Consumers' attitudes about milk quality and fertilization methods in dairy cows in Germany

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ABSTRACT

Major advances in assisted reproductive technologies have improved reproductive efficiency in dairy cattle. However, these developments occurred regardless of the perception of consumers, who often distrust biotechnology in food production. Therefore, the objective of this study was to investigate consumers' attitudes toward reproductive management practices in dairy cattle. In November 2012, 1,646 participants were interviewed by a commercial market research institute. Participants were selected from all regions and demographic categories to represent the general public in Germany. Seven questions regarding milk-drinking preferences and reproductive technologies were asked in face-to-face interviews. Descriptive statistics and multivariable logistic regression models were used. The majority of people drank milk at least weekly (63%) and found the taste of milk important (60%). Most people perceived advanced reproductive technologies negatively [e.g., the use of sexed semen (53%), embryo transfer (58%), cloning (81%), and hormone treatments to increase fertility (65%)]. Many people lacked basic knowledge about milk production (22% did not know that cows only give milk after calving; 51% did not know that milk naturally contains hormones); however, participants with a high school education, older participants, and those who had concerned themselves with dairy farming were more knowledgeable. Education and providing information might help to inform the public about reproductive management practices in dairy cows.

Key words: consumer attitude, consumer knowledge, reproductive technology, milk quality

INTRODUCTION

A wide variety of methods, tools, and management practices have been developed to ensure or improve

fertility of individual dairy cows and reproductive performance of animal populations in the past century. The development of assisted reproductive technologies in dairy cattle has been extensively reviewed (Foote, 2002; Moore and Thatcher, 2006). These methods include AI, endocrinological approaches (e.g., hormone therapy, synchronization protocols), embryo transfer, in vitro embryo production, use of sexed semen, cloning, and preimplantation diagnostic screening techniques. Their developments have been driven by different objectives, such as controlling venereal diseases (Foote, 2002), increasing genetic merit (Moore and Thatcher, 2006), increasing labor efficiency (Tenhagen et al., 2004), or facilitating insemination of cows at a predictable time relative to ovulation without estrus detection (e.g., Pursley et al., 1995; Rabiee et al., 2005). These technologies led to enormous increases in milk production but were accompanied by a decline in reproductive efficiency in high-producing cows worldwide (e.g., Lucy, 2001). Although high milk production and good reproductive performance are not mutually exclusive, this decline in fertility has likely perpetuated more research and development of new reproductive technologies that are widely applied in the dairy industry (von Keyserlingk et al., 2013).

Today, hormonal synchronization protocols have been widely adopted (Fricke et al., 2014) and the dairy industry relies heavily on the use of exogenous hormones to mitigate challenges associated with low fertility (Moore and Thatcher, 2006). Timed AI protocols to manage reproductive performance of at least some of the heifers or cows were used by 58% of all US dairy farms in 2007 (USDA, 2009). Although negative pharmacological effects on animal or human health have not yet been described, it has been speculated that few consumers are aware of such reproductive management practices (von Keyserlingk et al., 2013), and that consumers would likely perceive this type of assisted reproductive techniques to be unnatural and unwelcome (Boogaard et al., 2011).

Public perception of milk products arising from the introduction of new technologies is difficult to assess

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(von Keyserlingk et al., 2013). In general, the public frequently distrusts the use of biotechnology in food production (Gaskell et al., 2000; Lassen et al., 2006). More specifically, the public perceives hormones undesirably as the word “hormones” holds negative connotations in the context of food production (Higgins et al., 2013; Jung et al., 2015). The potential impact of consumer perceptions regarding these techniques and hormone use in reproductive management programs should not be underestimated and will likely play a significant role in determining future management practices (von Keyserlingk and Heuwieser, 2008). A negative consumer attitude could eventually result in image problems for the dairy industry. In addition to hormone use, there is a lack of information on how the public perceives practices or reproductive methods applied in the dairy industry today.

Consumers' attitudes about food might be associated with their knowledge about the industry (Hallman et al., 2003). Factors influencing knowledge and attitudes about food might include age (Verbeke and Viaene, 1999; Hallman et al., 2003; Worsley et al., 2013), sex (Rozin et al., 1999; Verbeke and Viaene, 1999; Hallman et al., 2003), education (Hallman et al., 2003; Worsley et al., 2013), place of residence (urban or rural; Weatherell et al., 2003), and whether or not the consumer has children (Schröck, 2014). Furthermore, whether or not the consumer knows a producer personally might also influence the attitude (Institute for Demoscopy Allensbach, 2002). Due to the different structures of the dairy industry in southern, western, and eastern Germany, with fewer, larger farms in eastern Germany and more numerous, smaller farms in southern and western Germany (Statistisches Bundesamt, 2013), one might speculate that consumers in eastern Germany less often know a farmer personally (Institute for Demoscopy Allensbach, 2002) and, therefore, have a more negative attitude toward the dairy industry.

Therefore, the objective of this study was to benchmark consumers in Germany regarding their attitudes about certain reproductive management practices in dairy cattle. Specifically, we set out to (1) evaluate consumers' knowledge and perceptions about reproductive methods in modern dairy farming, and (2) determine potential associations between consumers' demographic characteristics and knowledge about dairy farming.

MATERIALS AND METHODS

Questionnaire

Between November 10 and November 22, 2012, a commercial market research institute (Institute for De-

moscopy Allensbach, Allensbach, Germany) conducted a survey on behalf of the Clinic of Animal Reproduction, Freie Universität Berlin (Berlin, Germany). Participants were selected from all regions in Germany and had to be 16 yr of age or older. Participants were recruited personally (friends or relatives) by 467 interviewers and were selected based on quotas to represent proportions similar to census distributions (Statistisches Bundesamt, 2011) in terms of demographic data; that is, region, state, size of residence, sex, age, occupation, type of occupation, marital status, and size of household. The interviews were usually conducted in the participants' homes and no incentive was provided for participation. The interviewers themselves were also selected to represent the desired regional distribution.

The questions for this study ($n = 7$) were part of a multi-topic questionnaire (Hauptbefragung 11001 November/December 2012) containing 70 questions. The time required to complete the questionnaire in a face-to-face interview was about 50 min. The time required to complete the 7 questions related to this study was not separately recorded. Before the study questions, the topics of insurance companies and driving habits were investigated for other purposes. The questions were developed by questionnaire specialists from the Allensbach Institute and were pretested for comprehension and technical functionality. The interviewers were instructed to read the questions aloud and always ask the questions in the same order. Technical help was provided to the interviewee if necessary (Appendix Table A1).

Statistical Analysis

Frequency distributions over all categorical variables were calculated to describe the data. Sampling was disproportionately higher in eastern states by approximately one-third more than would be representative for the proportion of inhabitants (19%). This disproportionality was accounted for using weighted analysis. States were categorized into the following regions: south (Bavaria and Baden-Württemberg), west (North Rhine-Westphalia, Rhineland-Palatinate, Saarland, Hesse, Bremen, Hamburg, Lower Saxony, and Schleswig-Holstein), and east (Berlin, Brandenburg, Saxony, Saxony-Anhalt, Thuringia, and Mecklenburg-Western Pomerania). Multivariable logistic regression models were built for 2 questions: (a) “A cow can only give milk when she already gave birth to a calf. Have you heard about that or have you not heard about that but you would have expected it or you would have not necessarily thought that?” and (b) “The milk that comes from healthy cows that did not receive

hormone treatment also contains hormones. Did you know that or did you not know that?" as outcomes. Age, sex, education, region, place of residence (city or countryside), frequency of milk consumption, whether or not the participants had children, and whether or not the participants had concerned themselves with dairy production were tested as the predictors in both models. Region was tested in the models to investigate whether different structures of dairy farming (larger dairy farms in the east and smaller farms in the west and south) influenced knowledge and attitudes. For the first model, answer categories "I have heard that" and "I would have thought that" were combined into one category ("Participant knew that cows only give milk after calving"). Chi-square tests were conducted to screen for individual associations between all predictors and the 2 outcome variables, and those with $P < 0.1$ were tested in the respective multivariable model. Only plausible interactions among predictors were tested for significance in the models. Manual forward selection was used to build the models, and final models were assessed using Hosmer-Lemeshow test and residual analysis. For building the regression models, observations with the answer category "No answer" in predictors or outcomes were excluded from the analysis. Statistical analyses were performed using the computer program

SPSS (version 22, IBM Corp., Armonk, NY). A P -value < 0.05 was considered significant.

RESULTS

In total, 1,646 participants consented to be interviewed. Demographic characteristics were similar in participants and the general German population (Table 1). Over 50% of participants drank milk either multiple times per week, daily, or multiple times per day (Table 2). About 60 and 49% found the taste of milk and the fat content important, respectively. The origin of the milk (small farm) and type (organic product) were important to some respondents only (8 and 12%, respectively). More than 75% of participants had heard or would have thought that cows have to calve before producing milk. In total, 42% of all participants had concerned themselves with dairy farming. About 51% of participants thought that fertilization method would not influence milk quality. However, 18% believed that fertilization method would influence milk quality. Of those, most participants thought that AI with or without hormone treatment and embryo transfer would decrease milk quality. The majority of all participants disapproved of AI with sexed semen (53%), embryo transfer (58%), cloning (80%), and hormone treatment

Table 1. Demographic information of 1,646 survey participants compared with official demographical data of the German population (Statistisches Bundesamt, 2011, Federal Statistical Office, Germany)

Item	Survey participants		Statistisches Bundesamt (%)
	Weighted no.	%	
Regional distribution			
Western states including western part of Berlin	1,335	81	81
Eastern states including eastern part of Berlin	312	19	19
Size of residence			
Less than 5,000 inhabitants	259	16	16
5,000 to less than 20,000 inhabitants	440	27	27
20,000 to less than 100,000 inhabitants	454	27	27
100,000 and more inhabitants	492	30	30
Sex			
Men	800	49	49
Women	846	51	51
Age			
16–29 yr	305	19	19
30–44 yr	364	22	22
45–59 yr	446	27	27
60 yr and older	530	32	32
Marital status			
Married	875	53	53
Single	504	31	31
Widowed, divorced	267	16	16
Size of household (16 yr or older)			
1 person	385	23	23
2 persons	653	40	40
3 persons	288	18	18
4 persons	232	14	14
5 or more persons	89	5	5

to increase fertility (65%). However, most people (51%) did not know that milk naturally contains hormones without prior hormone administration.

Participants who had already concerned themselves with dairy farming were 4 times more likely (odds ratio = 4.2, $P < 0.001$) to have thought that cows only give milk after calving (Table 3). Additionally, high school or university graduates and older participants answered more often that they would have thought that cows produce milk only after calving. Not included in the model were sex, region, place of residence, frequency of milk consumption, and whether or not the participants had children. The model fit the data well (Hosmer-Lemeshow test, $P = 0.943$) and outliers were not detected.

Similarly, participants who graduated from high school or university (odds ratio = 1.8; $P < 0.001$) and older participants were more likely to know that milk from cows without hormone treatment also contains hormones (Table 4). We detected a significant interaction between frequency of milk consumption and whether or not consumers had concerned themselves with dairy farming (Figure 1). Consumers who had not concerned themselves with dairy farming were more likely to know that milk contains hormones without prior hormone treatment if they drank milk at least weekly compared with participants who drank milk less frequently. Consumers who had already concerned themselves with dairy farming were generally more likely to know that milk naturally contains hormones; however, there was no difference in the probability if they also drank milk more frequently. Not included in the model were sex, place of residence, and whether or not the participants had children. The Hosmer-Lemeshow test was not significant ($P = 0.378$) and outliers were not detected.

DISCUSSION

Although a variety of reproductive management practices such as AI and exogenous hormone use are being widely implemented in the dairy industry worldwide (e.g., Fricke et al., 2014) and improved applications of these methods are intensively researched, consumers' knowledge of such technologies and their potential impact on the perceptions of dairy products is more or less unknown (von Keyserlingk and Heuwieser, 2008).

To our knowledge, this is the first study describing results from a survey of consumer perception about reproductive management practices in dairy cows. By design, the distribution of participants among different demographic categories in this study was similar to that of the German population. A consumer study using a mail survey sent out to randomly selected California

households (rather than based on quota) yielded a biased study population in terms of age, education, and ethnic group (Bruhn et al., 1992). Furthermore, the present study enrolled a large number of participants ($n = 1,646$) and used one-on-one interviews rather than an online survey, which further increased validity of the results. Online surveys with self-enrollment might have had a biased group of participants in terms of age, sex, socioeconomic status, and education (Stopponi et al., 2009). However, as interviewers of the current study enrolled participants from their families and friends rather than a simple random sample from the population, we cannot be sure that the results are free of any bias. Nevertheless, the demographic distribution of participants was almost identical to that of the German population and, therefore, the results of this study can be considered representative of the public in Germany.

The questionnaire first contained questions about milk quality followed by questions on biotechnology in dairy cows. A positive attitude toward milk and milk quality might have influenced participants to think more positively about biotechnology. Future studies might consider asking the questions in a random rather than a specific order to avoid potential order effects. Despite the fact that the questions were generated by trained and professional personnel, some of the questions might have been formulated in a way that suggested a desired answer rather than leaving the desired answer category open. This might have biased the results toward a more positive attitude and more knowledge about the dairy industry.

It is surprising that organic products were important for 12% of participants. This is in contrast to the fact that only 2.9% of revenues from milk sales came from organic products in Germany in 2012 (Schaack et al., 2014). This difference might be explained by a high percentage of customers purchasing organic milk only occasionally rather than regularly (Schröck, 2014).

Approximately half of the participants (51%) thought that fertilization method would not influence milk quality. The remaining participants either had no opinion or thought there was an effect on milk quality. Advanced reproductive technologies such as use of sexed semen, embryo transfer, cloning, or hormone treatment to increase fertility were perceived negatively by the majority of participants. Therefore, advanced reproductive technologies might not be in agreement with consumer preferences. This finding is similar to other researchers, who have reported consumers' concerns about the use of hormones in dairy production (Refsdal, 2000; Jung et al., 2015). Consumers can affect use and future development of reproductive technologies by refusing to buy certain products that were produced in ways they do not approve of (von Keyserlingk et al., 2013). Con-

Table 2. Summary of responses by survey participants (n = 1,646) to questions related to consumers' attitudes about milk quality and fertilization methods in dairy cows

Survey question and answer categories	No. of responses	Proportion
How often do you drink milk?		
Multiple times daily	129	7.8
Daily	365	22.2
Multiple times per week	433	26.3
Once a week	106	6.5
Less often	327	19.8
Never	275	16.7
No answer	11	0.7
In general: what do you find important in milk? ¹		
The taste	983	59.7
An environmentally friendly packaging	289	17.6
The brand	213	12.9
Fat content	802	48.7
Where the milk comes from	505	30.7
That the milk is cheap	500	30.4
That the milk was produced sustainably	237	14.4
That animal welfare of the farm was adequate	552	33.5
That it is an organic product	205	12.5
That it is fresh milk and not UHT milk	548	33.3
That the milk comes from a small farm	138	8.4
None of these	34	2.0
No answer	16	1.0
A cow can only give milk when she already gave birth to a calf. Have you heard about that or have you not heard about that but you would have expected it or you would have not necessarily thought that?		
I have heard that	980	59.6
I would have thought so	262	15.9
I would have not thought so	357	21.7
Undecided; no answer	47	2.9
Does the way the cow gets pregnant influence the quality of the milk that she will give later or is there no influence?		
There is an influence	299	18.1
There is no influence	845	51.3
Don't know; no answer	502	30.5
What do you think: With which method is the milk that the cow gives later better or rather worse?		
Natural fertilization by a bull		
Quality is better	286	17.4
Quality is worse	7	0.4
There is no influence	1,347	81.9
No answer	5	0.3
Artificial insemination without hormone treatment of the cow		
Quality is better	130	7.9
Quality is worse	153	9.3
There is no influence	1,347	81.9
No answer	15	0.9
Artificial insemination after a hormone treatment of the cow		
Quality is better	12	0.7
Quality is worse	271	16.5
There is no influence	1,347	81.9
No answer	16	1.0
Transfer of an embryo (i.e., fertilized egg)		
Quality is better	34	2.1
Quality is worse	249	15.1
There is no influence	1,347	81.9
No answer	16	1.0
Independent of your opinion whether the method influences milk quality or not: Are there procedures that you disapprove of and that, in your opinion, should not be used for getting a cow pregnant? ¹		
Yes, specifically		
Special artificial insemination with prior selection of semen cells so that only female calves are born	878	53.3
Regular artificial insemination	249	15.1
Transfer of an embryo (i.e., fertilized egg) that was produced by fertilization in a Petri dish	947	57.5
Transfer of an embryo that was produced by cloning	1,324	80.5
Hormone treatment of a cow to increase her fertility	1,066	64.8
No, I do not disapprove of any of these	70	4.2
No answer	111	6.7

Continued

Table 2 (Continued). Summary of responses by survey participants (n = 1,646) to questions related to consumers' attitudes about milk quality and fertilization methods in dairy cows

Survey question and answer categories	No. of responses	Proportion
The milk that comes from healthy cows that did not receive hormone treatment also contains hormones. Did you know that or did you not know that?		
I knew that	740	44.9
I did not know that	837	50.8
No answer	69	4.2
Have you ever concerned yourself with dairy farming; e.g., how dairy cows are housed, how milk is produced, and so on, or is this not the case?		
Already concerned myself with dairy farming	686	41.7
Not the case	922	56.0
No answer	38	2.3

¹Multiple answers possible.

cerned citizens who oppose certain practices might also choose to give their political support to new regulations (von Keyserlingk et al., 2013).

In general, knowledge about basic reproductive biology of dairy cows was lacking in many participants. For example, 51% of consumers did not know that milk naturally contains hormones without prior hormone treatment. Consumers might be confused by getting to know that hormones are found in the milk and that hormones can be applied to dairy cows. They could be misled by thinking that these 2 facts were associated. However, both models showed that people who had concerned themselves with dairy farming were more knowledgeable compared with people who had not done so. This indicates that educational programs are needed to inform the public about the biology of dairy cows and dairy production practices (Curtis, 1987; Refsdal, 2000).

Participants who consumed milk frequently also more often knew about natural hormones in milk compared with participants who did not drink milk frequently. This finding, however, was only true for participants who had not concerned themselves with dairy produc-

tion. This might indicate that people are more interested in milk production if they also drink milk frequently.

Older participants more often had better knowledge about dairy production than younger participants. This was expected because older participants have more life experience and potentially more exposure to dairy-related topics in life. Participants with a high school education also had more knowledge about the biology of the dairy cow. This indicates that school education might help in informing the public about basic principles of food production. Similarly, Worsley et al. (2013) reported better knowledge about food safety in older and better-educated people. It might be that people with higher educational status are more interested in food production and quality per se and, therefore, inform themselves more often about food production practices.

Results from this study might motivate producers, veterinarians, and researchers to evaluate reproductive management practices in dairy cows. It might further stimulate dairy industry to better educate consumers about modern agricultural production. Although the strength of this study is its representative nature, the

Table 3. Multivariable logistic regression model predicting the probability of a participant knowing that cows only give milk after calving (n = 1,569)

Item	Odds ratio	95% CI		Wald P-value
		Lower limit	Upper limit	
School education				
Junior high or elementary school	Baseline	—	—	—
High school or university graduate	1.6	1.20	2.14	0.001
Concerned oneself with dairy farming				
No	Baseline	—	—	—
Yes	4.2	3.11	5.61	<0.001
Age category				
16–29 yr	Baseline	—	—	—
30–44 yr	1.7	1.16	2.40	0.006
45–59 yr	2.1	1.49	3.06	<0.001
60 yr or older	2.7	1.89	3.89	<0.001

Table 4. Multivariable logistic regression model predicting the probability that a participant knew that milk contains hormones without prior hormone treatment (n = 1,547)

Item	Odds ratio	95% CI		Wald <i>P</i> -value
		Lower limit	Upper limit	
School education				
Junior high or elementary school	Baseline	—	—	—
High school or university graduate	1.8	1.42	2.28	<0.001
Age category				
16–29 yr	Baseline	—	—	—
30–44 yr	1.2	0.85	1.69	0.314
45–59 yr	2.3	1.65	3.21	<0.001
60 yr or older	1.7	1.21	2.33	0.002
Concerned oneself with dairy farming				
No	Baseline	—	—	—
Yes	4.5	3.13	6.61	<0.001
Frequency of milk consumption				
Less than weekly	Baseline	—	—	—
Weekly or more often	1.6	1.22	2.23	0.001
Frequency of milk consumption (weekly and more often) × concerned oneself with dairy farming (yes)	0.6	0.37	0.93	0.023

Figure 1. Predicted probability of knowing that milk contains hormones without prior hormone treatment compared with not knowing (n = 1,569). Box = interquartile range (IQR, 25th to 75th percentile of values); dark line within box = 50th percentile (median); whiskers = data range, not exceeding 25th percentile—1.5 * IQR and 75th quartile + 1.5 * IQR; dot = outlier.

findings are clearly limited to consumers in Germany. Therefore, further research is warranted to generate similar data for other countries and societies with comparable dairy industries.

CONCLUSIONS

Consumers in Germany lacked basic knowledge about milk production but generally perceived assisted reproductive technologies in dairy cows negatively. Education is necessary to inform consumers about food production and modern farm management practices.

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APPENDIX

Table A1. Questionnaire administered to a panel of 1,646 Germans

Question (instruction for or action by interviewer)	Answer categories
How often do you drink milk, no matter whether a cup of milk or chocolate, or you eat something with milk such as cereal? Would you say . . . (In case of queries: "When you drink milk only with coffee, that is not what we mean here")	Multiple times daily Daily Multiple times per week Once a week Less often Never* No answer* *Go to question 3
(Interviewer gives green list) In general: what do you find important in milk? Please tell me according to this list. (circle all that apply)	The taste An environmentally friendly packaging The brand Fat content Where the milk comes from That it is cheap That the milk was produced sustainably That the cows were kept according to good animal welfare That it is an organic product That it is fresh milk and not UHT milk That the milk comes from a small farm None of these No answer
A cow can only give milk when she already gave birth to a calf. Have you heard about that or have you not heard about that but you would have expected it or would you have not necessarily thought that?	I have heard that I would have thought so I would have not thought so Undecided; no answer
There are different possibilities how a cow can get pregnant; for example, by using artificial insemination or naturally with a bull. What do you think: Does the way the cow gets pregnant influence the quality of the milk that she will give later or is there no influence? (Interviewer hands over blue card game and white picture page) On these cards are different possibilities describing how a cow can get pregnant. What do you think: With which possibilities is the milk that the cow gives later better or rather worse? (Circle the respective) (interviewee sorts the cards according to milk quality being better or worse)	There is an influence There is no influence* Don't know; no answer* *Go to question 5
(Interviewer hands over blue list) Besides natural breeding by a bull, there are other possibilities or procedures for how a cow can get pregnant. Independent of your opinion whether it influences milk quality or not: Are there procedures on this list that you disapprove of and that, in your opinion, should not be used for getting a cow pregnant? (circle all that apply)	Natural fertilization by a bull Artificial insemination without hormone treatment of the cow Artificial insemination after a hormone treatment of the cow Transfer of an embryo (i.e., fertilized egg that was produced by fertilization in the Petri dish) Yes, specifically: Special artificial insemination with prior selection of semen cells so that only female calves are born Regular artificial insemination Transfer of an embryo, so a fertilized egg, that was produced by fertilization in the Petri dish Transfer of an embryo that was produced by cloning Hormone treatment of a cow to increase her fertility No, I do not disapprove of any of these No answer
The milk that comes from healthy cows that did not receive hormone treatment also contains hormones. Did you know that or did you not know that?	I knew that I did not know that No answer
Have you ever concerned yourself with dairy farming; for example, how dairy cows are housed, how milk is produced etc. or is this not the case?	Already concerned myself with dairy farming Not the case No answer