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RESEARCH REGARDING THE EFFECT OF DEUTERIUM DEPLETED WATER FROM DILUENT ON SOWS' FECUNDITY

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Abstract

In the effectuated research, we aimed to observe the effect of dilution of boar sperm with water with a 30 ppm deuterium content on sows' fecundity. The control batches (CB) were formed by 367 sows inseminated with doses based on bi-distillate water. Experimental batches (EB) were formed by 366 sows inseminated with doses based on deuterium-depleted water. The effect of deuterium depleted water was analysed function on utilised synthetic diluent (BTS and Merck), boars' age and season for sperm gathering. In relation with utilised diluent, fecundity was between 79.5% and 80.2% at CB and between 78.7% and 81.9% at EB. Fecundity of boars aged 1 year oscillated between 79.9% at CB and 79.8% at EB, and at boars with age of 3.5 years between 79.8% at CB and 80.8% at EB. In spring, fecundity was between 81.1% at CB and 82.2% at EB, and in summer between 78.6% at CB and 78.3% at EB. No matter of analysed factor differences between control and experimental batches were insignificant.

Key words*: sows, boar, fecundity, deuterium-depleted water.*

INTRODUCTION

Deuterium-depleted water (DDW) has a lower concentration of deuterium than occurs naturally (less than 145 ppm) (Rehakova et al., 2016). Deuterium concentration interest area for deuterium-depleted water is in the range 20-110 ppm. Deuterium-depleted water is obtained by isotopic distillation under vacuum (Mladin et al., 2013).

Physicochemical properties of the light water include the melting and boiling points, kinematic viscosity, density, the spin-spin proton relaxation time, self-diffusion coefficients, and the small-angle laser light scattering (Goncharuk et al., 2010).

Deuterium content of living animals body can be increased, with dramatical effect over the health state, through bioaccumulation process by continuously adding of heavy water in their nourishment. On the other hand, deuterium depletion has been mentioned in literature as a health stimulator and a new possible anticancer tool (Ștefanescu et al., 2010).

A series of experiments have shown that deuterium depleted water has beneficial effects for life. According to Boros (2016) studies, the naturally occurring isotope of hydrogen (^{1}H), deuterium (^{2}H), could have an important biological role. Deuterium-depleted water delays tumour progression in mice, dogs, cats and humans. In the former, the DDW is thought to diminish the deuteration of sugar-phosphates in the DNA backbone, helping to preserve stability of hydrogen bond networks (Boros et al., 2016**).** The biologically active role was also explained by prevention of acetaminophen induced hepatotoxicity in rat. This protection may involve the reduction of oxidative stresses (Rasooli et al., 2016).

Also, Dzhimak et al. (2015) argues that a physiological solution prepared on deuterium-depleted water during induced apoptosis activates the DNA repair system, significantly reducing the number of single-stranded DNA breaks, which, in general, indicates an increase in the efficiency of defensive systems of the cell.

Some studies show the effect of depleted water on the nervous system. Strekalova et al. (2015) conducted a correlation analysis between tap water deuterium content and rates of depression in regions of the USA. Their data suggest that the deuterium content of water may influence the incidence of affective disorder-related pathophysiology and major depression, which might be mediated by the serotoninergic mechanisms. Mladin et al. are of the opinion that a deuterium desaturation treatment with deuterium depleted water might have a use in anxiety disorders. Another study on rats suggests that the administration of DDW may generate an improvement of the reference memory, as an index of long-term memory (Mladin et al., 2014).

Deuterium depleted water is proposed as an adjunct to cancer therapy (Boros, 2014; Krempels, 2008; Mirica, 2010).

Wang (2013) found that deuterium depleted water was an effective inhibitor of cancer cell proliferation. Deuterium depleted water is a new, nontoxic adjuvant therapeutic agent that suppresses the proliferation, migration and invasion of the cells of the nasopharyngeal carcinoma.

Some researchers have investigated the effect of depleted water on plant physiology. Thus Tanase et al. (2014) showed that deuterium-depleted water together with polyphenolic extracts from spruce bark can act in growth stimulation and also influence biosynthesis, the photosynthesizing pigments, and secondary metabolites in plants. Other researchers are of the opinion that plant physiological processes are optimal at concentrations of deuterium present in natural waters. Thus, Somlyai et al. (1993) are of the opinion that the deuterium concentration is either higher or lower than that of natural waters (150 ppm D), the growth of coleoptyl and root is hindered.

The role of water depleted in deuterium has also been demonstrated in fish reproduction. Pricope et al. (2003) showed that the reproduction of rainbow trout in a 1:1 solution of deuterium-depleted water and distilled water led to a significant increase in survival of roes during their embryonic development.

In mammals, the results of artificial insemination depend on the quality of the semen, the technique of inoculation and the good functioning of the female genital apparatus (Păcală, 2004). In pigs, the quality of the sperm depends on the age of the boars, the breed, the environmental conditions (Tăpăloagă et al., 2013) and the method of harvesting (Ciornei et al., 2012; Tăpăloagă et al., 2013).

The dilution medium for boar semen must provide the conditions for preservation (Buzan, 2015; Buzan, 2016) in order to achieve good results after insemination.

In this context, in which the biologically active role of depleted-deuterium water was identified, we aimed to investigate the effect of this water from the diluent on the sows' fecundity.

MATERIALS AND METHODS

From 4 boars of synthetic line LS 408 (2 boars -1 year old and 2 boars - 3.5 years old) was harvested the semen in April (16 ejaculates), May (24 ejaculates), July (16 ejaculates), and August (24 ejaculates). Harvesting was done through masturbation. After evaluation of the sperm quality, 4 types of doses were prepared with 4 billion mobile spermatozoa /dose. The sows were grouped in to 4 batches, depending on the type of diluent used to process the ejaculates, thus:

- CB 1 – control batches (the sows artificially inseminated with dose based on Merck III diluent and bi-distilled water);
- EB 1- experimentally batches (the sows artificially inseminated with dose based on Merck III diluent and deuterium-depleted water);
- CB 2 – control batches (the sows artificially inseminated with dose based on BTS diluent and bi-distilled water);
- EB 2- experimentally batches (the sows artificially inseminated with dose based on BTS diluents and deuterium-depleted water).

733 Camborough sows were inseminated between the first and fifth calves. For the first insemination, fresh dosages were used, and for the second, preserved for 12 hours at 17°C. Fecundity was calculated as a ratio between the number of pregnant sows at 63 days after insemination and the total number of sows inseminated. For the variance analysis, the Fisher test was used.

RESULTS AND DISCUSSIONS

Results obtained in function by the age of the boars.

The mean fecundity of artificially inseminated sows with semen harvested from young boars was 79.9% for CB and 79.8% for EB, and sows' fecundity inseminated with doses obtained from 3.5 years old was 79.8% for CB 80.8% for EB (Table 1).

Table 1. The sows' fecundity in function by the age of boars

Batches	Boars of 1 year old			Boars of 3.5 years old		
	Artificial inseminated (no)	Pregnant (no)	Fecundity (%)	Artificial inseminated (no)	Pregnant(no)	Fecundity (%)
CB	164	131	79.9	203	162	79.8
EB	163	130	79.8	203	164	80.8
	Insignificant differences $F(1;6) = 0.13 < F_{0.05}(1;6) = 5.99$			Insignificant differences $F(1;6)=0.13 < F_{0.05}(1;6) = 5.99$		

The difference between CB and EB corresponding to boars aged 1 year was 0.1% in favor of CB (statistically insignificant) and between batches corresponding for 3.5 years old, 1% in favor of EB, also insignificant. These values demonstrate that the age of the boars does not influence the effect of deuterium-depleted water on the sows' fecundity.

Results obtained in function by the synthetic diluent used

The average fecundity of CB 1 sows was 80.2%, with 0.7% higher than that achieved at CB 2: 79.5% (Table 2). The very small difference between the results obtained using the two types of diluent did not have statistical significance ($F(1;6) = 0.23 < F_{0.05}(1;6) = 5.99$). This proves that the two diluents have a similar effect on sperm fecundity. The fecundity of EB 1 sows (82.1%) was slightly superior to that of sows in CB 1, the difference being insignificant ($F(1;6) = 0.04 < F_{0.05}(1;6) = 5.99$).

At EB 2, the level of fecundity was only 78.6%, even lower than the sows' fecundity in CB 2 (Table 2). An unsteady dynamics of the results obtained was observed by using deuterium-depleted water. Its use has insignificantly influenced the fecundity of the sows ($F(1;6) = 0.14 < F_{0.05}(1;6) = 5.99$). Under our investigations, the results of using deuterium depleted water were maximal in association with Merck III diluent. For experimental lots, the maximum level of fecundity was also achieved using Merck III diluent.

Table 2. The sows' fecundity in function by the synthetic diluent used

Batches	Boars of 1 year old			Boars of 3.5 years old			Total		
	A.I.* (no)	Pregnant (no)	Fecundity (%)	A.I.* (no)	Pregnant (no)	Fecundity (%)	A.I.* (no)	Pregnant (no)	Fecundity (%)
CB1	85	68	80.0	102	82	80.4	187	150	80.2
EB1	84	67	79.7	101	85	84.2	185	152	82.1
Insignificant differences $F(1;6) = 0{,}13 < F_{0{,}05}(1;6) = 5{,}99$									
CB2	79	63	79.7	101	80	79.2	180	143	79.5
EB 2	79	63	79.7	102	79	77.4	181	142	78.6
Insignificant differences $F(1;6) = 0{,}09 < F_{0{,}05}(1;6) = 5{,}99$									

A.I.* - artificial insemination

Results obtained in function by the season of the artificial insemination

In the spring season, mean fecundity of CB sows was 81.1% and in the summer, 78.6% (Table 3). Statistically, the difference was insignificant ($F(1;6) = 0.14 < F_{0.05}(1;6) = 5.99$). The level of fecundity of EB sows was 82.2% in the spring season and 78.3% in the summer. During the spring season was found an insignificant superiority of the fecundity of EB sows compared to that recorded in the CB, which was not preserved in the warm season, when the sows' fecundity in CB was superior to that recorded in EB (Table 3).

Although the lowest performances were found at sows in EB, in the months of the warm season, we believe that this is not due to the effect of deuterium-depleted water in the diluent on spermatozoon fecundity.

Table 3. The sows' fecundity in function by the season of the artificial insemination

Season	Batches	Artificial inseminated (no)	Pregnant (no)	Fecundity (%)
Spring	CB	180	146	81.1
	EB	180	148	82.2
Insignificant differences F (1;6) =0.13 < $F_{0,05}$(1;6) = 5.99).				
Summer	CB	187	147	78.6
	EB	186	146	78.3
Insignificant differences F(1;6) = 0.14 < $F_{0,05}$(1;6) = 5.99)				

CONCLUSIONS

The use of depleted water in semen diluents did not have a steady effect on the sows' fecundity. Inconstancy has been manifested both in relation to the age of the boars and in relation to the sowing season or the synthetic diluent used. The differences between control and experimental batches were insignificant.

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