Short note

The influence of microwave radiation on the juvenile stages of *Trichinella*

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Helminthiases and in particular trichinellosis have a great social and economic importance among the parasitic diseases of humans and animals. Trichinellosis is widespread in nature from the North Pole to the southern tip of the African continent, and synanthropic foci of trichinellosis are also registered in many countries worldwide. The causative agent of trichinellosis is a nematode of the family Trichinellidae Ward, 1907, genus *Trichinella* Railliet, 1895. Nematodes of the genus *Trichinella* can infect three classes of vertebrates – mammals, birds and reptiles (Pozio *et al.*, 2006).

In recent years, the number of genotypes that are considered as species has increased significantly. The existence of 12 genotypes of *Trichinella* (T1-T12) is recognized currently, nine of which are recognized as valid species (Pozio *et al.*, 2009).

The experiments were conducted with two capsule-forming species of *Trichinella*, *T. spiralis* (Owen, 1835), initially isolated from the muscles of the domestic pig, and *T. nativa* Britov & Boev, 1972 from a brown bear, and a non-capsulated species, *T. pseudospiralis* (Garkavi, 1972), initially isolated from the muscles of the domestic cat. The viability of these types of *Trichinella* infection was checked in laboratory rodents (white rats, mice, hamsters and rabbits) in the vivarium of the Institute. Experimentally infected white rats and mice were anesthetised with ether; skin and internal organs were removed from the carcasses, and the muscle tissue was ground and subjected to biochemical digestion in simulated gastric fluid (SGF) containing 1% hydrochloric acid (density 1,175) and 3% pepsin. Freshly prepared SGF was heated to a temperature of 40±2°C in the 'Gastros' apparatus (Petrolazer, St. Petersburg, Russia) and proteolysis of muscle tissue was performed for 2 h. Decapsulated juveniles of *Trichinella* were placed in saline warmed to 37°C, counted and then rabbits were infected at the dose of 2 juveniles $g^{-1}$of body weight. In total, for each nematodes species there were three groups of five rabbits. The duration of infection was 90 days.

Portions of muscles (150-160 g and 1.5-2.0 cm thick) from the thigh of carcasses of rabbits experimentally infected with *Trichinella* were exposed to microwave radiation at 800 W for 2 and 4 min. in a domestic microwave oven. The extent of destructive changes of the internal organs of *Trichinella* juveniles after treatment with microwave radiation was studied by light microscopy. The viability of the juveniles was determined by bioassay by feeding treated meat to white laboratory rats. Each experimental group consisted of 10 white rats and there were three animals in three control groups. The positive controls for each group were animals eating raw trichinous meat. Analysis of results was carried out within 45 days by proteolysis of muscles carcasses of rats in the treated and control groups in SGF.

All the rats from the control groups were infected with *Trichinella* with an average intensity of infection: *T. spiralis* 725.3 juveniles g^{-1} of muscle tissue, *T. pseudospiralis* – 237.8 juveniles g^{-1}, *T. nativa* – 65.1 juveniles g^{-1}. The intensity of infection with *T. spiralis* in rats fed on meat after 2 min of microwave treatment was 0.02-0.03 juveniles g^{-1}, with only three rats becoming infected out of 10. Similar results were obtained for *T. nativa* – 0.03-0.05 juveniles g^{-1}, with three rats infected out of ten; infected rats were not found in the experiment with *T. pseudospiralis*. The groups of rats fed on meat after 4 min of microwave exposure were free from infection.

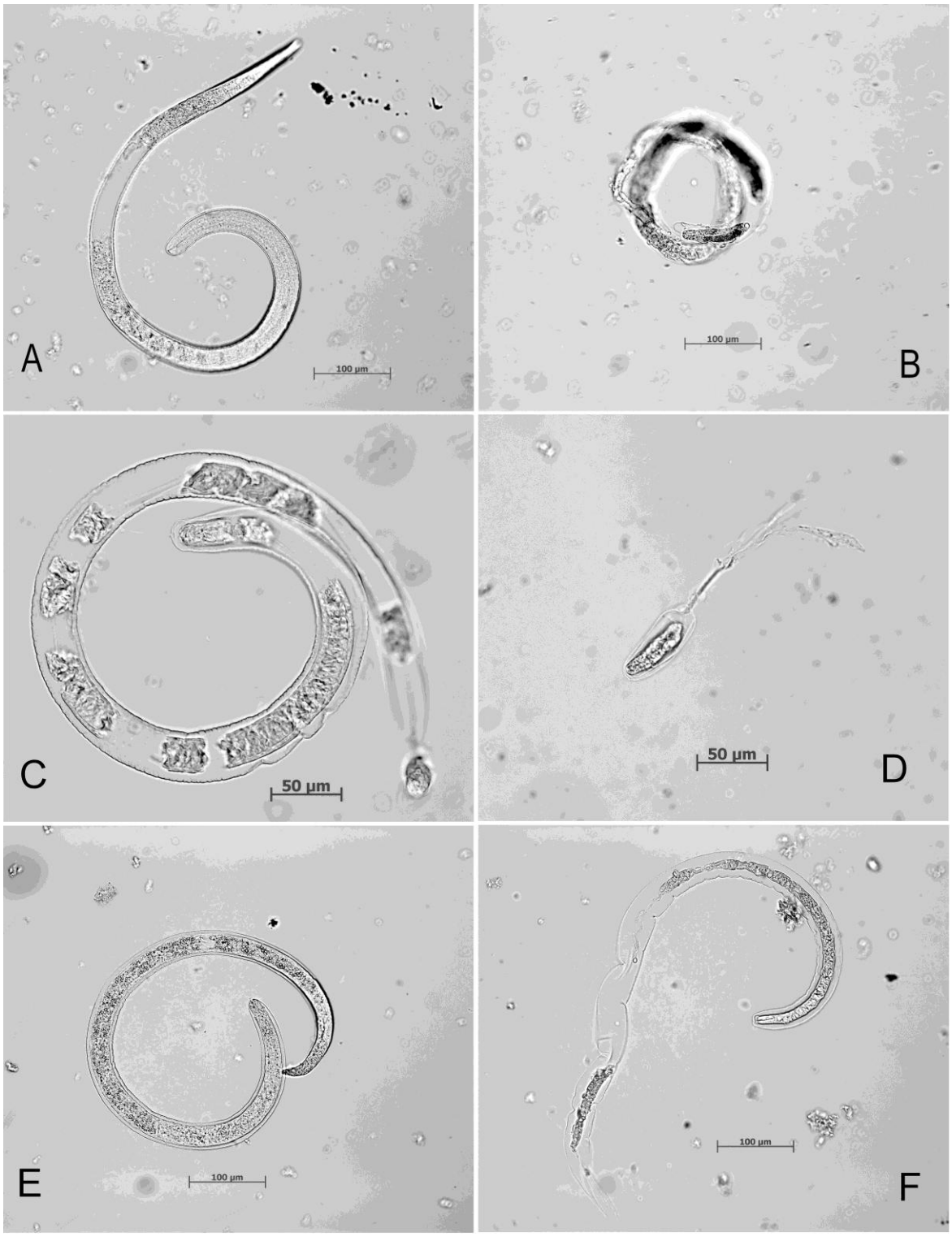

Fig. 1. Effects of microwave irradiation on *Trichinella* juveniles: A: *T. spiralis* 2 min – capsule and organs destruction; B: *T. spiralis* 4 min – complete juvenile destruction; C: *T. pseudospiralis* 2 min – collapse of internal structures; D: *T. pseudospiralis* 4 min – complete juvenile destruction; E: *T. nativa* 2 min – destruction of cellular structure, detachment of cuticle; F: *T. nativa* 4 min – complete juvenile destruction.

Morphological analysis of juveniles isolated from muscle after treatment with microwave radiation, showed the following.

During the 2-min treatment capsule and internal organs were damaged in most *T. spiralis*; with *T. pseudospiralis* destruction of the capsule and the collapse of internal structures occurred; in *T. nativa* destruction of the cell structure and peeling of the cuticle was evident.

After 4-min treatment there was complete destruction of juveniles of *T. spiralis*, *T. pseudospiralis* and *T. nativa* (Fig. 1.)

Previously, various authors (Carlin *et al.*, 1982; Kotula *et al.*, 1982, 1983; Zimmermann, 1983, 1984; Redkin & Borovkov, 2007) studied the effects on microwave treatment on meat infected with *Trichinella* juveniles. The author examined the efficiency of the meat thermal treatment, the temperature inside the meat, and the influence of temperature on the viability of juveniles. The authors ignored the effect of microwave radiation on *Trichinella* juveniles.

EMR microwave among the electromagnetic radiation (EMR) of the radio-wave (non-ionizing) range has marked biological effects. 'Heat effect' of microwaves associated with the increase of temperature of the irradiated tissue is the most extensively studied. In addition to thermal effects, microwaves might cause non-thermal effects in biological objects (Ismailov, 1987).

The effect of microwave radiation on biological objects is determined by the amount of penetrating and absorbed electromagnetic energy. A significant part of microwave energy is converted into heat, and vibrations of the ions and dipolar molecules of water molecules in tissues lead to the destruction of the internal organs and even the body of *Trichinella* juveniles. The penetrating ability of microwave radiation, time and radiation power, and weight of the irradiated object must be taken into account in the preparation of meat infected with *Trichinella*. The temperature factor of the environment (meat) around the parasite is secondary. This is fully consistent with the data of Presman (1968) for the influence of microwave radiation on microorganisms.

It is also interesting to note that the capsule-forming *Trichinella* is more resistant to microwave radiation than non-capsulated, but this observation needs further verification.

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