ELECTRICALLY TREATED WATER IN PIG FARMING AND PIG MEAT QUALITY

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Abstract

Electrically treated water (ETW) has a character of nanotechnology. It is produced by special equipment for dissociation of water molecules. The practice of adding ETW to the wet diet of growing pigs was subjected to an experiment. A control group of pigs that did not receive any ETW was matched by two experimental groups, one getting 4% of ETW in the total feed (Exp-4%), and the other 8% (Exp-8%). The dosage was maintained throughout the entire fattening period up to the slaughter. Meat quality was assessed by technological and sensory evaluation. The tests did not reveal any negative effect of ETW addition on meat quality in either experimental group.

Key Words: pig farming, nanotechnology, dissociated water, meat quality

Electrically treated or dissociated water, one of the new trends in nanotechnology, was initially studied by Shimizu and Hurosawa (1992) in Japan. They described its strong bactericidal properties useful in food protection. Hsu (2005) gave a general description of an ETW-generating device. It consists of a cylinder and two electrodes under direct electric current. The positive and negative ions pass through a semi-permeable partition separating the two electrodes. Each electrode produces a different solution. The anode produces anolyte with pH 2.3-2.7 and a high (above 1000 mV) oxidation reduction potential (ORP), containing free ions of chlorine. On the other electrode, the cathode, reduction produces catholyte having pH 10.0-11.5, and dissolved hydrogen with a very low ORP (-800 to -900 mV). Per Shigeto et al. (2000), the main advantage, compared to the usual hydrochloric or sulfuric acid, is its safety. ETW is not corrosive to the skin, mucous membranes or organic materials. On the other hand, it does contain a small amount of sodium hypochlorite, a toxic irritant of skin and mucous membranes. In human medicine, ETW replaces formaldehyde vapors in cleaning and disinfecting digestive tracts of patients. Per Sakura et al. (2003), the cost of using it is about 230 times lower than the classical methods. According to Kiur et al. (2002), the major disadvantage of ETW is a rapid loss of anti-microbiological activity. Tanaka et al. (1999) point out that the issues of concern are chlorine emissions, corrosion of metal and plastic, and free ClO^- ions.

MacPherson (1993) asserts that the optimal bacterial growth is generally in the range of pH 4-9. A typical ORP range for aerobic bacteria is +200 to +800 mV, as opposed to -700 +200 for anaerobic bacteria. ORP value may cause changes in the metabolic flux and ATP production, and probably affect the electron flow within the cells as well. According to Marriott and Gravani (2006), the presence of chlorine may be disruptive to protein synthesis, oxidative decarboxylation of amino-acids into aldehydes and nitrites, and metabolic imbalance after the destruction of microorganisms' key enzymes.

A growing popularity of ETW as a cleaning agent in food industry is evident in many countries was noted by Hricov et al. (2008). Bacterial cells in suspensions have been typically reduced by more than 6.0 log CFU/mL using catholytes (pH 2-3). However, catholytes are less bactericidal on the surfaces of kitchen utensils and appliances. On some food commodities, a greater reduction was achieved by anolytes. The ETW technology merits consideration for industrial sanitation of equipment and decontamination of food. The traditional hygienic and processing practices should be flexible enough to utilize the ETW in food protection.

The extensive experiment culminated in an assessment of meat quality after the slaughter in order to confirm the absence of any potentially negative effects of ETW on the properties of meat.

Materials and Methods

The experiment with electrically treated water (ETW) was carried out on a pig farm with the nominal capacity of 1440 pigs. The facility is divided into 9 halls, each accommodating 160 animals. The pigs are fed via a wet portioning system. The ventilation is vacuum-based, with the air drawn from under the grates and exhausted through a chimney situated 5 m above the roof level. The farm is equipped with an ETW-producing reactor.

Three halls were chosen for the experiment: One with the control group, the second with the 4% ETW experimental group (Exp-4%), and the third with the 8% ETW experimental group (Exp-8%). The additive was anolyte with pH below 3. Gas emissions were measured 4 times during the experiment. So far, the NH_3 emissions and greenhouse gases have shown a decreasing tendency. Odor emissions were lower in the 8% ETW experimental group, while the 4% group registered only a slight reduction. The concentration and emission of both dust components (PM_{10} and $PM_{2.5}$) are practically unchanged. As to the weight increase, the control group had a gain of 750 g/pc/day, the Exp-8% experimental group 780 g (or 4% more), and the Exp-4% group 710 g (or 5.3% less). The experiment continues.

Meat Evaluation Methodology

With respect to the main objective, the studied applications proved to be effective. In these types of experiments, it is desirable to monitor also the fattening indicators, carcass value and meat quality in consumer-friendly parameters.

Not knowing any negative consequences of the monitored applications on the analytical values of the meat after slaughter, we focused on technological and sensory indicators of meat quality as the signs that could signal potential changes.

Technological Evaluation

Among the technological criteria, we monitored the meat color values, with L* being the lightness of color on a scale of 0 (black) to 100 (white), a* on a scale of -60 (red) to +60 (green) and b* on a scale of -60 (yellow) to +60 (blue). This three-dimensional matrix common in other fields provides the most accurate definition of meat color. Along with the pH values, it allows to classify possible deviations as meat defects in standard categories. However, this was not the intention, since there was no assumption of ETW causing or otherwise influencing the appearance of meat deficiencies. An important culinary parameter, although largely overlooked in consumer education, is a spontaneous loss of moisture, or drippage for short, in two 24 hour periods after the slaughter, on a 100 g sample of pure muscle tissue stored in a PE wrapper at 4-7°C. The pH values were measured at the same time.

Sensory Evaluation

For a test of consumer significance, we chose sensory evaluation. We heat-treated pure muscle tissue m.l.d., or boneless roast, by grilling it on a glass-ceramic contact grill. The grilling, without salt or spices, was on a surface heated to 250°C until the temperature inside the slice of meat 2 cm thick reached 90°C. The slice was then cut into cubes with about 2 cm long edges, then temperature-equalized in a closed container at 50°C until served to the evaluators. The presentation occurred in approximately one hour's time.

Working individually, the evaluators considered a number of criteria per Table 1. To avoid the influence of subconscious decision-making, the samples were marked with graphic symbols rather than numbers. The samples (cubes) of the control and experimental groups were always served together. A total of 10 samples/pigs per group was evaluated, always by 10 evaluators. A nine-grade rating scale was used, with 9 being the best and 1 being the worst. There was no inedible category, nor was there such a case. The overall rating reflected the evaluator's fundamental priority independent of any other ratings.

Results

Meat Evaluation Results

Application of electrically treated water (ETW), also termed dissociated water.

The dissociation creates two components characterized by an ion shift, resulting in pH 9-12 as "live water" and pH 5-3 as "dead water". Live water was added at 4% or 8% level to the wet feed mixture, always just before the feeding. Immediately prior to distribution from the tanks, the mixture had pH 5.01 in the control group, pH 5.67 in the 4% experimental group, and pH 5.75 in the 8% experimental group. The experiment was done on a pig farm in Starosedlský Hrádek, the slaughter in an abattoir in Příbram. The results of meat quality evaluation are shown in Tables 1 and 2. The differences between the values in the control and experimental groups, and between the two experimental groups, were not statistically significant due to the inherent variability of the data.

Table 1. Technological Evaluation of Meat

Parameter	pH 1st day	pH 2nd day	L* 1st day	a*	b*	Drippage
Control Group						
Average	5.69	5.49	54.84	2.39	12.65	4.7
s=	0.42	0.03	2.37	1.21	0.97	1.8
Experimental Group – 4%						
Average	5.52	5.55	52.97	1.96	11.63	4.5
s=	0.11	0.07	1.79	1.15	0.73	1.6
Experimental Group – 8%						
Average	5.55	5.59	56.08	1.84	12.81	6.4
s=	0.20	0.12	1.68	1.15	0.49	2.3

Table 2. Sensory Evaluation

Parametr	Smell intensity	Smell appeal	Crispness	Texture	Juiciness	Chewability	Flavor intensity	Overall rating
	Control Group							
Average	5.73	5.47	5.27	5.17	4.97	5.13	5.32	5.0
S=	1.73	1.91	2.20	2.02	2.21	2.18	2.00	2.37
	Experimental Group – 4%							
Average	6.20	5.95	6.28	6.00	5.42	5.92	6.00	6.10
S=	1.79	2.12	1.65	1.61	1.86	1.73	1.71	2.17
	Experimental Group – 8%							
Average	5.38	4.80	5.24	4.98	4.46	5.34	5.06	4.82
S=	1.91	1.94	1.90	1.64	1.71	1.66	1.43	1.97

Conclusion

Nanotechnology applications have been tested on other species of farm animals with similar results. A monogastric broiler chicken operation, comparable to pig farming, yielded similar data on meat quality, the differences in some criteria being insignificant.

In conclusion, it may be said that ETW has a positive effect on atmospheric emissions without an indication of a negative impact on meat quality per selected criteria. In that sense, the applications proved to be beneficial.

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