



Alternatives to the use of antimicrobial agents in pig production: A multi-country expert-ranking of perceived effectiveness, feasibility and return on investment



Merel Postma^{a,*}, Katharina D.C. Stärk^b, Marie Sjölund^{c,d}, Annette Backhans^{c,d}, Elisabeth Grosse Beilage^e, Svenja Lösken^e, Catherine Belloc^f, Lucie Collineau^b, Denise Iten^{g,1}, Vivianne Visschers^g, Elisabeth O. Nielsen^h, Jeroen Dewulf^a, on behalf of the MINAPIG consortium²

^a Veterinary Epidemiology Unit, Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium

^b Safe Food Solutions Inc. SAFOSO AG, Bremgartenstrasse 109A, 3012 Bern, Switzerland

^c Department of Animal Health and Antimicrobial Strategies, National Veterinary Institute (SVA), SE-751 89 Uppsala, Sweden

^d Swedish University of Agricultural Sciences, P.O. Box 7070, SE-750 07 Uppsala, Sweden

^e Field Station for Epidemiology, University of Veterinary Medicine Hannover, Büscheler Straße 9, D-49456 Bakum, Germany

^f ONIRIS, UMR 1300 BioEpAR, BP 40706, F-44307 Nantes, France

^g ETH Zürich, Institute for Environmental Decisions (IED), Consumer Behavior, Clausiusstrasse 37, CH-8092 Zürich, Switzerland

^h Danish Agriculture and Food Council, Axelborg, Axeltorv 3, DK-1609 Copenhagen, Denmark

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ABSTRACT

Nineteen alternatives to antimicrobial agents were ranked on perceived effectiveness, feasibility and return on investment (ROI) from 0 (not effective, not feasible, no ROI) to 10 (fully effective, completely feasible, maximum ROI) by 111 pig health experts from Belgium, Denmark, France, Germany, Sweden and Switzerland.

The top 5 measures in terms of perceived effectiveness were (1) improved internal biosecurity, (2) improved external biosecurity, (3) improved climate/environmental conditions, (4) high health/Specific Pathogen Free/disease eradication and (5) increased vaccination. The top 5 measures in terms of perceived feasibility were (1) increased vaccination, (2) increased use of anti-inflammatory products, (3) improved water quality, (4) feed quality/optimization and (5) use of zinc/metals. The top 5 measures in terms of perceived ROI were (1) improved internal biosecurity, (2) zinc/metals, (3) diagnostics/action plan, (4) feed quality/optimization and (5) climate/environmental improvements. Univariate linear regression showed that veterinary practitioners rank internal biosecurity, vaccination, use of zinc/metals, feed quality optimization and climate/environmental on average highest, while researchers and professors focused more on increased use of diagnostics and action plans. Financial incentives/penalties ranked low in all countries. Belgian respondents ranked feed quality significantly lower compared to the German respondents while reduction of stocking density was ranked higher in Belgium compared to Denmark.

* Corresponding author. Tel.: +32 9 264 75 48; fax: +31 848369077.

E-mail address: Merel.Postma@ugent.be (M. Postma).

¹ Current address: INNOWATECH GmbH, Empfingen, Germany.

² MINAPIG project: Evaluation of alternative strategies for raising pigs with minimal antimicrobial usage: Opportunities and constraints.

More information can be found at <http://www.minapig.eu>.

Categorical Principal Component Analysis applied to the average ranking supported the finding that veterinary practitioners had a preference for more practical, common and already known alternatives.

The results showed that improvements in biosecurity, increased use of vaccination, use of zinc/metals, feed quality improvement and regular diagnostic testing combined with a clear action plan were perceived to be the most promising alternatives to antimicrobials in industrial pig production based on combined effectiveness, feasibility and ROI.

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1. Introduction

Antimicrobials are commonly used in pig production, often to treat important bacterial infections caused by for example *Escherichia coli*, *Streptococcus suis*, *Mycoplasma hyopneumoniae* and brachyspira, or as a preventive measure against primary or secondary bacterial infections as such (Schwarz et al., 2001; Callens et al., 2012a,b; Post, 2012; Varela et al., 2013; Burow et al., 2014; van Duijkeren et al., 2014). Reduced antimicrobial usage in livestock is widely discussed and highly promoted in Europe and worldwide as a public health measure to reduce antimicrobial resistance. However, to assure animal health, welfare and economic viability, effective and efficient alternatives are necessary. In the literature, many alternatives to antimicrobial usage have been described. Seal et al. (2013) provide a summary of options which include antimicrobial peptides, pre- and probiotics, feed additives such as enzymes, phytogenic feed additives, immunity stimulants and vaccines. Cheng et al. (2014) recently reviewed the development and application of alternatives to antibiotics.

Pre- and probiotics were tested in broilers with positive results on production performance, while increasing at the same time the caecal beneficial bacteria and fatty acids (Mookiah et al., 2014). Probiotics proved furthermore capable of altering the presence of pro-inflammatory cytokines and chemokines in vitro or the gut microbiota in live pigs (Badia et al., 2012). This subsequently improved the gut health and thus served as an alternative to antimicrobial agents (Bhandari et al., 2008; Hermes et al., 2009; Jacela et al., 2010; Badia et al., 2012; Upadrasta et al., 2013). Intestinal bacterial diversity could also be improved by using fermented feed (Niba et al., 2009; Tajima et al., 2009). Other feed additives that influence the immune response, the microbiome or that show antibacterial effects such as some phytotherapeutics are suggested to be alternatives to antimicrobial agents as well (Jacela et al., 2010; Ohno et al., 2012; Chu et al., 2013). Improved feeding strategies and the use of organic acids related to pig health are described by Heo et al. (2012) and Visscher et al. (2008) amongst others. Dietary modulation by means of peptides through short-chain fatty acids is another promising feed related alternative to antimicrobial agents (Zeng et al., 2013).

Not only additives to feed or acidification of feed, but also the acidification or disinfection of drinking water are potential alternatives to antimicrobial agents (Venkitanarayanan et al., 1999). A review by Knoll and Mylonakis (2013) and a comment by Henein (2013), as well as Seal et al. (2013) mention the potential of bacteriophages as an alternative in the treatment of bacterial

infections including multi-drug-resistant organisms (Heo et al., 2012). Metals like copper and zinc are mentioned as potential alternatives in the literature too. They have been allowed as a (prescription) medicine in piglet feed in some European Union countries for several years, while in other EU countries it is not tolerated due to legal differences (Smith et al., 1998; Fard et al., 2010; Pérez et al., 2010; Mavromichalis, 2011; European Food Safety Authority (EFSA) panel on Additives Products or Substances used in Animal Feed (FEEDAP), 2012; Center of Expertise on Antimicrobial Consumption and Resistance in Animals (AMCRA), 2014c). Thacker (2013) addresses less traditional alternatives such as rare earth elements, clay minerals, antimicrobial peptides or essential oils and subsequently highlights the inconsistent results and the inferior effectiveness compared to antimicrobial agents of the majority of these compounds.

Vaccination can also be seen as an alternative to antimicrobial agents, because it should reduce infection pressure and increases immunity. Therefore, vaccination may improve the overall health status of the pig while lowering the risk of (secondary) infection. Several studies confirm the reduction of antimicrobial usage after vaccination (Adam, 2009; Brockhoff et al., 2009; Aerts and Wertenbroek, 2011; Bak, 2011; Bak et al., 2011; Coube et al., 2012; Koenders and Wertenbroek, 2012; Tebar et al., 2012).

Laanen et al. (2013) found a positive association between biosecurity, production parameters and antimicrobial usage. She also described that farmers perceived biosecurity as a tool to reduce disease (Laanen et al., 2014).

Hygienic and other general management measures can also play a role in the optimization of the health status of a herd, indirectly lowering the necessity of antimicrobial agents (Zimmermann et al., 1989). In a similar way, disease prevention through optimization of the climate and housing conditions of the pig can lead to a lower antimicrobial usage (Dee et al., 2012).

Benchmarking and communicative advisory tools can be seen as alternatives to antimicrobial use since they highlight problem areas at the farm and help farmers in the optimization of the herd together with reducing antimicrobial usage (Bak, 2011; Flipsen and van Eijden, 2011; Bundgaard et al., 2012; Janssen, 2012; Postma et al., 2012; Laanen et al., 2013; van Geijlswijk et al., 2014a). Implementation of financial penalties for high antimicrobial users is discussed in several countries as a method to reduce antimicrobial usage (Beemer et al., 2010; Boerenbond, 2014; Koeleman, 2014; Veterinary Ireland, 2014).

Use of genetically enhanced, high-resistance breeds or efforts towards eradication of diseases might also play a

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