

The Benefits and Risks Associated with the Consumption of Raw Drinking Milk

Ton Baars *Editor*
Catharina Berge
Gerry Danby

1 Introduction

- 1.1 On 14 March 2018, at a meeting of the Board of the Food Standards Agency (FSA), a discussion on raw drinking milk took place. Heather Hancock, Chair of the Board, invited officers to comment on the benefits and risks of raw drinking milk. The officer contributions were unclear and demonstrated a lack of awareness of research which has been undertaken into the benefits and risks of raw drinking milk.
- 1.2 This report sets out the current state of research into the benefits and risks associated with the consumption of raw drinking milk which has been and is being undertaken. It is not the case, as stated at the meeting of the Board of the FSA, that there are no health benefits associated with the consumption of raw drinking milk. Furthermore, the identifiable risks associated with the production of raw drinking milk can be mitigated to an acceptable level.
- 1.3 Copies of the publications and references cited in this report can be provided if required.

2 The expertise which underpins this report

- 2.1 This report has been prepared with the expert assistance of Professor Ton Baars who holds a Master of Science degree in ecology from Utrecht University and obtained a PhD in grassland ecology and social science at Wageningen University in the Netherlands. Professor Baars was the first (endowed) chair for biodynamic agriculture at the University of Kassel in the State of Hessen in Germany from 2005-2011 and earned the honorific of 'Professor'.
- 2.2 Professor Baars has supervised PhD studies on milk quality, dealing with the topics covered in this report.¹ Over the past ten years, his research interests have been related to milk quality differentiation and raw milk as it relates to health. Currently, Professor Baars works as a senior scientist for milk quality and animal welfare for the Research Institute of Organic Agriculture (FiBL) in Frick, Switzerland. FiBL is an independent, non-profit research institute whose aim is to advance science in the field of organic agriculture. Since 2015, Professor Baars has also cooperated with the Department of Pharmaceutical Sciences of Utrecht University on food allergy and asthma in relation to milk processing, milk origins, and milk products.

- 2.3 Professor Baars has published several peer reviewed articles on milk quality and human health, milk's fatty acid composition and methodologies to distinguish between different milk origins. In 2011, he organised the first scientific raw milk conference in Prague, Czech Republic, to address the topic 'raw milk: health or hazard' and for which he presented a position paper² and at the 10th zoonotic symposium of the Netherlands National Institute for Public Health and the Environment held at Bilthoven, The Netherlands, in November 2016. This Dutch research institute is an independent agency of the Dutch Ministry of Health, Welfare and Sport. Over one hundred scientists, medical doctors and veterinarians were present at this 10th zoonotic symposium.
- 2.4 Professor Baars is a member of the Board of Directors of the Raw Milk Institute (RAWMI), an international non-profit organisation. The RAWMI's mission involves "improv[ing] the safety and quality of raw milk and raw milk products through training and mentoring farmers, establishing raw milk guidelines, improving raw milk accessibility and production transparency, and education, outreach and research." RAWMI acts as an independent third party in providing the names of certified farmers who comply with stringent biosecurity and hygiene guidelines and ensures transparency by publishing data on milk quality, hygiene and safety of raw milk.
- 2.5 In 2017, Professor Baars submitted two book chapters for a book on raw milk. The first was on the history of raw milk sales and production systems of milk, and the second about the immunological aspects of raw milk consumption.³ Professor Baars owns and operates a scientific website: www.milkandhealth.com. Based on a scientific evaluation of peer reviewed literature, it provides information to the public on all aspects of raw milk production and consumption.
- 2.6 Professor Baars is honorary scientific advisor to the German Federal Association of Vorzugsmilch Producers (see paragraph 4.2 below).

3 Issue identification

- 3.1 The European Food Safety Authority (EFSA) document on risk related issues from raw milk⁴ differentiates between intrinsic and extrinsic contaminations of raw milk that can create a hazard. Intrinsic contamination can arise through cow related diseases and infections. Extrinsic contamination is related to the hygiene of the farm environment and arises mainly from fecal contamination and unclean milk equipment.
- 3.2 EFSA statements generally on the risks of raw milk consumption and similar publications of other governments do not differentiate raw milk quality, raw milk origin, the purpose of the milk's production or what kind of raw milk is being produced.

- 3.3 The risk evaluation of raw milk consumption should be based on an improved definition of raw milk, which in turn distinguishes between different types of raw milk. Risk evaluations should be based upon quantitative risk assessment rather than evaluations of outbreaks. In general, no differentiation is made between types of raw milk, milk is milk. Under Regulation (EC) 853/2004 concerning hygiene rules for foodstuffs, for example, it is necessary to label any raw milk intended for direct human consumption, whether it is to be pasteurised or not, with the words 'raw milk'.
- 3.4 The problem, however, is that there are two types of raw milk. Pre-pasteurised raw milk is produced in the knowledge that the milk will be, and must be, heat treated during processing. This applies to most raw milk, because most raw milk produced nowadays is unsafe for direct consumption and its hygienic quality is controlled through heat-treatment. On the other hand, fresh unprocessed raw milk intended for direct consumption is produced intentionally to be consumed unpasteurised. Farmers producing this quality of raw milk have the knowledge about how to improve hygienic milk quality and reduce its zoonotic risk. In a risk evaluation of raw milk consumption, it is necessary to distinguish between these two types of raw milk.

4 Raw milk: health or hazard

- 4.1 In discussing the negative and positive effects of raw milk, and whether raw milk is hazardous or has health benefits, it is necessary to be aware of the ways and practices of raw milk production and handling. This knowledge is key to knowing how to reduce the societal risks of raw milk and to understanding its positive health effects.
- 4.2 German Vorzugsmilch, which is certified Grade-A raw milk approved for direct consumption is lawfully available fresh unprocessed raw milk which has legally been sold in shops since the 1930s and may not be compared with the consumption of general raw milk.

4.3 Risk reduction in controlled raw milk production in Germany

- 4.3.1 Germany has had a federal regulation for raw milk consumption for many years. Vorzugsmilch is the only legal farm milk that may be sold without the warning that states "heat-treat prior to consumption". Vorzugsmilch is raw milk produced under stringent requirements for hygiene, bacterial composition, packaging and transport. It may be marketed only by approved farms, must be stored at no more than 4°C, and sold no later than 96 hours after milking.
- 4.3.2 The health of the staff and the animals of farms that produce Vorzugsmilch are monitored by the Veterinary Service of the German state where the Vorzugsmilch is produced. The Veterinary Service enforces the Vorzugsmilch regulation by

monthly farm visits to inspect hygiene and animal health, sample milk and sample for mastitis of every animal in the herd. The raw milk is controlled for:

- (a) Fraud: the enzyme phosphatase must still be active.
- (b) Handling and processing: the temperature should be below 4°C and the pH should be normal.
- (c) Hygienic parameters: total aerobe bacteria (limit: 20,000 CFU/ml) and Enterobacteriaceae (limit: 10 CFU/ml).
- (d) Udder health: somatic cell count (limit: 200,000 cells/ml), gram-positive *Staphylococci* or *Staphylococcus aureus* (limit: 10 CFU/ml), eventually other mastitis bacteria; and
- (e) Zoonotic bacteria: *Salmonella enteric spp.*, *Campylobacter spp.*, *Listeria monocytogenes* and verotoxin/shigatoxin producing *Escherichia coli* (VTEC/STEC or EHEC). The limit for zoonotic bacteria acceptance is zero. Depending on the local situation the Veterinary Service can decide to control for additional zoonosis.

4.3.3 Due to this monthly control, the risk of becoming infected from Vorzugsmilch is low. This can be verified by reference to the epidemiological yearbooks of reportable infectious diseases, summarised by the Robert Koch Institute (RKI) for 2010-2015. The RKI is the German federal government's central scientific institution of biomedicine. Although the potential danger of any raw milk consumption is mentioned in the yearbooks, there are no cases of illness based on Vorzugsmilch.

4.4 General Raw Milk vs. Vorzugsmilch

4.4.1 There have been two studies on the results of microbiological milk safety of 'general raw milk' compared to Vorzugsmilch. The first data are from a PhD study conducted by C. Coenen in 2000.⁵ The second set of data are from the analysis by Professor Baars of official data from the Bundesanstalt für Riskobewertung, or Federal Institute for Risk Assessment (BfR) in Berlin.

4.4.2 In the Coenen study it was shown that in all but one item, Vorzugsmilch has a better result compared to general raw milk, as Table 1 below demonstrates.

Table 1: Comparison of Microbiological Results of Milk Samples from General Raw Milk ("Raw") and Vorzugsmilch ("VZM")

	Raw	VZM
Farms sampled (N)	115	35
Milk samples (N)	149	74
<i>Listeria monocytogenes</i> /ml	10.1	16.2*
<i>Bacillus cereus</i> /ml	8.1	0.0

	Raw	VZM
<i>Verotoxin producing E coli</i> /VTEC/ml	0.7	0.0
<i>Salmonella spp.</i> /25 ml	0.0	0.0
<i>Campylobacter spp.</i> /ml	0.0	0.0
Total aerobic bacteria x 1,000 /ml	49	8.7
Somatic cell counts x 1,000 /ml	190	160
<i>E. coli</i> /ml	1.1	0.08
Coliform bacteria /ml	110	10

* All positive samples were found in one single farm.

4.4.3 In the second data set, data from the past eleven years are presented. The data shows the zoonotic risks of milk produced in Germany based on the yearly prevalence of bacteria in milk samples taken by the BfR. These data indicate strongly that Vorzugsmilch shows less zoonotic risk than general bulk milk and other raw milk samples intended for pasteurization. In Table 2 below, the prevalence of contaminated milk samples is presented based on the origin of the milk.

Table 2: Regular milk samples (2004-2015) taken by BfR; sampled in 4 milk types (VZM=Vorzugsmilch; Farm=single farm milk; Bulk=other bulk milk samples raw milk; Past=Pasteurized milk); total number of samples (N) and percentage of positive samples

Species of bacteria	Milk type	Number of milk samples (N)	Number of positive samples (N)	Percentage of positive samples (%)
<i>Salmonella enterica spp.</i>	VZM	1808	0	0.00
<i>Salmonella enterica spp.</i>	Farm	732	0	0.00
<i>Salmonella enterica spp.</i>	Bulk	4426	1	0.02
<i>Salmonella enterica spp.</i>	Past	8694	1	0.01
<i>Campylobacter jejuni</i>	VZM	1506	7	0.46
<i>Campylobacter jejuni</i>	Farm	1063	9	0.85
<i>Campylobacter jejuni</i>	Bulk	3550	33	0.93
<i>Campylobacter jejuni</i>	Past	71	0	0.00
<i>E.coli</i> , VTEC	VZM	1361	14	1.03
<i>E.coli</i> , VTEC	Farm	1088	25	2.30
<i>E.coli</i> , VTEC	Bulk	3362	114	3.39
<i>E.coli</i> , VTEC	Past	160	3	1.88
<i>Listeria monocytogenes</i>	VZM	1720	15	0.87

Species of bacteria	Milk type	Number of milk samples (N)	Number of positive samples (N)	Percentage of positive samples (%)
<i>Listeria monocytogenes</i>	Farm	739	26	3.52
<i>Listeria monocytogenes</i>	Bulk	3349	78	2.33
<i>Listeria monocytogenes</i>	Past	6094	2	0.03
<i>Yersinia enterocolitica</i>	VZM	642	7	1.09
<i>Yersinia enterocolitica</i>	Farm	144	9	6.25
<i>Yersinia enterocolitica</i>	Bulk	64	5	7.81
<i>Yersinia enterocolitica</i>	Past	No data		
<i>Methicillin Resistant Staph. Aureus (MRSA)</i>	VZM	316	7	2.22
<i>MRSA</i>	Farm	326	15	4.60
<i>MRSA</i>	Bulk	229	17	7.42
<i>MRSA</i>	Past	No data		
<i>Mycobacteria</i>	VZM	32	0	0.00
<i>Brucella spp.</i>	VZM	80	0	0.00
<i>Brucella spp.</i>	Bulk	50738	1	0.00

- 4.4.4 The data shows that a farmer's approach towards raw milk safety and zoonotic reduction had a positive effect on the quality of the raw milk. The number of samples with too-high levels of zoonotic bacteria were found in 'bulk raw milk' and 'farm milk', while Vorzugsmilch samples showed a steep reduction. The samples of Vorzugsmilch were very similar to the samples of pasteurized milk, showing that hygiene management at Vorzugsmilch farms reaches a zoonotic risk level comparable to pasteurized milk.
- 4.4.5 Further it is important to realise that, if a positive sample is detected in Vorzugsmilch, the farmer is not allowed to sell any raw milk until he can show in the next weeks, that his milk reaches the safety standards again. The Vorzugsmilch standards are a good guide for how to organise repeated milk sampling.
- 4.4.6 In April 2016, BfR published a leaflet containing "questions and answers on raw milk consumption". The leaflet starts with: "Is Vorzugsmilch Safe? BfR answers this question (translation provided by Professor Baars):

"Vorzugsmilch is packaged raw milk from specially controlled milk retailers. There are strict rules for Vorzugsmilch production and treatment as well as microbiological checks of the milk. The packaging shall be marked with the word 'raw milk'."

No mention is made that milk should be boiled before consumption and the leaflet continues:

“Despite strict controls and compliance with microbiological criteria, it cannot be ruled out, that even Vorzugsmilch may contain pathogens that are responsible for food-borne infections. It is to be assumed that the probability of a food related infection by Vorzugsmilch in contrast to raw milk from conventional farms is reduced.”

- 4.4.7 A study by Claeys et al. (2013) concluded that over the last decades, no confirmed cases of death could be associated with the consumption of general raw milk in Western countries.⁶

5 Origin of the raw milk concern

- 5.1 Concern about safe raw milk for children began around the end of the 19th Century and initiatives were taken in all parts of the world. The main zoonotic issue for health caretakers then was the presence of tuberculosis in cows and men. To tackle the problem, raw milk production and animal health was controlled and in 1920, researchers at Reading University summarised the experience of raw milk production in a five-point scheme to maintain a safe milk quality:⁷
- (a) Milk should be cooled within three hours of milking.
 - (b) The prevention of dust, hairs, etc. from falling into open milk buckets.
 - (c) Sterilization of milking equipment (dairy utensils).
 - (d) Attention to the cleanness of the cows, including washing the udder before starting milking; and
 - (e) Training, motivation and education of the staff involved in the milking process.
- 5.2 The main focus was to get ‘clean and guaranteed milk’, as parents wanted to get rid of impure milk and were looking for pathogen-free milk for their children. Their approach for increased safety was not materially different from the standards for safe raw milk production today, described by the German Federal Association of Vorzugsmilch Producers and the RAWMI. Due to the change from the old way of milking into open buckets under cows with swishing dirty tails to closed milking systems, and due to the cooling systems at farms nowadays, the hygienic and zoonotic quality of raw milk has been improved enormously.

6 Quantitative microbial risk assessment

- 6.1 In 2014 three quantitative microbial risk assessments (QMRAs) and other scientific papers on the topic of raw milk were subject to review.⁸ The reviewer demonstrated how inappropriate evidence has long been mistakenly used to affirm

that raw milk is a high risk food. The scientific papers cited demonstrated a low risk of illness from raw milk consumption for each of the pathogens *Campylobacter*, *Shiga-toxin producing E. coli*, *Listeria monocytogenes* and *Staphylococcus aureus*. The low risk profile applied to healthy adults as well as members of susceptible groups: pregnant women, children and the elderly.

- 6.2 The QMRAs contradicted the long held view that raw milk is a high risk food and their accuracy was confirmed using foodborne illness outbreak data.

7 Health benefits of raw milk

- 7.1 Within the scientific community, there is a granular debate about the health benefits of raw milk. Raw milk has been found to be a single protective factor for asthma, allergies, hay fever, and even middle ear infections. A large number of epidemiological studies across the world show a reduction of disease if raw milk is consumed from an early age and onwards. See, for example, Braun-Fahrlander et al, (2011)⁹.
- 7.2 It is important to note that the effects of raw milk intake are found not only in farm children who have well documented immunities not shared by non-farm children. There is also an independent immunological effect of raw milk on non-farm children, as identified by Perkin and Strachan (2006).¹⁰ Further, at the moment that milk gets ‘cooked’, its protective effects are gone. As Loss et al. (2011)¹¹ found, even in a group of farm children living with dairy animals, allergies, atopy and asthma increased after they consumed their own farm milk in boiled form. This was confirmed in murine models for cow milk allergy in a study by Abbring et al. (2016)¹² and for asthma in Abbring et al. (2017).¹³
- 7.3 The Perkin and Loss studies were large epidemiological studies calculating statistical correlations between environmental factors, patterns in diet, mothers’ behaviour and clinical outcomes in children. Kusche (2015), and Abbring et al (2018, in preparation),¹⁴ performed an additional provocation study of multiple allergic children. These children, whose average age was eighteen months and were weak and ill due to allergies, were tested in a double blinded placebo controlled trial, comparing biodynamic Vorzugsmilch with conventional origin, pasteurised and homogenised shop milk. It was shown that there were no differences in skin reactions when small amounts of milk were sprayed under the skin in what is known as the “skin prick test”. However, in the provocation test, almost all children strongly reacted to the heat-treated milk with all kinds of allergic reactions, and the intake of milk had to be stopped after several millilitres of intake. In contrast, by far most children could digest the biodynamic Vorzugsmilch up to its maximum of 50 millilitres. Differences in threshold tolerance between the two milk origins were significant.
- 7.4 After the milk provocation test, the parents were advised to look for a similar biodynamic or organic farm in their neighbourhood to get access to Vorzugsmilch

quality raw milk. After a period of weeks, a doctor re-examined the children and confirmed that they had lost most of their allergies, whereas before the trial they had been diagnosed with multiple allergies, including to milk.

- 7.5 Epidemiological studies have shown that raw milk is not only protective against milk allergies, but also against asthma.¹⁵ Vorzugsmilch was tested in a mouse asthma model by Abbring (2017). After several weeks of milk consumption, the animals were infected with the house dust mite. Besides the negative and positive control, two treatments of milk consumption were compared: raw Vorzugsmilch and heat-treated Vorzugsmilch. After heat treatment of the Vorzugsmilch, mice reacted in a similar way to house dust as the positive control group, whereas the raw milk mice did not show any asthmatic reaction, as in the negative control group. Also, according to Abbring et al. (2017), the blood and tissue immune parameters supported these clinical findings.
- 7.6 In a running multicenter study, over 500 consumers of raw milk and raw milk kefir were evaluating their changes in health before and after starting raw milk consumption. In this retrospective epidemiological study validated questionnaires were used to evaluate changes in the bowel and skin symptoms, their mood, overall immunity and health. There is a significant increase of health and a reduction of complaints since the start of consumption of raw milk or raw milk kefir. There is a significant better improvement of self-reported health, if people had a reduced immunity and/or suffering from chronic disease (Baars et al. (2018, in preparation)).¹⁶

8 Conclusion

- 8.1 It is, in short, incorrect to state that there is no evidence of any health benefits arising from the consumption of raw drinking milk.
- 8.2 Epidemiological studies undertaken, experimental clinical evidence in children and animal models, have all clearly demonstrated the health benefits of raw milk. These benefits are both preventive and corrective. Furthermore, the available scientific evidence shows that raw milk can be produced with a very limited zoonotic impact on human health and no hazardous epidemics have been found after consumption of such type of raw milk.

April 2018

¹ Wohlers J. (2011), *Ermittlung geeigneter Methoden zur Differenzierung und Qualitätsbeurteilung unterschiedlicher Milchqualitäten aus verschiedenen on-farm-Experimenten (Methodenvergleich)*; Dissertation Universität Kassel, FB11, Witzenhausen and Kusche, D. (2015), *Untersuchungen zu Qualität und Verträglichkeit Ökologischer Milch - Differenzierbarkeit biologisch-dynamischer und konventioneller Milchqualität auf Betriebsebene anhand analytischer Qualitätsparameter und unter*

Einbezug von Verträglichkeitstestungen bei Kindern mit Nahrungsmittelallergien; PhD Thesis, University of Kassel

² Kusche, D., Kuhnt, K., Ruebesam, K., Rohrer, C., Nierop, A.F., Jahreis, G. and Baars, T. (2014), 'Fatty acid profiles and antioxidants of organic and conventional milk from low- and high-input systems during outdoor period', *J Sci Food Agric.* Feb;95(3), p. 529-539; Baars T. (ed.) (2011), 'Summaries of oral presentations of the First International Raw Milk Conference "raw milk, health or hazard"?' , Prague, May 2011; and, Baars T. (2013), 'Milk Consumption, Raw and General, in the Discussion on Health or Hazard', *J. Nutr. Ecol. and Food Res.* 08/2013; 1(2):91-107

³ Baars T, (2017(1), in preparation), 'Immunological challenges related to raw milk' in Nero L.A. and De Carvalho A.F. (eds), *Raw Milk: Balance Between Hazards and Benefits*, Elsevier publishers; and, Baars T, (2017(2), in preparation) 'Production systems in dairy farms' in Nero L.A. and De Carvalho A.F. (eds), *Raw Milk: Balance Between Hazards and Benefits*, Elsevier publishers

⁴ EFSA, 'Scientific Opinion on the Public Health Risks Related to the Consumption of Raw Drinking Milk', *EFSA Journal*, 13 January 2015

⁵ Coenen, C. (2000), *Untersuchungen zum Vorkommen und zur Risikoeinschätzung pathogener Keime in Rohmilch und Rohmilchprodukten aus der Direktvermarktung*. Dissertation Berlin, Fakultät Veterinärmedizin an der Freien Universität Berlin

⁶ Claeys, W.L., Cardoen, S., Daube, G., De Block, J., Dewettinck, K., Dierick, K., De Zutter, L., Huyghebaert, A., Imberechts, H., Thiange, P., Vandenplas, Y. and Herman, L. (2013), 'Raw or heated cow milk consumption: Review of risks and benefits', *Food Contr.* 31, p. 251–262

⁷ Atkins P. (2010), 'Dirty milk and the ontology of "clean"' in: Atkins P. (2010), *Liquid materialities, a history of milk, science and the law*, Routledge: Ashgate Publishing Limited

⁸ Ijaz, N, 'Canada's 'Other' Illegal White Substance: Evidence, Economics and Raw Milk Policy', *Health Law Review*, Volume 22, Issue 1, 2014, pp26-39

⁹ Braun-Fahrlander, C. and Von Mutius, E. (2011), 'Can farm milk consumption prevent allergic diseases?', *Clin Exp Allergy.* Jan;41(1), pp29-35

¹⁰ Perkin, M.R. and Strachan, D.P. (2006), 'Which aspects of the farming lifestyle explain the inverse association with childhood allergy?', *J Allergy Clin Immunol*, Jun; 117(6), pp1374-1381

¹¹ Loss, G., Apprich, S., Waser, M., Kneifel, W., Genuneit, J., Büchele, G., Weber, J., Sozanska, B., Danielewicz, H., Horak, E., Van Neerven, R.J., Heederik, D., Lorenzen, P.C., Von Mutius and E., Braun-Fahrlander, C., GABRIELA study group (2011), 'The protective effect of farm milk consumption on childhood asthma and atopy: the GABRIELA study', *J Allergy Clin Immunol.* Oct;128(4), pp766-773

¹² Abbring S., Ayechu Muruzabal V., Diks M.A.P., Dingjan G.M., Baars T., Garssen J. and van Esch B.C.A.M. (2016), 'Comparing the sensitizing capacity of raw and processed cow's milk in a murine sensitization model for food allergy', *Allergy*, 71 (Suppl. 102), pp118–272

¹³ Abbring S., Verheijden K.A.T., Diks M.A.P., Leusink-Muis A., Hols G., Baars T., Garssen J. and Van Esch B.C.A.M. (2017) 'Raw Cow's Milk Prevents the Development of Airway Inflammation in a Murine House Dust Mite-Induced Asthma Model', *Front. Immunol.* 8:1045. doi: 10.3389/fimmu.2017.01045

¹⁴ Abbring, S., Roos, T. C., Diks, M. A. P., Hols, G., Garssen, J., Kusche, D., Baars T. and van Esch, V. C. A. M. (2018, in preparation), 'Milk processing increases the allergenicity of cow's milk in a murine model for food allergy – preclinical evidence supported by a human proof-of-concept provocation trial'

¹⁵ Perkin, M.R. and Strachan, D.P. (2006) and Loss, G., Apprich, S., Waser, M., Kneifel, W., Genuneit, J., Büchele, G., Weber, J., Sozanska, B., Danielewicz, H., Horak, E., Van Neerven, R.J., Heederik, D., Lorenzen, P.C., Von Mutius, E., Braun-Fahrlander, C., GABRIELA study group (2011)

¹⁶ Baars T., Berge A.C. and Verster J. (2018, in preparation), 'Evaluation of self-reported changes in human health after consumption of raw milk and raw milk kefir'