UDC 621. 316. 929

PARAMETERS OF INFORMATION ELECTROMAGNETIC FIELD RESEARCH FOR COWS' REPRODUCTIVE FUNCTIONS THERAPY

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Abstract: The work is devoted to electromagnetic field intensity research. It was obtained its average value dependence from the wave frequency for non-drug therapy of cows' stock ovaries diseases. This can be done using information electromagnetic radiation of the EHF range. The biotrope parameters as influence exposure of electromagnetic radiation, its tension, power flux density and required radiation source power were defined as well.
Keywords: **ovarian pathology; informative electromagnetic field; biotrope parameters; EHF band; diffraction; antenna system; electrodynamic model.**

The main postpartum cows' diseases are gynecological diseases, among which the main place is ovarian pathology. The percentage of infertile cows on farms is 17-30%, and in some cases reaches 40% of breeding stock. The only one cow maintenance with impaired reproductive function causes serious economic damage. Disease of cows with gynecological diseases entails a decrease in the fertility rate of cows by 17–40%, an increase from calving to fruitful insemination by 40–60 days, decrease of breeding and milk production by 12–18% [1, p.59].

The main cows' ovaries diseases are: inflammation, hypofunction, atrophy, sclerosis, persistent yellow body, ovarian cyst. In modern conditions, antibiotics, hormones and other chemicals are used to treat diseases and disorders of the cows’ ovaries function. However, therapeutic efficacy remains low [2, p.25]. During the milk and cow meat ingestion, antibiotics and other medicines penetrate the human body. This leads to immunity decrease, various diseases. Thus, non-drug treatment of cows’ ovaries is an urgent task.

Treatment of cows’ ovarian disease is possible through the use of information electromagnetic radiation (EMR) of the EHF band [3, p.24]. An analysis the effect of information electromagnetic field (EMF) onto the animal’s body shows that EMR has a very strong effect on biological processes in a living organism. However, the desired changes in the properties of biological objects can be obtained only under optimal combination of biotropic EMF parameters (frequency, power flux density, exposure, modulation, polarization).

To determine these parameters, it was necessary to theoretically determine the EMF distribution at various frequencies and exposures of radiation, different power flux density. To solve this problem, EMR is considered as a linearly polarized monochromatic electromagnetic wave that extended in the environment where the ovaries are located.

The model of a cow's ovaries can be represented as a rotation spheroid (Fig. 1) filled with an isotropic environment with dielectric $\varepsilon\varepsilon_0$ and magnetic μ_0 permeability (ε_0 and μ_0 – the dielectric and magnetic permeability of vacuum).

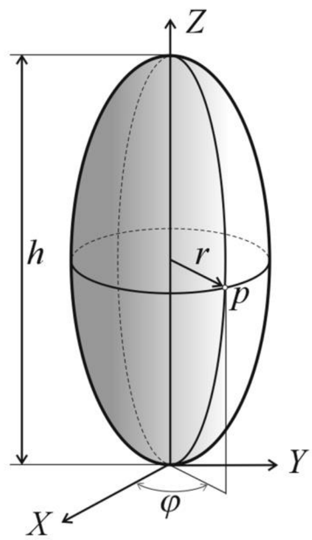

Fig.1. Cow’s ovary electrodynamic model

As a result of the electromagnetic wave diffraction on cow's ovary, a diffraction field arises with vectors of electric and magnetic fields $\vec{E}_{\pm}$, $\vec{H}_{\pm}$, satisfying a homogeneous equations system, both in the middle of the ovary and outside:

$$rot\vec{E}_{\pm} = i\omega\mu_0\vec{H}_{\pm}, \qquad rot\vec{H}_{-} = -i\omega\varepsilon_1\varepsilon_0\vec{E}_{-}, \tag{1}$$

$$rot\vec{H}_{+} = -i\omega\varepsilon\varepsilon_0\vec{E}_{+}, \qquad \mathrm{div}\vec{E}_{\pm} = 0, \qquad \mathrm{div}\vec{H}_{\pm} = 0. \tag{2}$$

In addition to equations (1), (2), the diffraction field must satisfy the boundary conditions on the ovaries surface, and outside the ovaries – the radiation condition. The integral equation equivalent to (1), (2) can be represented by vector potential functions and integral formulas:

$$rot\vec{H} = -\frac{ik}{W}\vec{E} + \vec{j}, \tag{3}$$

$$rot\vec{E} = ikW\vec{H}. \tag{4}$$

We introduce the notation $k = \omega\sqrt{\varepsilon_1\varepsilon_0\mu_0}$, $W = \sqrt{\dfrac{\mu_0}{\varepsilon_1\varepsilon_0}}$.

Suppose Q means the region of space occupied by the ovaries, then equations (1), (2) take the form:

$$\vec{E} = \begin{cases} \vec{E}_{+} + \vec{E}^{\text{пад}}, & p \in Q \\ \vec{E}_{-} + \vec{E}^{\text{пад}}, & p \notin Q \end{cases} \qquad \vec{H} = \begin{cases} \vec{H}_{+} + \vec{H}^{\text{пад}}, & p \in Q \\ \vec{H}_{-} + \vec{H}^{\text{пад}}, & p \notin Q \end{cases} \tag{5}$$

$$\vec{j} = \begin{cases} \dfrac{ik}{W}(\varepsilon - \varepsilon_0)\vec{E}_{+}, & p \in Q \\ 0, & p \notin Q \end{cases} \tag{6}$$

Equations (3), (4) can be considered as inhomogeneous Maxwell equations in a homogeneous environment with dielectric $\varepsilon\varepsilon_0$ and magnetic μ_0 permeability, and the vector function $\vec{j}$ can be considered as the current density in a given region. Assume the $\vec{j}$ quantity is known. Then the equations solution (3), (4) can be represented using the vector $\vec{F}$:

$$\vec{F}(p)=\int_Q \vec{j}(q)G(|p-q|)dv_q, \qquad (7)$$

$$\vec{E}=\frac{W}{ik}qraddiv\,\vec{F}-ikW\vec{F}, \qquad (8)$$

$$\vec{H}=rot\vec{F}. \qquad (9)$$

The $G(|h-q|)$ is the Green's function of the three-dimensional scalar Helmholtz equation, where $|p-q|$ is the distance between the points p and q. Taking into account (5), after the transformations, the integral-differential equation of the electric field strength in the middle of the ovaries is obtained (region $p\in Q$)

$$\begin{aligned}\vec{E}_+(p)=k^2\left(1-\frac{\varepsilon}{\varepsilon_1}\right)\int_Q \vec{E}_+(q)G(|p-q|)dv_q+\\+\left(1-\frac{\varepsilon}{\varepsilon_1}\right)qrad\,div\int_Q \vec{E}_+(q)G(|p-q|)dv_q+\vec{E}^{\text{пад}}\end{aligned} \qquad (10)$$

Equation (10) allows to calculate the electric field outside the ovaries. Using the integral-differential formulas of the vector fields theory, it can be represented as:

$$\begin{aligned}\vec{E}_+(p)=k^2\left(1-\frac{\varepsilon}{\varepsilon_1}\right)\int_Q \vec{E}_+(q)G(|p-q|)dv_q-\\-\left(1-\frac{\varepsilon}{\varepsilon_1}\right)\int_{\partial Q}\left(\vec{E}_+(q),\vec{n}\right)qrad_q G(|p-q|)ds_q+\vec{E}^{\text{пад}}\end{aligned} \qquad (11)$$

Expression (11) is the equation of the EMF in the middle of the ovary. An expression can be obtained to calculate the average value of the electric field inside the ovaries:

$$U_{cp} = \frac{E_{zcp}}{E_0} \cong \frac{9\pi kR}{16}\left[1-(kR)^2\left(1-\frac{\varepsilon}{\varepsilon_1}\right)\frac{9ih^4}{16R^4}D_1\right], \qquad (12)$$

where $D_1 = 0{,}5\int_0^\infty \frac{J_1\left(\frac{x}{2}\right)J_2\left(\frac{x}{2}\right)}{x^3}\left(1-x^2\right)dx - \frac{4i}{\pi}\int_0^\infty \frac{J_2\left(\frac{x}{2}\right)\sin\frac{x}{2}}{x^3}\left(\cos^2\frac{x}{2} - x^2\sin^2\frac{x}{2}\right)dx.$

From this equation it follows that the most effective interaction of EMR on cow's ovaries is the frequency band, where *kR*~10, *kh*~10. In view of ovaries' average geometric dimensions, this band is located 61 GHz $\le f \le$151 GHz.

According to Fig. 2 the maximum value of U_{cp} reaches at frequency f = 72.2 GHz. This electromagnetic wave frequency is optimal for the effective interaction of EMR on cow's ovaries. As a result of calculations the EMR power is 10 ... 15 mW, the irradiation time of cows' ovaries to inhibit pathogenic organisms is t = 70 s and the field intensity is E = 44.88 V/m.

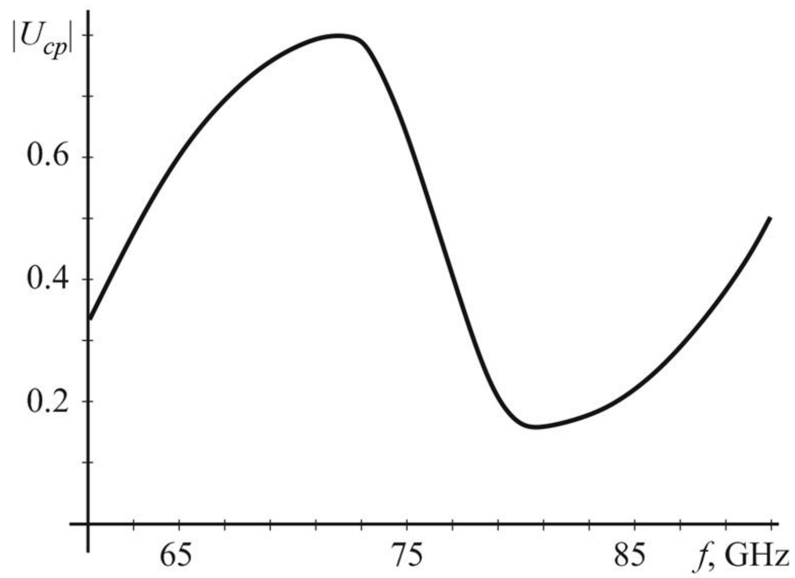

Fig.2. The average value of the electric field dependence from wave frequency radiation

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