
Public Acceptance of Antibiotic Use in Livestock Production Canada and Germany

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ABSTRACT

The use of antibiotics in livestock production has repeatedly been in the dock over the last few years. However, reducing antibiotic treatments without increasing the suffering of animals requires changes in animal husbandry practices which will likely come at a cost. The objective of the paper is to investigate the factors influencing consumers' willingness to consume products of animals that have been treated with antibiotics, their willingness to pay for a considerable reduction in the use of antibiotics and their willingness to consider animal welfare in the context of 'antibiotic free' livestock production. The study is based on an online survey of citizens in Germany and Canada, conducted in October 2016. The results reveal differences in the individual's willingness to consume livestock products from animals treated with antibiotics between Canada and Germany with lower acceptance rates in the latter. Results also show that in both countries individuals with higher concerns about the treatment of animals more strongly reject the use of antibiotics in livestock production. This might indicate that consumers are not aware that banning antibiotics in livestock production might have negative repercussions for animal welfare.

Keywords: *Acceptance; Antibiotics; Livestock production; Animal welfare.*

1 Introduction

With the emergence and spread of microorganisms resistant to the most affordable and effective antibiotics, these drugs are declining in effectiveness, a development which is seen as one of the leading human health threats of our time (e.g. Ashbolt et al. 2013; Carlet et al. 2014; Cecchini et al. 2015; Laxminarayan et al. 2013; WHO 2015). The use of antibiotics in livestock production is blamed as one of the main reasons for the increase in antibiotic resistance leading in some cases to a call for 'antibiotic free' livestock production (e.g. Spellberg et al. 2016; Woolhouse et al. 2015; O'Neill 2015; WHO 2015). However, to deny sick animals a treatment with

antibiotics if needed conflicts with animal welfare considerations (D'Angeli et al. 2016)¹. Reducing the need for antibiotic use in livestock production without increasing the suffering of animals requires adjustments in animal husbandry that likely comes at a cost (e.g. Jensen and Hayes 2014).

The objective of the paper is to investigate, for members of the public, the willingness to consume products of animals that have been treated with antibiotics², the willingness to pay for a considerable reduction in the use of antibiotics and the willingness to consider animal welfare in an 'antibiotic free' livestock production. Additionally, we explore the factors that influence those behaviors, including awareness of the antibiotic resistance issue, personal antibiotic experience and knowledge of antibiotic use in livestock production.

In this research, a comparison is made between two countries: Canada where antibiotic use in livestock production is currently allowed for growth, for prevention and for treatment and where there is increasing pressure for antibiotic free production, and Germany where antibiotic use is more limited and consideration of further antibiotic restrictions are being discussed at the EU level rather than in the wider public.

This issue is of such public health importance that many governments (Canada is an example where this is happening) are developing much stricter guidelines or regulations on antibiotic use in livestock production. That this may have negative repercussions for animal welfare is recognized by scientists but may not be as easily understood by the public – this study is a first attempt to investigate whether the additional costs of livestock production will be acceptable if animal welfare standards are to be maintained when antibiotic use is reduced.

¹ Casewell et al. (2003) even argue that the ban on growth-promoting antibiotics in the EU had detrimental effects on animal health and welfare.

² Zingg and Siegrist (2012) investigate the peoples' willingness to eat meat from vaccinated animals and their drivers. Some of the constructs used in this study are adjusted to antibiotic use and applied in this study.

2 Study design, material and methods

The analysis is based on an online survey of consumers in Germany and Canada, conducted in October 2016 using Survey Gizmo and the CINT database. Data were collected from about 500 respondents in each country. Table 1 reveals that the respective samples were reasonably representative, with, however, a slight bias towards older, more educated members of the population as is commonly the case with online surveys.

Table 1: Comparison of Survey Demographics to National Statistics

Variable	Canada		Germany	
	Survey 2016 n=501	Census 2011	Survey 2016 n=499	Census 2011
Sex - % male	48.9	49.4	49.9	48.8
Age	43.9 (14.5)	40.6	45.3 (14.6)	43.3
Education (years)	15.4 (1.5)	15.1	13.15 (3.94)	10.32
Income (\$ 000 or Euros)	\$75.8 (33.6) ¹	\$61.1	€2,843 ²	€3,144 ^{2,3}
Household Size - % 1 person	21.76	27.82	22.04	37.2
% 2 persons	35.73	33.83	36.07	33.1
% 3 persons	21.16	15.79	19.64	14.5
% 4 persons	15.97	14.29	17.03	10.4
% more than 4 persons	5.39	8.39	5.21	4.8

Note: Standard deviation in brackets; ¹ Average annually net income; ² Average monthly net income; ³ StBa 2017.

The survey contains questions on each individuals' knowledge about, attitude towards, and experience with antibiotics (and resistance) as well as meat (livestock product) eating behavior. We are particularly interested in the perceived linkage between antibiotic use in livestock production and perceived animal welfare. For example, do the proponents of 'antibiotic free' livestock production think through the animal welfare implications of not using antibiotics? To that end a set of animal welfare statements (Likert scale agreement) derived from Cembalo et al. (2016) related to animal welfare driven food choice and attitudes towards animal treatment are used. In addition, statements used to elicit public views about the use of vaccination in livestock production (Zingg and Siegrist, 2012) are modified to investigate similar views of antibiotic use. Furthermore, participants are asked about their willingness to pay additionally for meat produced with lower antibiotic use but higher expenditures due to the additional animal husbandry (space, monitoring for example) costs associated with lower antibiotic use.

3 Results

Respondents' views differed on many issues between Germany and Canada, though differences vary depending on the behavioral characteristics investigated. Differences also exist with respect to consumption habits. Figure 1 provides information of the number of respondents (%) in each country who reported non-consumption of various livestock products. Apart from seafood, the livestock product that is not eaten by the largest group of people in each country is meat (although eggs are very close behind in Germany). The respective share is higher in the Canadian (8.8%) compared to the German sample (4.8%).

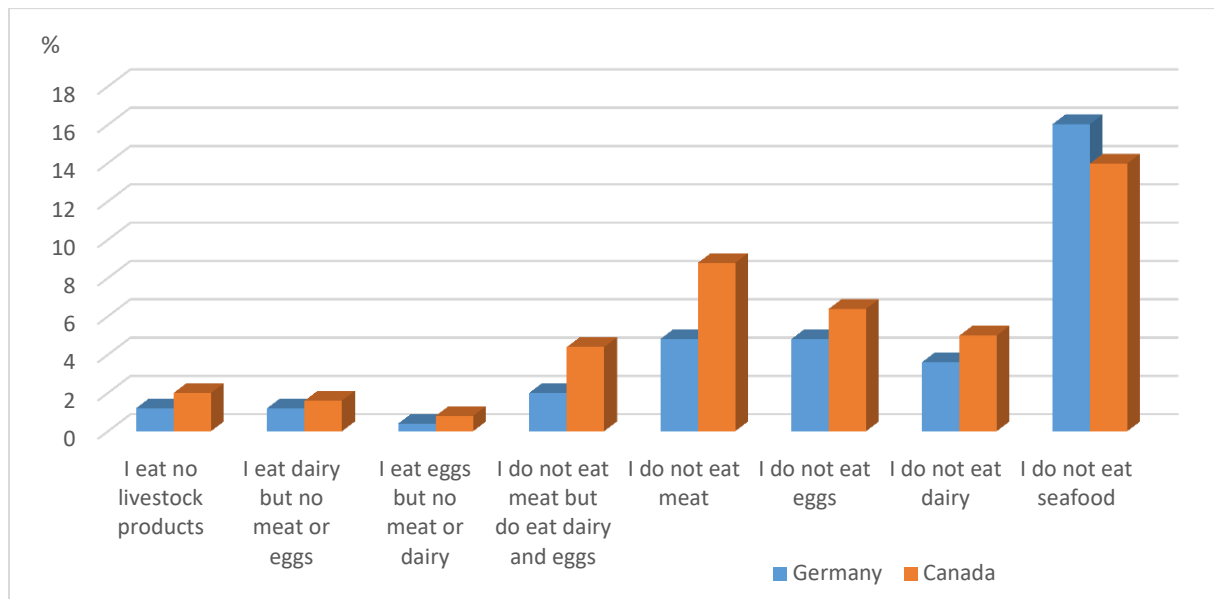


Figure 1: Eating preferences (% of respondents)

Source: Own calculations.

Besides the consumption of animal products, another factor likely important to any consideration of antibiotic use in livestock production is the personal (and family) experiences of antibiotic use of survey respondents. Figure 2 shows survey participants' responses to various questions related to antibiotic use. The results reveal similar experiences across the two countries. In each country more than 20% of survey respondents state that they had situations where antibiotics 'have not worked'. The share of respondents indicating that family members were confronted with such a situation is similar. Our findings also show that there is a high degree of concern among participants about being affected by the problem of antibiotic resistance in the future (63% of respondents in Canada and 65% in Germany, see Figure 2).

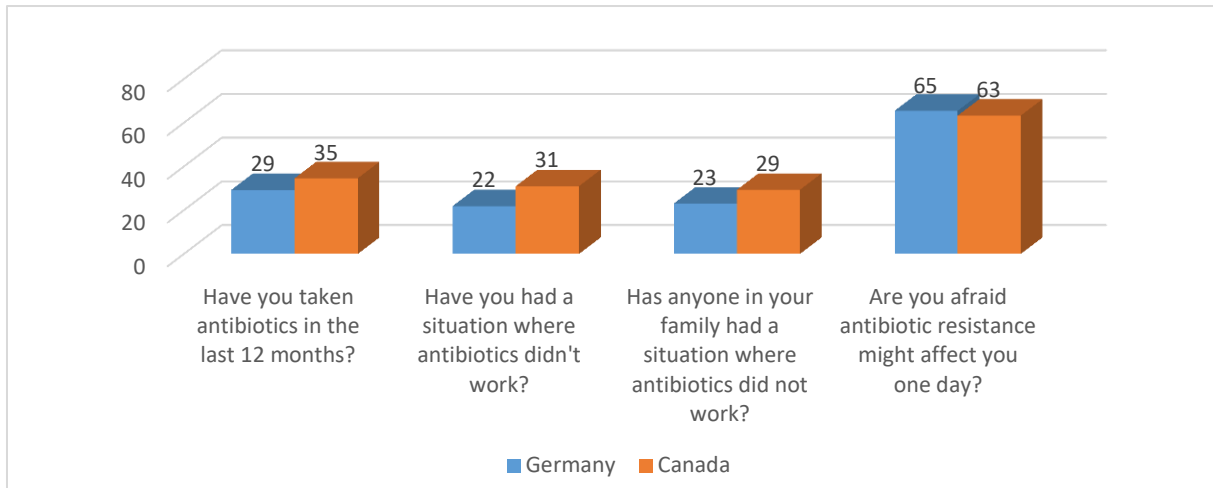


Figure 2: Personal antibiotic use statements (% yes)

Source: Own calculations.

Using the Roselius (1971) risk ranking method, the following graphs identify the strength of agreement (disagreement) with various statements by country. Thus, the number of unfavorable responses (1 and 2 on a scale of 6 from strongly disagree (1) to strongly agree (6)) is subtracted from the number of favorable responses (5 and 6 on the respective scale). The difference is divided by the total number of responses. The quotient, when multiplied by 100, yields a net percent of favorable responses, labeled as "net agreement". The net agreement indicator ranges from +100 to -100, with the former reflecting a complete agreement and the latter complete disagreement (Roselius, 1971). Regarding animal welfare/treatments the strength of agreement to the statements is lower for Canadian compared to German survey participants; this holds especially for the statements referring to animal treatment (see Figure 3).

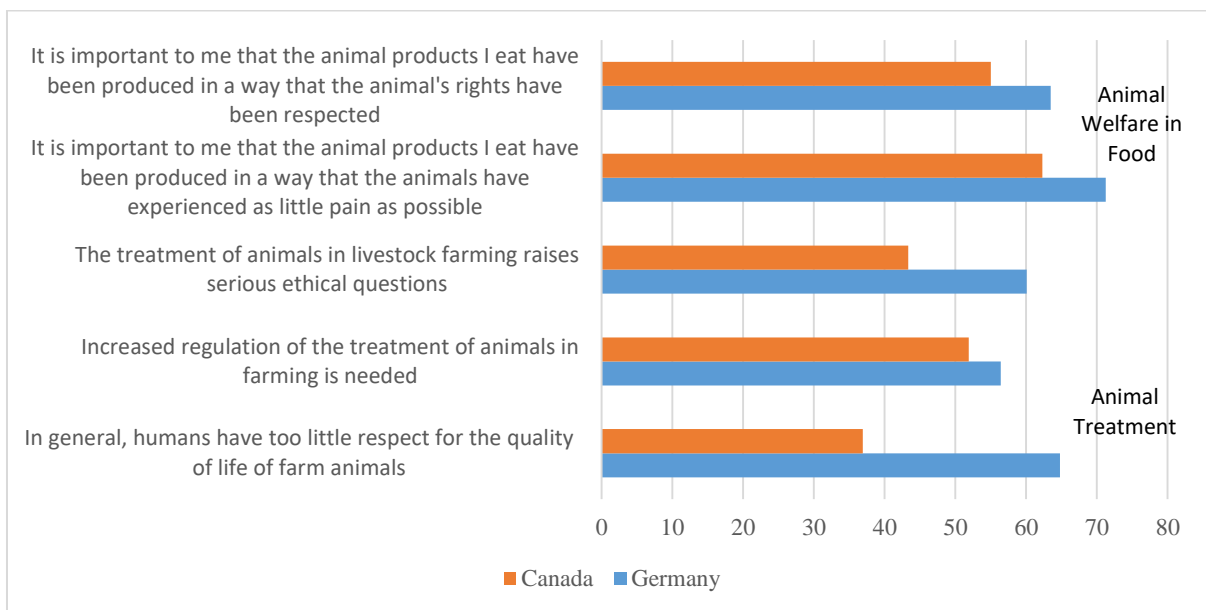


Figure 3: Animal welfare/animal treatment statements (net agreement %)

Source: Own calculations.

The strength of agreement with respect to the acceptability (again Roselius ranking of acceptance) of antibiotic use in livestock shows some marked differences between Canada and Germany (see Figure 4). In general, there are much stronger opinions in Germany than in Canada about antibiotic use, even notably stronger disagreement with the statement that overall antibiotics provide more benefits than harm in Germany.

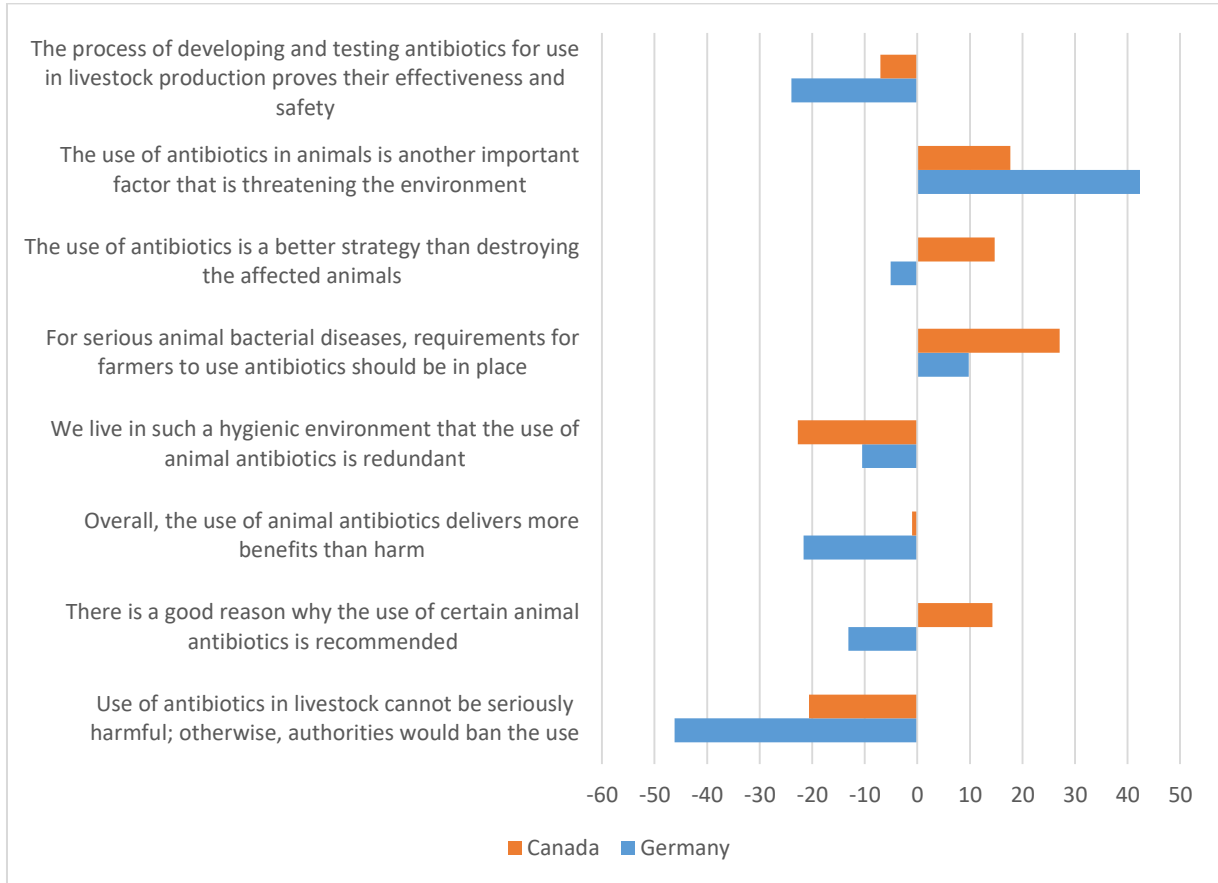


Figure 4: Perceived antibiotic use benefits (net agreement %)

Source: Own calculations.

The objective of the paper is to investigate consumers' willingness to consume products of animals that have been treated with antibiotics, their willingness to pay for a considerable reduction in the use of antibiotics and their willingness to trade animal welfare for an 'antibiotic free' livestock production. For those three key variables important differences across countries were observed.

1. "Willingness to consume meat (or other livestock products) from animals treated with antibiotics (% of respondents)" (which almost all people currently are although they may be unaware)

Canadians (43.7%) show a much higher willingness to consume meat (or other livestock products) from animals treated with antibiotics than Germans (27.0%) (see Figure 5).

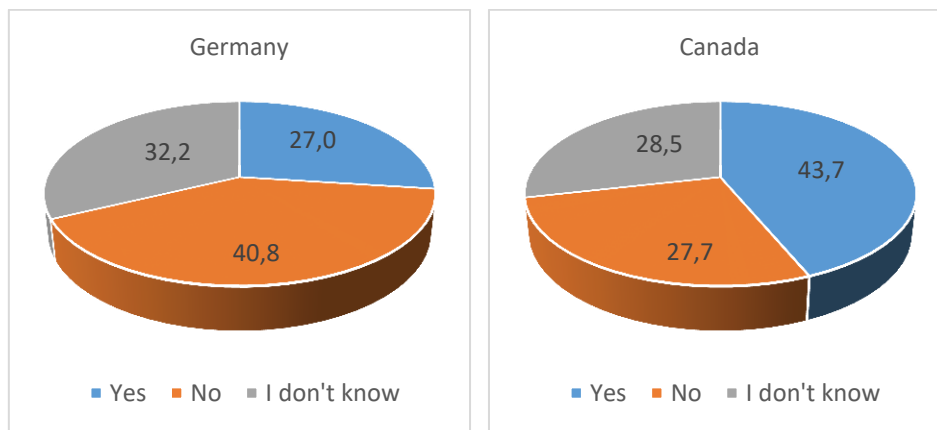


Figure 5: Willingness to consume meat (or other livestock products) from animals treated with antibiotics (% of respondents)

Source: Own calculations.

2. "Willingness to pay more for livestock products produced with fewer antibiotics used (number of respondents)".

With respect to consumers' willingness to pay for animal products from animals that have been treated with 60% fewer antibiotics Canadians are more conservative than Germans. 9% (45 respondents) of the German participants reveal no willingness to pay extra. This share is with 15% (77 participants) much higher in the Canadian sample (see Figure 6).

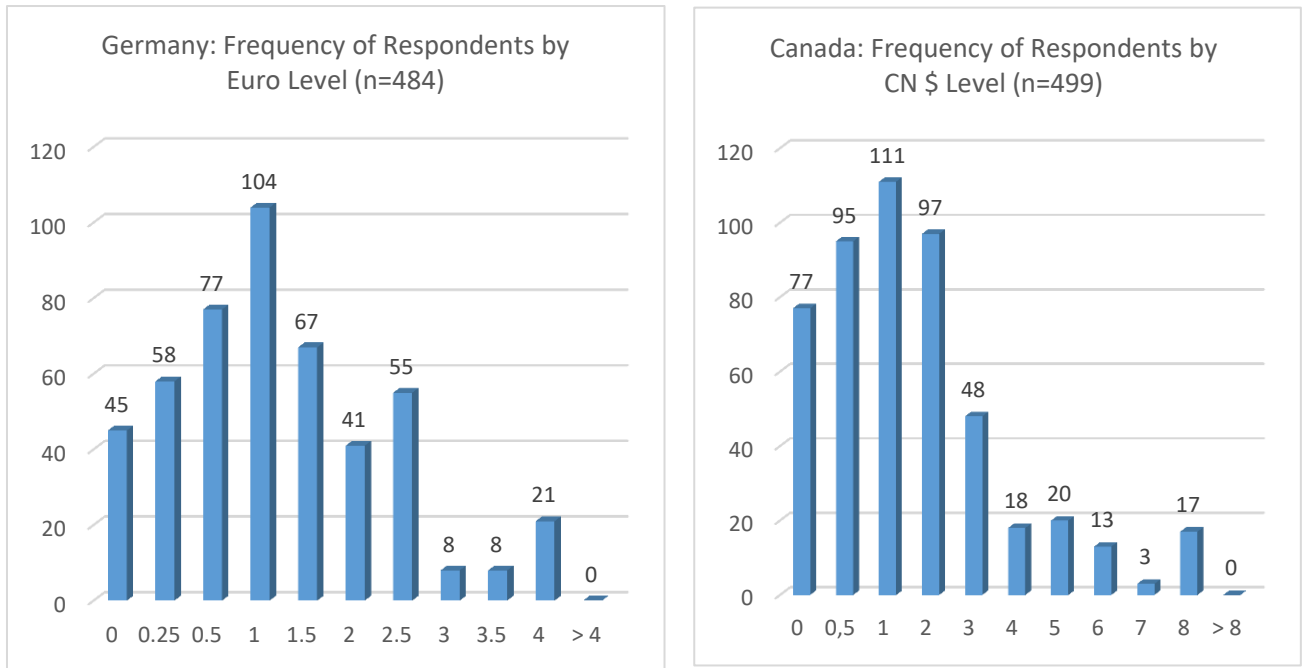


Figure 6: Willingness to pay more for livestock products produced with 60% fewer antibiotics (number of respondents)

Note: Vertical axis shows the number of participants, horizontal axis shows the different price levels. Canada: from about 5% more (this is equal to \$ 0.50 on a \$10.00 purchase of, for example, meat or dairy products) to more than 80% more (this is equal to more than \$8.00 on a \$10.00 purchase of, for example, meat or dairy products); Germany: from about 5% more (this is equal to € 0.25 on a € 5.00 purchase of, for example, meat or dairy products) to more than 80% more (this is equal to more than € 4.00 on a € 5.00 purchase of, for example, meat or dairy products); Different price levels due to exchange rate $1\text{€} \triangleq 1.4\text{CN}\$$,

Source: Own calculations.

3. “Antibiotics should never be used in livestock production, even in medical need, since it is critical to maintain useful antibiotics for public health use (% of respondents)”.

For this variable, the results are more similar across the two countries with a relatively normal distribution and a larger proportion of the German sample believing this to be a good approach than Canadians.

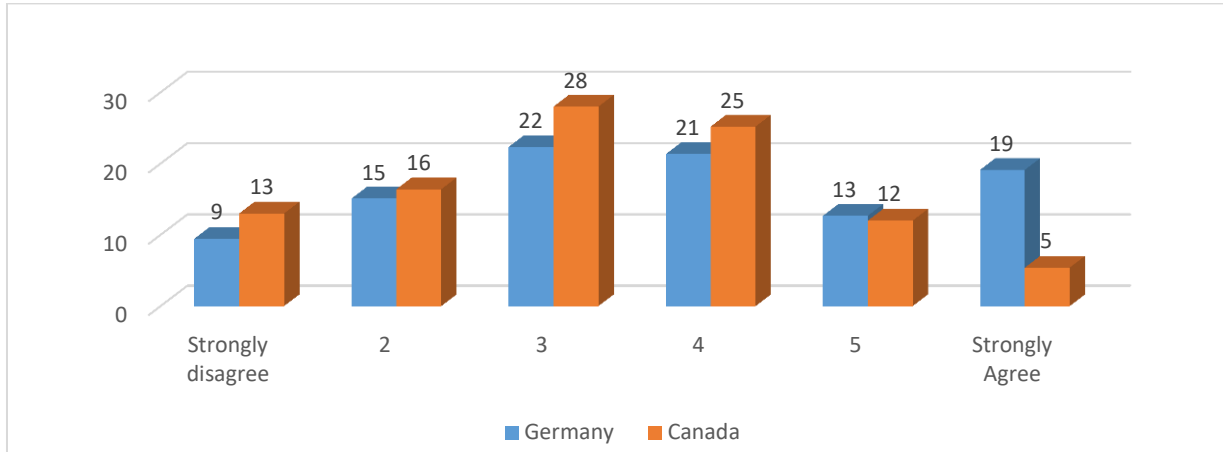


Figure 7: Antibiotics should never be used in livestock production, even in medical need, since it is critical to maintain useful antibiotics for public health use (% of respondents)

Source: Own calculations.

Using logit, probit and ordered probit regressions we examined the role of various variables in affecting the three key variables identified above. In the first set of equations we compared the factors influencing the “intention to eat meat (or other livestock products) from animals treated with antibiotics in their lifetime”. The results reveal some similarities across the two countries (Table 2): Males and people who generally trust other people (those who don’t eat meat) are less likely (are more likely) to reject eating livestock products from animals given antibiotics. In Canada people who have used antibiotics recently are more likely to say ‘No’ than ‘Yes’ while the opposite holds for Germany. Older Germans, those worried about antibiotic resistance as well as those with high concerns for animal treatment are more likely not to want to eat the livestock products from animals given antibiotics.

Table 2: Factors influencing the decision to eat meat (or other livestock products) from animals treated with antibiotics (MLogit)

	Parameter	Germany		Canada	
		Estimate	t-statistic	Estimate	t-statistic
No vs. Yes ¹	C2	-2.78	-2.75	-2.89	-1.95
	Male	-1.12	-3.98	-0.54	-2.25
	Trust ²	-0.59	-2.27	-0.48	-2.00
	Taken antibiotics ³	-0.84	-3.02	0.68	2.93
	Worried about antibiotic resistance ⁴	1.14	4.05	-0.22	-1.29
	Age	0.04	3.75	0.01	1.53
	Education	0.02	0.63	-0.02	-0.24
	Income	0.00	0.36	0.00	-0.81
	Household size	-0.15	-1.26	0.02	0.20
	Animal Treatment ⁵	0.14	2.45	0.07	1.49
	Animal welfare in food choice ⁶	-0.01	-0.11	0.11	1.58
Not eat meat	1.53	2.04	1.12	2.69	
I don't know vs. Yes ¹	C3	2.20	2.17	-2.74	-1.90
	Male	-1.76	-5.98	-0.16	-0.69
	Trust ¹	-0.44	-1.65	-0.86	-3.70
	Taken antibiotics ³	-0.85	-2.90	0.38	1.74
	Worried about antibiotic resistance ⁴	0.60	2.16	0.01	0.06
	Age	0.01	1.42	0.02	2.33
	Education	0.00	-0.12	-0.03	-0.41
	Income	0.00	-0.86	0.01	1.40
	Household size	-0.28	-2.21	0.05	0.47
	Animal Treatment ⁵	-0.03	-0.57	0.03	0.68
	Animal welfare in food choice ⁶	-0.01	-0.14	0.10	1.54
Not eat meat	-0.30	-0.34	-0.05	-0.10	
	Number of observations	480		491	
	Scaled R squared	0.28		0.15	

Note: ¹1=yes, 2=no, 3=I don't know; ²Question: "Generally speaking, would you say that most people can be trusted?" Answers: 1=Most people can be trusted; 2=You can't be too careful when dealing with people, 3=I don't know. ³Question: Have you taken antibiotics in the last 12 months? 1=Yes; 2=No, 3=I don't know. ⁴Are you worried that antibiotic resistance might affect you one day? 1=yes, 2=no, 3= I don't know; ⁵ Index out of three animal treatment questions (see Figure 3) "The treatment of animals in livestock farming raises serious ethical questions", "Increased regulation of the treatment of animals in farming is needed", "In general, humans have too little respect for the quality of life of farm animals"; Scale: 1=strongly disagree, 6=strongly agree; ⁷ "It is important to me that the animal products I eat have been produced in a way that the animals have experienced as little pain as possible", "It is important to me that the animal products I eat have been produced in a way that the animals' rights have been respected", Scale: 1=strongly disagree, 6=strongly agree.

Probit models are estimated to explain what factors influence people's lack of WTP (0 = pay a positive amount, 1 = pay zero \$ or Euros) for livestock products from animals with 60% lower antibiotics used. Results reveal that in Germany, older people are more likely not to pay extra for animal products from animals treated with less antibiotics. The opposite holds for people with higher education, people concerned about current animal treatment and people who are worried about antibiotic resistance. Regarding the latter the opposite holds for the Canadian sample. In addition, in Canada people with higher incomes are less likely to choose a zero price for meat from animals with 60% fewer antibiotics use.

Table 3: Probit Models for WTP Statements

Parameter	Germany (1=Select zero €)		Canada (1=Select zero \$)	
	Estimate	t-statistic	Estimate	t-statistic
C	0.23	0.34	0.08	0.09
Age	0.02	2.72	0.00	-0.79
Male	-0.08	-0.44	0.04	0.31
Education	-0.05	-2.05	-0.05	-0.97
Income	0.00	-0.31	0.00	-1.79
Household Size	0.03	0.35	-0.02	-0.30
Trust	-0.13	-0.73	-0.05	-0.32
Animal Treatment	-0.08	-2.17	-0.03	-1.35
Animal Welfare in Food Choice	-0.05	-0.99	0.00	-0.06
Taken Antibiotics	0.06	0.31	0.16	1.16
Worried about Antibiotic Resistance	-0.40	-2.27	0.22	2.37
Number of Observations	483		501	
Scaled R-squared	0.09		0.05	

Investigating the characteristics of survey respondents linked to the decision about how strongly people feel that antibiotics should not be used in livestock production at all, reveals differences between Germany and Canada (see Table 4). In Canada males are more likely to more strongly agree and respondents who generally trust other people are less likely to strongly agree. Those characteristics are of no relevance with respect to the results from the German sample, while having taken antibiotics recently as well as feeling that antibiotics are being used properly makes people less likely to strongly agree and being worried about antibiotic resistance makes people more likely to strongly agree (neither is significant in Canada). In both countries those concerned about how animals are treated are likely to more strongly agree that antibiotics should not be used in livestock production. This might be related to concerns about overuse of antibiotics for non-treatment reasons.

Table 4: Comparison of ordered probit results for agreement with statement that antibiotics should never be used in livestock production

Parameter	Germany		Canada	
	Estimate	t-statistic	Estimate	t-statistic
C	0.86	1.85	1.34	1.93

Male	0.15	1.44	0.19	1.92
Trust	-0.05	-0.49	-0.23	-2.34
Taken antibiotics	-0.26	-2.43	0.00	0.02
Worried about antibiotic resistance	0.21	2.02	0.03	0.43
Age	0.00	0.66	0.00	0.65
Education	-0.01	-0.91	-0.05	-1.48
Income	0.00	0.93	0.00	0.10
Household size	-0.01	-0.15	0.03	0.61
Animal Treatment	0.06	3.03	0.06	3.19
Animal welfare in food choice	-0.01	-0.50	0.01	0.25
Eat meat	0.46	2.04	-0.29	-1.66
Antibiotic Use Attitude ¹	-0.03	-4.06	-0.01	-0.70
MU3	0.64	9.19	0.62	9.86
MU4	1.27	15.31	1.39	17.50
MU5	1.87	20.40	2.16	23.10
MU6	2.29	23.10	2.85	24.30
Number of observations	480		485	
Scaled R Squared	0.11		0.07	

Note: ¹Antibiotic Use Attitude is the sum of statements related to antibiotic use as derived from Zingg and Siegrist's statements on the use of vaccination.

4 Conclusion

In summary, there are some similarities in the concerns about antibiotic resistance in Canada and Germany, but there are also considerable differences. Results reveal that only 44% of the respondents in Canada and only 27.0% of respondents in Germany are willing to consume livestock products from animals treated with antibiotics. At this point it is worth reiterating that the vast majority of people now are eating livestock products from animals given antibiotics, but they may not know this. It appears that the level of understanding of how antibiotics are being used isn't high. As well, people may be suggesting (through their answers) that they 'wish' to not eat meat from animals given antibiotics (something the major restaurant chains may be picking up on in their antibiotic free moves recently receiving much press in North America and the UK).

The results reveal a link between concerns about animal treatment and the respondents' belief that antibiotics should not be used in livestock production, which suggests that the public is not aware of the negative repercussions a banning of antibiotics in livestock production might have on animal welfare. Further analysis will be necessary to identify exactly what is driving concerns about how animals are currently being treated and the public (linked) desire for fewer antibiotics to be used in livestock production.

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References

- Ashbolt, N.J., Amézquita, A., Backhaus, T., Borriello, P., Brandt, K.K., Collignon, P., Coors, A., Finley, R., Gaze, W.H., Heberer, T. and Lawrence, J.R., 2013. Human health risk assessment (HHRA) for environmental development and transfer of antibiotic resistance. *Environmental Health Perspectives (Online)*, 121(9), p.993.
- Carlet, J., Pulcini, C. and Piddock, L.J.V., 2014. Antibiotic resistance: a geopolitical issue. *Clinical Microbiology and Infection*, 20(10), pp.949-953.
- Casewell, M., Friis, C., Marco, E., McMullin, P. and Phillips, I., 2003. The European ban on growth-promoting antibiotics and emerging consequences for human and animal health. *Journal of antimicrobial chemotherapy*, 52(2), pp.159-161.
- Cecchini, M., Langer, J. and Slawomirski, L., 2015. Antimicrobial Resistance in G7 Countries and Beyond Economic Issues, Policies and Options for Action. <http://www.oecd.org/els/health-systems/Antimicrobial-Resistance-in-G7-Countries-and-Beyond.pdf>, last accessed 02.10.2016.
- D'Angeli, M.A., Baker, J.B., Call, D.R., Davis, M.A., Kauber, K.J., Malhotra, U., Matsuura, G.T., Moore, D.A., Porter, C., Pottinger, P. and Stockwell, V., 2016. Antimicrobial stewardship through a one health lens: observations from Washington State. *International Journal of Health Governance*, 21(3), pp.114-130.
- Jensen, H.H. and Hayes, D.J., 2014. Impact of Denmark's ban on antimicrobials for growth promotion. *Current opinion in microbiology*, 19, pp.30-36.
- Laxminarayan, R., Duse, A., Wattal, C., Zaidi, A.K., Wertheim, H.F., Sumpradit, N., Vlieghe, E., Hara, G.L., Gould, I.M., Goossens, H. and Greko, C., 2013. Antibiotic resistance—the need for global solutions. *The Lancet infectious diseases*, 13(12), pp.1057-1098.
- O'Neil, J., 2015. Antimicrobials in Agriculture and the Environment: Reducing Unnecessary Use and Waste. *The Review Antimicrobial Resistance*. <http://amr-review.org/sites/default/files/Antimicrobials%20in%20agriculture%20and%20the%20environment%20-%20Reducing%20unnecessary%20use%20and%20waste.pdf>, last accessed 02.10.2016.
- Roselius, Ted. "Consumer rankings of risk reduction methods." *The journal of marketing* (1971): 56-61.
- Spellberg, B., Hansen, G.R., Kar, A., Cordova, C.D., Price, L.B. and Johnson, J.R., 2016. Antibiotic Resistance in Humans and Animals.
- StBa, 2017. Einkomme, Einnahmen und Ausgaben. https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/EinkommenKonsumLebensbedingungen/EinkommenEinnahmenAusgaben/Tabellen/FruheresBundesgebiet_LWR.html last accessed 05.04.2017.
- World Health Organization (WHO), 2015. Global action plan on antimicrobial resistance.
- World Health Organisation (WHO), World International Property Organisation (WIPO), World Trade Organisation, 2016. Antimicrobial resistance – a global epidemic. http://www.wipo.int/edocs/mdocs/mdocs/en/wipo_who_wto_ip_ge_16/wipo_who_wto_ip_ge_16_inf_2.pdf, last accessed 02.10.2016.

- Woolhouse, M., Ward, M., van Bunnik, B. and Farrar, J., 2015. Antimicrobial resistance in humans, livestock and the wider environment. *Phil. Trans. R. Soc. B*, 370(1670), p.20140083.
- Zingg, A. and Siegrist, M., 2012. People's willingness to eat meat from animals vaccinated against epidemics. *Food Policy*, 37(3), pp.226-231.