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IMPROVING THE SUSTAINABILITY OF PIG TRUCKS CLEANING AND DISINFECTION PROCEDURES

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I. INTRODUCTION

Cleaning and disinfection of livestock vehicles is known to be a key measure to prevent animal farm diseases and to improve the quality and safety of pigs and carcass and thus, the meat in slaughterhouses. Therefore, it is one of the critical steps to avoid, or minimize, the presence of zoonotic microorganisms and to potentially reduce the associated food-borne diseases [1]. Some zoonotic pathogens, mainly those of intestinal origin such as *Salmonella*, pose an increased risk to carcass contamination, thus compromising the not compliance of the microbiological process hygiene criteria at the slaughterhouse level and also the meat safety.
The current cleaning and disinfection procedure uses a high amount of water per truck, which represents a high economical and environmental cost. The sustainable management of resources is a critical issue and to avoid the need of the use of valuable running drinking water, the use of recycled water from the slaughterhouse itself is a must. Moreover, it is also important to consider reducing the high environmental impact of cleaning and disinfection products, as well as the risks to operators associated with these products.
The aim of this project is to design a pilot plant procedure to obtain proper water quality suitable to be used for cleaning and disinfection of pig trucks in the slaughterhouse, together with the *in-situ* validation of the efficacy of alternative cleaning and disinfection procedures with more sustainable products (detergents and disinfectants).

II. MATERIALS AND METHODS

To obtain recycled water of enough quality to be used in the cleaning and disinfection procedure of trucks and that fulfill the requirements defined in the European legislation [2], a pilot plant able to produce 1 m^3/day of recycled water was built and temporally installed in the slaughterhouses. The pilot plant consisted of a sand filter, specific ultrafiltration, ultraviolet light and final chlorination. A polymeric ultrafiltration membrane of T CUT UF 150 080 050 1000 was choosen as it offers an extraordinary efficiency in the separation of biomass and in the complex separation of oil/water emulsions. The 150 kDa cut off was reported to be able to eliminate *E. coli*, *Salmonella*, *Legionella* and nematodes [3] [4]. The *in-situ* efficacy of the pilot plant was studied by measuring chemical and microbiological parameters of the recycled water.
To *in-situ* assess the efficacy of the alternative procedures with more sustainable products for the cleaning and disinfection of livestock trucks, pig trucks provided by their owners were cleaned and disinfected at the registered sites of the pig slaughterhouses [5]. Classical and the alternative (more sustainable) cleaning and disinfecting products, properly registered for this use, were supplied by a certified enterprise.
Microbiological sampling of the trucks was performed at three different sites (comprising a total surface of 1,500 cm^2) at three different timepoints of the procedure: After organic matter removal and initial rinse, after detergent application and its rinse and after disinfectant and a proper rest and safety time. For sampling, sterile sponges moistened with Dey-Engley, to neutralize disinfectant residuals, were used. Samples were transported refrigerated to the microbiological lab in order to perform the microbiological tests as follows: Total aerobic microorganisms counts (in PCA medium Scharlab incubated 72ºC 30ºC), *Enterobacteriaceae* and *Escherichia coli* (REBECCA media, BioMerieux incubated 24 h 37ºC) and presence/absence of *Salmonella* [6]), in which, pressumptive colonies were confirmed by *Salmonella* agglutination latex kit (ThermoFisher Scientific) and PCR (MicroSEQ™ *Salmonella* spp. Detection Kit, ThermoFisher Scientific).
For statistical treatment, ANOVA and Tukey-Kramer significance comparison test using JMP Pro 17 (JMP Statistical Discovery LLC from SAS Institute) was used. For presence/Absence of *Salmonella*, Fisher exact test with Cochran-Armitage was used.

III. RESULTS AND DISCUSSION

The built pilot plant, designed to recycle the residual water of the pig slaughterhouses and to be used for the cleaning and disinfection of the pig trucks, was able to reduce the suspended solids (82%), turbidity (90%) and oils and fats (87%) after the ultrafiltration process. No presence of intestinal nematodes was observed in the initial water samples,

and no presence of *Salmonella* was observed after the ultrafiltration process. In artificially inoculated *E. coli* slaughterhouses residual water samples the log reduction was assess and 0.32-0.64% of free chlorine after ultrafiltration was needed to achieve it, thus this dosing will be recommended for worst cases.
The use of recycled or not recycled water was not determinant in any of the cleaning and disinfection procedures tested at the different slaughterhouses and no significant differences were observed ($p>0.05$).
The alternative, more sustainable, cleaning and disinfection procedures applied in this consisted of a disinfectant based on hydrogen peroxide with a minimal concentration of quaternary ammonium compounds and three different detergents of different alkalinitys, ranging from neutral to more alkaline. All these three strategies were able to reduce the total aerobic and *Enterobacteriaceae* counts between 2-3 log, achieving very low counts, under 1 CFU/cm^2 for *Enterobacteriacea,* at the end of the procedure. A tendency for even lower counts was observed in the combination of the alternative disinfectant and the alkaline detergent. Additionally, the presence of *Salmonella* was also significatively reduced ($p<0,05$) from initial 8.33% to 1.85% in the combination with the neutral detergent and it was also reduced from the initial concentration of 22% to the no-detection level in the combination using an alkaline detergent. In general, the alternative procedures tend to be more efficient than traditional ones, only the traditional procedure using a disinfectant composed by glutaraldehyde and quaternary ammonium compounds showed a similar effectivity to the one obtained with the alternative procedures.

IV. CONCLUSION

The polymeric ultrafiltration membrane of 150 KDa associated to chlorine treatment was the best treatment to obtain proper quality of recycled water coming from residual water of slaughterhouses in order to be used for cleaning and disinfection of pig trucks.

Alternative disinfectants based on hydrogen peroxide associated to a minimal quantity of quaternary ammonium compounds were equally effective and more sustainable than the ones based in higher amount of quaternary ammonium compounds and containing glutaraldehyde.

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