaria also tried to introduce new measures for reduction of wild boar populations, regarding ASF through legislative amendments. Proposals in the Bulgarian Law on hunting and game protection from 2020 tried to make legitimate wild boar culling with some unselective approaches like the use of baits with chemical poisonous or intoxicating substances. This provoked the authors to study the experience of other countries on particular toxicants used for baiting for control of wild boar populations. We investigated the available scientific literature on the selective character of chemical baiting and the effect on non-target species. Moreover, the participation of different stakeholders in the process of development and implementation of the mentioned measures was discussed. Thus, proposals were made for better preparatory, scientific and efficiency investigation at the preliminary stage of animal disease control measures development.

Key words: animal disease control, baiting, toxicants, wild boar

INTRODUCTION

African swine fever (ASF) is a viral contagious animal disease which was exotic once for Europe (Tsachev, 2006) but after entering the continent appeared to pose a continuous threat for both wild and do-

mestic pigs (Woźniakowski *et al.*, 2016). At a global scale, the disease is present in Africa, Europe and Asia with a significant spread of the registered outbreaks since 2016 as 30% of the OIE member states

have reported the presence of the disease in the period 2016–2020 (OIE, 2021b). Existing knowledge on the transmission routes of the African swine fever virus (ASFV) to the susceptible representatives of *Suidae* family has defined two main transmission cycles: “sylvatic” and “domestic” (Costard *et al.*, 2013), relating the “domestic cycle” to ASFV circulation in wild boar and domestic pig herds due to the efficient direct or indirect transmission (Guinat *et al.*, 2016). ASF is not contagious to humans but causes up to 100% fatality in pigs, leading to severe economic losses to the pig industry (Nikolova *et al.*, 2011). The lack of a vaccine against ASF or a specific treatment (Zakaryan & Revilla, 2016), drove the efforts towards risk assessment of spread of the disease (Likov *et al.*, 2011; Nielsen, 2019) and control measures set within the international and European animal health legislation.

Being both susceptible animals and reservoirs of the virus, wild boars are subjected to a range of legally introduced measures for control of wildlife reservoirs with the purpose of ASF prevention (Guberti *et al.*, 2019). Different methods for wild boar population management are implemented at different stages of the epidemic (More *et al.*, 2018). Besides the success achieved in some European countries through measures like hunting activities, the competent authorities should take into consideration also the adverse effect they have on non-target animals and the environment in general.

As a legislative proposal was made for amendment of the Bulgarian Law on hunting and protection of game from the autumn of 2020 with the purpose to make legitimate the culling of wild boars with some non-selective approaches like toxic baiting, this study tried to investigate how

this method was implemented by the other countries with regard to animal disease control. Its aim was therefore to identify and highlight the expected possible effects of toxic baiting if such a method is to be introduced in future.

MATERIALS AND METHODS

For the purpose of the study, an analysis on the existing legislative framework for animal health and welfare with a focus on disease control measures in wild boar populations was made. This involved evaluation of official international documents/reports and website information from OIE, EU, national (Bulgarian) legislation on hunting and protection of game and accompanying proposals for amendments. The aim was to present the current state of ASF management in feral swine with the experience of some other countries on non-selective approaches as culling with poisonous baits. The public acceptability of such measures was analysed by presenting the summarised opposing arguments of the Bulgarian citizens and comparing them with the findings of researchers who organised group discussions on the topic among stakeholders.

RESULTS

The World Organisation for Animal Health (OIE) is the recognised international organisation responsible for development and introduction of particular strategies for prevention, control and eradication of animal diseases. The huge economic importance and financial, social and welfare impact of ASF on the pig sector are addressed in the measures determined by the OIE (OIE-WAHIS, 2020; OIE, 2021a) (Table 1).

Table 1. Measures on ASF management

Measures for risk management of ASF	Scope
Disease notification	The notification of animal diseases is essential to rapidly alert authorities to disease outbreaks and facilitate their response so that further outbreaks can be prevented
Monitoring General surveillance Targeted surveillance	Animal health surveillance means the systematic ongoing collection, collation, and analysis of information related to animal health and the timely dissemination of information so that action can be taken.
Screening	Screening refers to the application of a medical procedure or test to people or animals who as yet have no symptoms of a particular disease, for the purpose of determining their likelihood of having the disease
Selective killing and disposal	Application of the measures described for “stamping out” only on a group of animals within the susceptible population (e.g. killing and disposal of cases only).
Slaughter	Killing of animals for disease control purposes and intended for commercial use or own use.
Stamping out	Killing of the animals which are affected and those suspected of being affected in the herd and, where appropriate, those in other herds which have been exposed to infection by direct animal to animal contact, or by indirect contact with the causal pathogen. Animals should be killed in accordance with Chapter 7.6. (of the OIE manual) and their carcasses, and where relevant, animal products, disposed of by rendering, burning or burial, or by any other method described in Chapter 4.12.
Ante and post-mortem inspections	Ante and post-mortem inspections, allow official veterinarians in slaughterhouse to identify potential disease and stop spreading it via food and notify competent authorities to implement measures in animal holdings.
Compartmentalisation	Compartment means an animal subpopulation contained in one or more establishments under a common biosecurity management system with a distinct health status with respect to a specific disease or specific diseases for which required surveillance, control and biosecurity measures have been applied for the purpose of international trade.
Zoning	Delineation (by regulatory means) of part of a country/territory containing an animal subpopulation with a distinct health status or risk with respect to a specific disease, infection or infestation for which required surveillance, control and biosecurity measures have been applied for the purpose of international trade.
Movement control inside the country	Measures aimed at avoiding the spread of the disease, infection or infestation within a country/zone/compartiment due to the movement of animals or their products.
Precautions at the borders	Measures aimed at avoiding the spread of the disease, infection or infestation between a countries
Control of vectors	Implementing measures to control insect or any living carrier that transports an infectious agent from an infected individual to a susceptible individual or its food or immediate surroundings
Control of wildlife reservoirs	Measures to reduce the potential for wildlife to transmit the disease to domestic animals and human beings (control of wildlife reservoir populations, vaccination of target wildlife, etc.).

Table 2. Recommended measures on wildlife for ASF management

Control of wildlife reservoirs	Scope
Passive surveillance	Observer-initiated provision of animal health-related data (e.g. voluntary notification of suspected disease) or use of existing data for surveillance
Manipulation of the carrying capacity of wild boar habitats	Carrying capacity, the average population density or population size of a species below which its numbers tend to increase and above which its numbers tend to decrease because of shortages of particular food, shelter, and social requirements
Wild boar density reduction/depopulation measures <ul style="list-style-type: none"> ✓ Hunting ✓ Trapping/snaring ✓ Hunting combined with trapping/snaring for depopulation ✓ Fertility control ✓ Poisoning ✓ Feeding bans 	Methods to reduce the wild boar population density
Wild boar separation methods <ul style="list-style-type: none"> ✓ Fencing ✓ Odour and gustatory repellents ✓ Light and sound repellents 	Impedes communication between different animal populations, thus reduces the risk of spreading the disease

The understanding of the role of wild boars in both the sylvatic and domestic cycles of ASFV transmission has led to development of a more comprehensive approach for reducing the risk to virus transfer to the domestic pigs (Guberti *et al.*, 2019) (Table 2).

After ASF entered Bulgaria in 2018, an increase in the number of outbreaks was registered, especially for the wild boar populations (Fig. 1), from 5 in 2018 through a peak of 533 outbreaks in 2020 to 127 in 2022. This led to the decision to strengthen the measures against the disease in the wild reservoirs through inclusion of non-selective measures for wild boar population control.

In 2020, a proposal for legislative amendments in the national Law on hunting and game protection (LHGP) was

made, allowing the employees of the Ministry of Agriculture, Food and Forestry, the Ministry of Interior, the Ministry of Defense and their structures to perform hunting activities for reducing wild boar populations with regard to ASF eradication (Anonymous, 2020a). To this end, it was proposed to grant permission to the employees for use of methods and means for hunting, included in the prohibitions under art. 65 of LHGP (Anonymous, 2020b) (Table 3).

Being still prohibited by the LHGP, the proposal to use the above-listed methods and means of hunting for reduction of wild boar population has received a negative public reaction (Table 4).

The summary of the most important arguments presented by citizens and NGOs against the amendments in the

period for public consultations on the proposal (Anonymous, 2020a), were related to:

- Violations of the European legislation: Council Directive 92/43/EEC of 21

May 1992 on the conservation of natural habitats and wild fauna and flora (EU, 1992); Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the

Table 3. Methods, subject to proposal for ammendment of LHGP for the purpose of ASF management in wild boars

Methods and means of hunting	Regulated by LHGP	Proposal for use for wild boars
Firearms that do not meet the requirements of Art. 56, para. 1 and 2 (LHGP) and crossbows	Prohibited	Allowed
Traps, snares and nets, glues and pits (traps), if they are used for indiscriminate hunting or killing	Prohibited	Allowed
Poisonous or intoxicating substances, as well as bait with such substances	Prohibited	Allowed
Electric sound reproducing devices and artificial light sources, as well as devices for illuminating the target	Prohibited	Allowed
Mirrors and other blinding objects	Prohibited	Allowed
Explosives, gassing or smoking	Prohibited	Allowed
Devices for night shooting, containing an electronic converter or an image magnifier	Prohibited	Allowed

Table 4. Stakeholders' position on the proposed ammendment of LHGP in Bulgaria

Stakeholders	Number of submitted positions/ comments	Position on the proposal for LHGP ammendment	Concerns
Union of hunters and fishermen in Bulgaria	1	Opposed	Legislative objections Game concerns Hunters' rights
Association Green legislation	1	Opposed	Legislative violations Conservation concerns
Academia	1	Opposed	Legislative violations Animal welfare violations
Citizens	167	Opposed	Animal welfare violations Religious concerns Ban on hunting

- conservation of wild birds (EU, 2009);
- Destruction of specimens from protected species listed in Annex 3 of the Biodiversity Act (Anonymous, 2022);
- Deaths of domestic animals;
- Endangering human health and life.

The amendments aimed at allowing the use of non-selective means of disease control like poisoning, trapping, night shooting and explosives, did not pass in the National Assembly but raised questions for finding appropriate scientifically proven ways for control of wildlife populations in future disease outbreak management.

DISCUSSION

Management of contagious animal diseases is a subject of regulation at international and national level under a comprehensive legal framework. Regarding African swine fever, the set of measures for its management has proven to be successful after the elimination of ASF from the Iberian Peninsula in 1995 (Arias *et al.*, 2002). With the re-emergence of the disease in the European continent in 2007 and entering the EU member states in 2014 it became clear that multiple solution approaches with inter- and transdisciplinary research have to be implemented to combat the disease effectively (Schulz & Boklund, 2020).

One of the main emphases in the multi-layered inter-institutional approach is put on the role of the wild boars in the ASF epidemiology with the aim to break the ASFV infection cycle through keeping wild boar population as small as possible and maintaining surveillance, combined with the detection and removal of wild boar carcasses to reduce the viral load in the environment (Oļševskis *et al.*, 2020). Regarding the measures for control of

wildlife defined by the OIE (Guberti *et al.*, 2019) and in compliance with the provisions for effective management of contagious animal diseases within Regulation (EU) 2016/429 of the European Parliament and of the Council (“Animal Health Law”) (EU, 2016) some member states implemented activities for trapping wild boars (Aleksandrov *et al.*, 2011), their culling (Boadella *et al.*, 2012) or reduction through poisonous baits or fertility control (Croft *et al.*, 2020).

As EFSA has provided scientific evidence that hunting or trapping could not drastically reduce wild boar populations in Europe for ASFV elimination (EFSA, 2014) efforts were shifted towards finding more effective methods of control like target baiting (Peris *et al.*, 2019).

A potential biocide should meet certain criteria in order to be registered, legalised and officially applied in population control programmes through toxic baiting for animal disease management, including reduction of wild boars. Guberti *et al.* (2019) determined that the substance should be target-specific, attractive and easily accepted by wild pigs, with minimum possibility for consumption by non-target species, therefore without secondary or accidental poisoning of the latter and without health risks for people involved in field operations.

None of the biocide methods could be 100% effective, but some toxins have shown efficacy for wildlife control (Murphy *et al.*, 2007; Eason *et al.*, 2010; 2014), including boars (Bengsen *et al.*, 2010; 2011; Lapidge *et al.*, 2012; Snow *et al.*, 2017). Further research has identified appropriate delivery systems for oral administration of toxins to feral swine with quite satisfactory field results – the Boar-Operated-System (BOSTTM) (Campbell *et al.*, 2011) and the HogHopperTM (Camp-

bell *et al.*, 2012). However, studies have shown that part of the delivered baits were eaten by non-target animals, some of them being protected species (Snow *et al.*, 2020), thus posing a risk to the biodiversity in the area. Some trials found that birds and foxes removed far more surface-laid meat-baits than did feral pigs, and as little as 12% of baits may have been available to pigs (Fleming *et al.*, 2000).

There are also other factors that reduce the consumption of baits by wild boars. For example, an increase of pasture biomass was found to have a significant negative effect on the relationship between percentage uptake of bait trails and pig density. This finding indicates that at higher levels of pasture biomass, the same number of pigs fed on fewer bait trails than they did at lower pasture biomass (Choquenot & Lukins, 1996). These factors can reduce the effectiveness of the method and, on the other hand, can lead to high mortality in non-target species which is argued as one of the main motives against the introduction of poisonous baiting for ASFV management in Bulgaria.

For the purpose of more effective control on feral pigs, attempts were made to create baits that are more species-specific and avoid poisoning of non-target animals. The ‘toxic core’ is implemented to reduce potential risks to non-target species that may nibble the poison of the bait. An animal is required to eat to a depth of more than 2 cm of bait substrate before it encounters the toxic core. This has to prevent the birds from reaching it. Although selective baits reduce significantly the bait number consumed by non-target species, there is still such consumption even by domestic animals (Cowled *et al.*, 2006) and risk of secondary poisoning in scavengers (Snow *et al.*, 2019; Lazarova & Balieva, 2020). However, Snow *et al.*

(2019) reported no risk for humans consuming muscle and liver from baits for feral pigs poisoned with micro-encapsulated sodium nitrate, although toxic baiting was considered to endanger human health and life by the wide public in our study (Anonymous, 2020a).

As argued by Campbell *et al.* (2011), the efficacy of the bait delivery systems could be modified in order to overcome the disadvantages of the method like consumption by non-target animals and unfeasibility in residential areas (Massei *et al.*, 2011), thus becoming valuable tool for feral swine disease management. However, implementation of such a measure will be continuously opposed by the public unless experts and key stakeholders are included in its development, transparent discussion and execution. Thus, Urner *et al.* (2020) measured the acceptance of certain control activities against ASF in wild boars through inclusion of hunters in focus group discussions, finding bait feeding favourable. Investigation on the hunters’ opinion and engagement in swine disease management through participatory approach was also recommended by Schulz *et al.* (2016). For comparison, the opinion of hunters was presented in the period of public consultation on the proposed measures but after the proposal was already approved by the Council of Ministers in Bulgaria.

A model for inclusion of valuable stakeholders in discussion and development of ASF control measures in wild boars appeared to be the “World Cafe” method performed by Jori *et al.* (2020). The authors succeeded in gathering key expert veterinarians, wild boar managers, hunters, epidemiologists, mathematical modellers and social scientists representing governments, national and international organisations, the hunting lobby and

private industry in EU with the aim to improve the current strategy for ASF control in European wild boar. Regarding toxic baiting, Jori *et al.* (2020) reported a negative attitude from the general public and hunters and variable acceptance by the other professionals, with proposal for additional risk assessment of the benefits and potential threats. However, although found effective and technically feasible, the discussed method was perceived by the public as inhumane and is not legal in the EU. Overall, killing with toxic substances is not currently considered an option to control wild boar populations in the member states as the FAO Animal Production and Health Manual stated that it is absolutely impossible to promptly design and implement an effective and safe large-scale programme for poisonous baiting of wild boars in any of the European countries (Guberti *et al.*, 2019).

CONCLUSION

Being registered on the territory of the EU and leading to huge economic losses for the pig industry, ASF is a subject to strict control, including management of wild boar populations. With regard to the current animal health strategy, the epidemiological situation and resources available in the affected member states, several approaches are in use to reduce the feral swine populations and thus to break the ASFV transmission cycle. Some non-selective control measures such as toxic baiting have been proven to be an effective disease management tool in the USA and Australia in research studies. However, from a local perspective various stakeholders oppose the implementation of poisoning due to the numerous disadvantages of the method, including environmental and biodiversity concerns. With

regard to a more fruitful and efficient epidemiological control on ASF in the European wild boar populations, it is necessary to improve communication and collaboration among stakeholders through focus group discussions with additional scientific risk assessment of the methods for control.

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