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ON THE EFFECT OF SILVER IONS ON RESISTANCE

K. PETERSON, Ü. PAVEL. HÕBEDA IOONIDE MÕJUST RESISTENTSUSELE
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Silver ions have been extensively used as a bacteriostatic preparation in various human and animal infections (Кульский, 1960; Васильев, 1962; Nõmm, Peterson, 1963; Nõmm et al., 1963). Biochemical studies have shown that silver ions in a low concentration affect energy processes in the cell by stimulating the activity of adenosine triphosphatase (Энгельгардт et al., 1941; Chapell, Greville, 1954; Hollunger, 1960). Likewise silver ions have a morphogenetic activity (Рапопорт, 1961; Remm, Pavel, 1964).

Proceeding from the above, the aim of the present study was to establish if it is possible to raise chick resistance to artificial infection by *S. gallinarum* by the administration of silver ions. Another object was to find out if the silver ions administered simultaneously with vaccine raise immunological response to artificial infection following vaccination.

Materials and Methods

White Leghorn chicks were used in experiments. With the aim of raising their resistance, the chicks were subjected to double vaccination as in our previous studies (Peterson, 1964).

For the first time, on the twelfth incubation day, 0.1 ml of killed vaccine prepared from strain 15-S of *S. gallinarum* was injected into the air-chamber of an egg.

For the second time, on the first or the second day after hatching, vaccine was subcutaneously injected in a double dosage into the thigh region of the chick.

The experimental group of chicks was injected with vaccine, and the control group was injected with 0.1 ml (25 μg/ml) of silver-ion solution. Ionized silver solution was prepared by the method of Kulski (Кульский, 1960).

To establish the stimulating action of silver ions on immunogenesis, vaccine containing 25 μg/ml silver ions was employed.

To establish the action of vaccination as well as that of silver ions on chick resistance, the chicks were infected 1—2 days after the second vaccination. Live culture of *S. gallinarum* was used as a means of infection; 1.2×10^8 live bacteria were subcutaneously injected into the thigh region of the chicks.

Results

The data given in Table 1 show that the preceding double vaccination considerably raised chick resistance to artificial infection by live culture of *S. gallinarum*. Thus, the mortality of the vaccinated chicks was con-

Table 1

The preventive effect of vaccination

Series	Group	Preparation	Dosage of vaccination	Number of chicks	Chicks perished within 21 days	
					number,	%
I	1	Bacterial antigen in physiological solution	4×10^7	172	120 $P<0.001$	69.8
	2	Bacterial antigen in ionized silver solution	4×10^6	124	68 $P<0.001$	54.8
	3	Control	—	117	113	96.6
II	4	Bacterial antigen in physiological solution	6×10^7	165	131 $P<0.001$	79.4
	5	Bacterial antigen in ionized silver solution	6×10^7	76	47 $P<0.001$	61.8
	6	Ionized silver solution	—	82	73 $P>0.05$	89.0
	7	Control	—	156	145	92.9

Note: Within the limits of a series the data obtained on groups were compared with those on the control group by the χ^2 test. Respective probabilities are given in the penultimate column.

The probability of the difference (P) between the groups was found to be, as follows: between 1 and 2 — $P<0.05$; between 4 and 5 — $P<0.01$; between 4 and 6 — $P>0.05$; between 5 and 6 — $P<0.001$.

Table 2

Stimulating effect of silver-ions on immunogenesis in dependence on vaccine dosage

Group	Preparation	Dosage used to affect the embryo	Number of chicks	Chick perished within 21 days	
				number,	%
1	Bacterial antigen in ionized silver solution	6×10^8	67	51 $P<0.001$	76.1
2	ditto	6×10^7	76	47 $P<0.001$	61.8
3	ditto	6×10^6	80	46 $P<0.001$	57.5
4	ditto	6×10^5	79	61 $P<0.001$	77.2
5	Control	—	150	145	92.9

Note: The data obtained on all the groups were compared with those of the control group by the χ^2 test. Respective probabilities (P) are given in the penultimate column. Comparisons were also carried out between groups 1 and 2, 1 and 3, 1 and 4, 2 and 3, 2 and 4, 3 and 4. Respective probabilities were established to be as follows: between 1 and 2 — $P>0.05$; between 1 and 3 — $P<0.05$; between 1 and 4 — $P>0.05$; between 2 and 3 — $P>0.05$; between 2 and 4 — $P>0.05$; between 3 and 4 — $P<0.05$.

siderably lower than that of the control chicks. This was particularly pronounced in the groups where the vaccine contained silver ions (cf. groups 2 and 5).

As regards the effect of silver ions, the sole use of the silver-ion solution did not prove to be sufficient to raise chick resistance (cf. group 6); the silver-ion solution along with the bacterial vaccine, however, stimulated the processes of immunogenesis in the vaccinated chicks (cf. groups 2 and 5). The fact that the bacterial vaccine plays a basic role in raising resistance and that silver ions apparently merely stimulate the reaction of the organism to vaccination and to the injected live bacteria is confirmed by the data shown in Table 2. It appears from the data that the resistance-enhancing effect depends on the dosage of the vaccine.

The data presented above suggest that silver ions, by apparently stimulating the energy processes of immunogenesis released both by vaccination and by injected live bacteria.

Summary

Twofold vaccination enhances the resistance of chicks to subsequent artificial infection by *S. gallinarum*. The stimulating effect of vaccination can still be increased by adding silver ions to the vaccine.

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