VACCINATION AGAINST AFRICAN SWINE FEVER AS A MODERN TOOL FOR POSSIBLE OUTBREAK PREVENTION MEASURES FOR SAVING OF UKRAINIAN PIGGERY INDUSTRY

The analysis of the epidemic process of African swine fever (ASF) in the period 2010-2023 indicates its rooting in Ukraine in the form of associated infections of domestic and wild pigs [1]. It’s results show that modern antiepizootic measures based on "stamping-out" are able to counteract only spontaneous (single) transboundary introductions of ASF [2]. In the face of a massive cross-border infusion of the disease in Ukraine since 2014 (as in Georgia to the Moscow attack in 2008), and even more so in the situation of the enzootic spread of ASF (ASFmix), these measures have become incompatible with the pig-farming economy. Numerous agro-terrorist manifestations of Moscow aggression have a so negative impact on the pig-farming stability that Ukraine can not counteract with own state resources [1, 3]. This forces Ukrainian business to look for ways to strengthen protection of their investment in piggery [4].

By all modern anti-epizootic canons, the shortest way to control of the emergent infections is vaccine prophylaxis in a complex of quarantine measures [5]. The regulatory framework for ASFV vaccine prevention is currently only beginning to be developed: primarily due to the success of the commercial use of innovative live vaccines of Vietnamese production from deletion strains of American development [6]. The purpose of our publication is to initiate the creation regulatory framework for ASFV vaccine process in Ukraine, taking into account the current threats and possibilities.

From closest to commercial use, the modern market of veterinary drugs offers two Vietnamese-made vaccines, the comparative characteristics of which are shown in Table 1. Both intramuscular vaccines are made from deletion hemadsorbing strains of agent and are en
lyophilized. At the same time, the AVACO drug uses a vaccine strain with the deletion of the 6 agent genes which responsible for its virulence, while the NAVETCO drug contains a strain with the deletion of only one virulence gene of the ASFV pathogen – the I177L gene. In addition, one dose of the AVAC ASF LIVE vaccine contains almost one logarithm more hemadsorbing units of the vaccine virus than the NAVETCO vaccine and is therefore used once. In addition, the deeper weakening of the pathogen's virulence in the AVAC ASF LIVE vaccine allows it to be used on pigs from the age of 1 month, and not from 2 months as in the NAVETCO vaccine. Post-vaccination immunity to ASF develops as early as 2 weeks after vaccination (p.v.) and lasts up to 5 months. Group immunity after the use of the AVAC ASF LIVE vaccine on the 28th day p.v. allows to protect at least 80% from death, and up to 100% from contact/horizontal infection of vaccinated piglets (Fig. 1). A very valuable characteristic of this vaccine is the absence of viremia of the vaccine virus already after 2-4 weeks p.v., as well as absence of the excretion of this virus with feces, urine and naso-oral secretions - and, accordingly, the absence of its horizontal transmission; the virus disappears from the tissues of the vaccinated pigs after almost 4 weeks p.v.

Data on the endurance of 1-month-old piglets to 5lg HAD50 of the ASFV-G-ΔMGF strain indicate the possibility of adapting the Vaccine Efficacy Test procedure to Ukrainian realities (see below). Both vaccines have DIVA support: PCR-test for AVAC ASF LIVE vaccine requires trio of primers (for ASFV P72, D-GUS et MGF genes), PCR-test NAVETCO vaccine requires duet of primers (for ASFV P72 & I177L genes).

Table 1
Comparison of approval ASF Vietnamese vaccines from ASFV-G-ΔMGF and ASFV-G-ΔI177L strains of PIADC-USDA

<table>
<thead>
<tr>
<th>Company</th>
<th>AVAC</th>
<th>NAVETCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine strain</td>
<td>ASFV-G-ΔMGF</td>
<td>ASFV-G-ΔI177L</td>
</tr>
<tr>
<td>Source</td>
<td>PIADC-USDA</td>
<td>PIADC-USDA</td>
</tr>
<tr>
<td>Genome strait</td>
<td>Deleted 6 genes</td>
<td>Deletion of a I177L gene</td>
</tr>
<tr>
<td>Cells for vaccine production</td>
<td>Macrophage-derived cell line</td>
<td>Primary macrophage</td>
</tr>
<tr>
<td>Vaccine virus/dose Regime</td>
<td>&gt; 10^3.5 HAD50 1 shot</td>
<td>&gt; 10^2.6 HAD50 2 shots</td>
</tr>
<tr>
<td>Age for use</td>
<td>&gt; 4-week old Intramuscular</td>
<td>8-10 week old: first shot 12-14 week-old :2nd shot Intramuscular</td>
</tr>
</tbody>
</table>

*) taken from AVACO.VJSC presentation, prepared to GARA meeting in USA (2023)

**Fig. 1. Results of AVAC ASF LIVE vaccine efficacy test. For details see in text**
According to the NAVETCO vaccine trial report data presented by Dr. Ta Hoang Long from the Vietnam National Veterinary Control Center (DAH) at the OIE meeting, 23,344 doses of the drug (1 dose per animal) were used on date 26/08/2022. Only 27 vaccinated pigs had post-vaccination complications. They were manifested exclusively in pigs, carriers of causative agents of circovirus infection and PRRS. PCR analysis of blood samples for the gene of the viral polypeptide p72 and the deletion gene of the asfarvirus 1177L (DIVA technology) showed that viremia in vaccinated pigs is associated only with the vaccine virus and is manifested no earlier than the 7th day after vaccination (p.v.). In the control groups of swine ASF patients, viremia developed as early as the 3rd day after challenge. If say about AVAC ASF LIVE vaccine so on date of January 2023 there 600,544 pigs were vaccinated with on 543 farms in 32 provinces of Vietnam (more than 50 of them are homestead farms): according to testing for 28 days p.v. 93.34% of them were seropositive. In February 2023, this vaccine was tested on 6 pig farms in the Luzon region of the Philippines: on the 42nd week of excretion and viremia of the causative agent of ASFV were not detected, seropositivity in the 4th week of the p.v. was 100%, and State Vet Service of Philippines recommended AVAC ASF LIVE vaccine for implementation. After it AVACO.VJSC exported 300,000 doses to the Philippines in July 2023 by addition. By last reports the 99% vaccinated swine of the 77 farms in 17 provinces achieved of stable postvaccinal seroconversion. Although the outbreak rate at this region for small scale farms was about 80-90% generally in past, there outbreaks reposted at the vaccinated herds aren't registrant so far.

As a normative basis for the introduction of ASFV vaccine prevention in Ukraine, it is advisable to choose the current Methodological recommendations of the StopASFm system of measures [7]. In the current timecard, it is expedient to use it to accompany ASFV vaccine prophylaxis in Ukraine in canvas of "break of the epizootic chain" of ASFV in industrial pig farming. This topic is the most painful problem of saving investments in pig farming, because according to modern requirements, all pig herds of the farm, where the virus is detected, are subject to stamping out - bloodless destruction through burning or appropriate burial [5, 8]. But otherwise, since the 1970s, in Cuba, Spain, Italy, and in some cases in the former USSR, the use of certain meat processing technologies (thermal processing, certain technologies of jamon etc.) has been successfully tested to significantly reduce losses without reducing the effectiveness of ASF counter-measures and without destruction of the production resource of pig farming.

By today, it is clear that long-term carriage of any asfarvirus by pigs, whether vaccine or field, is unacceptable [8]. But the Vietnamese data on ASFV vaccine prevention add even more arguments in favor of softening the "stamping-out" format - if especially its combine with the mentioned meat processing approaches. Even now, ASFV vaccine prophylaxis can be guaranteed to become a tool for the selective stamping-out of pig groups which exposed with agent in the sector / sector’s cages of the pig complex affected by the virus and the conditional "stamping-out" by way of longtime/gradual processing of vaccinated herd on meat. Moreover, we believe that today there are enough methodical approaches and means to create a "protection strip" of vaccinated pigs around the suspected foci of the disease per applying of chemo - and probiotic therapy to stop the possible circulation in the herd of asfarvirus during the yellow phase of biothreat in the biosafety system "StopASFmix" [1, 7]. Here it is only necessary to adds that the implementation of the specified measures must be ensured by appropriately tested, specially trained and certified employees. In order to implement these measures, it was very interesting to study the possibility of applying the Soviet experience of emergency vaccination against CSF - oral vaccination of pre-colostrum newborn piglets, as well as intradermal vaccination of the rest of the pig herd.

Remediation of wild boar populations in the territories of stationary centers of the disease is also an extremely urgent, if not primary, task of ASFV vaccine prevention. Oral administration of the vaccine cannot be dispensed with here. For this, the most rational approach is the approach of prof. I.Y. Kulesko with using the vaccine in a form that maximally stimulates the protective function of the tonsils and lymphoid follicles of the intestine of a wild boar [9].
Regarding using in Ukraine of the mandatory test of the protective activity of vaccines against variants of the pathogen circulating in Ukraine (Efficacy test), it should be noted that there are no suitable vivariums in the country for conducting such a test on piglets or adult pigs like to one which are used by state vet service of Vietnam. An adequate solution to this problem could be the implementation of our methodical approach using suckling piglets in vivariums/vivarium chambers for laboratory animals with the biosafety level BSL-3 [10]. In cooperation with Vietnamese colleagues, it would be expedient to validate this methodical approach first on the territory of Vietnam with their field virus, and then on the territory of Ukraine with the Ukrainian field virus. This approach could be formalized in the current order as an cost-save international protocol for testing the protective activity of vaccines against ASF.

References:
7. Methodological recommendations of the StopASFMix system for measures of early protection of industry pig-farming ASF outbreaks, approved by SSUFSCP Ukraine in 2021, 47pp
9. Кулеско І. І. Пероральна імунізація поросят проти чуми та бешки. Вісник сільськогосподарських наук. 1961. № 11, стор. 28-37