Position Statement on Raw Milk Sales and Consumption
Cornell University Food Science Department

We recommend pasteurization of milk intended for consumption by humans. Specifically, we strongly recommend that raw milk not be served to infants, toddlers, or pregnant women, or any person suffering from a chronic disease or a suppressed immune system. In addition, we strongly recommend that raw milk not be provided to the general public at farms; raw milk consumption could expose consumers to unnecessary and/or extremely costly and painful risks for which a milk producer may be held legally responsible. Pasteurization offers protection, both for the consumer and for the producer, from the consequences of foodborne infection by pathogens that can be found in raw milk.

Health Hazards Associated with Raw Milk Consumption

Physicians linked consumption of raw milk with the spread of disease early in the 20th century. Raw milk consumption was associated with many serious human diseases, including diphtheria, typhoid, tuberculosis, and brucellosis (1). In fact, in 1938, 25% of all U.S. illnesses resulting from consumption of contaminated food and water were linked back to milk consumption (2). During this era, human illnesses typically resulted from consumption of milk that had been obtained from unhealthy cows under unsanitary conditions. Modern U.S. dairy products are associated with considerably less than 1% of foodborne illnesses that are traced back to food source each year (2). The reduction in numbers of foodborne illnesses associated with milk consumption over the years reflects implementation of: (i) on-farm programs to control animal diseases, including brucellosis, tuberculosis and mastitis; (ii) enhanced farm sanitation practices; (iii) temperature control of milk products from the farm to the consumer (milk must be kept at 45^{o}F or below within 2 hours of milking); and (iv) pasteurization of the majority of commercial dairy products (2).

In addition to the reduction in the number of illnesses associated with dairy product consumption since 1938, the nature of dairy-borne human illnesses has changed, as well. In the past 20 years, illnesses from dairy product consumption have been predominantly associated with *Salmonella enterica, Listeria monocytogenes, Campylobacter jejuni*, and *Escherichia coli* O157:H7 (3). These organisms can be present in milk obtained from healthy animals, typically as a consequence of contamination that occurs during or after milking (e.g., milk contamination from contact with fecal material or inadequately cleaned equipment) (4). In recent years, pathogenic microorganisms have been isolated from bulk tank samples (Table 1) at rates ranging from 0.87% to 12.6% of total samples collected (5, 6, 7, 8, 9, 10), indicating a measurable probability of encountering pathogenic bacteria in raw milk. The prevalence and detection of foodborne pathogens in farm raw milk can be influenced by a number of factors including the season of the year, geographical location, the number of animals, farm size and layout, production and farm management practices, employee training, herd health, as well as sampling and testing procedures used to detect pathogens (10).

Milk Pasteurization

The public health objective of milk pasteurization, as defined in the Grade "A" Pasteurized Milk Ordinance (2), is to eliminate all non-spore forming pathogens commonly associated with milk. Pasteurization processes are specifically implemented to reduce the potential risk to consumers of illness due to pathogens that may be present in raw milk. All milk intended for human consumption must be handled according to good agricultural and manufacturing process procedures. As pasteurization is not designed to sterilize milk, it may not eliminate all harmful bacteria if raw milk is

Table 1. Examples and prevalence of foodborne pathogens isolated from raw bulk tank milk[1]

Pathogen	State or Province	# Farm Bulk Tanks Sampled	% Positive Bulk Tanks	Reference
Salmonella	WI, MI, IL	678	4.70 %	6
	Ontario	1,721	0.17 %	8
	SD, MN	131	6.10 %	5
	TN, VA	292	8.90 %	9
Listeria	Ontario	1,721	2.73 %	8
	SD, MN	131	4.60 %	5
	TN, VA	292	4.10%	9
E. coli (STEC)[2]	Ontario	1,721	0.87 %	8
	SD, MN	131	3.80 %	5
	WI	115	10.00 %	7
Campylobacter	Ontario	1,721	0.50 %	8
	SD, MN	131	9.20 %	5
	TN, VA	292	12.30 %	9

[1] Adapted from Ruegg, P. http://www.uwex.edu/milkquality/PDF/zoo.pdf and Oliver et al (10).
[2] Shiga toxin-producing *E. coli*, including *E. coli* O157:H7

heavily contaminated. Therefore, milk intended for human consumption must be obtained from healthy cows and protected from contamination. The temperature and time regime for pasteurization is currently designed to kill *Coxiella burnetii*, an animal pathogen that is the causative agent of Q-fever in humans. *C. burnetii* is currently accepted as the most heat-resistant human pathogen found in milk. Good hygiene practices during milking and subsequent handling of milk are essential to reduce the risk of contamination on the farm and in the milk processing plant. Careful packaging of pasteurized milk in clean, sanitized containers also helps retard spoilage of milk so it lasts longer after it is purchased. Milk that is not properly handled can become re-contaminated after the heat treatment. Rapid cooling after pasteurization, sanitary handling, and storage in a clean, closed container at 40^{o}F or below are also important aspects of ensuring safe milk.

Many Types of Raw Foods Can be Hazardous for Human Consumption

Many raw foods may be contaminated with harmful bacteria. Certain raw foods should always be treated as if they are contaminated. For example, ground beef may be contaminated with a number of organisms associated with a cow's gastrointestinal tract, including *E. coli* O157:H7, however proper cooking will kill these organisms. Other foodborne disease outbreaks from *Salmonella* and *Campylobacter* are associated with consumption of undercooked chicken. *Salmonella* infections also have been associated with consumption of raw or undercooked eggs. *Listeria monocytogenes* infections have been attributed to consumption of a number of foods, including improperly cooked hotdogs. Heat treatments for many foods are commonly accepted practices that not only make the food more palatable, but also, when conducted in accordance with accepted food safety guidelines, reduce the risk of acquiring foodborne infections.

Examples of Recent Outbreaks Attributed to Raw Milk Consumption

From 2000 to 2006, state public health agencies reported 40 separate outbreaks attributed to raw milk consumption that resulted in nearly 600 illnesses (11, 12). *Campylobacter* was the causative agent in a majority of these outbreaks (33 reported), followed by *E. coli* O157:H7 (6 reported). Notable in this time period were two *E. coli* O157:H7 outbreaks that made national headlines as

several children became severely ill. In December 2005, 18 out of 140 people who reported consuming milk from a cow-leasing program in Washington became ill with *E. coli* (13). Five children (aged 1-13 years old) were hospitalized and four of these patients developed Hemolytic Uremic Syndrome (HUS). In 2006, *E. coli* O157:H7 was again responsible for illness in six children in California (14), 3 of whom were hospitalized. Litigation on behalf of two of the children was filed against the retail raw milk bottler (15). In another 2006 case, *E. coli* O157:H7 was responsible for causing serious illness in two more children in Washington (16). The most notable *Campylobacter* outbreak reported during the 2000-2006 period occurred in 2001 in Wisconsin, with 75 cases associated with the consumption of raw milk purchased in a cow-leasing program (17). *Salmonella* was only involved in one reported outbreak, but in this event there were 62 culture confirmed cases spread over 4 states (18). As a result of the outbreak, the implicated dairy and restaurant, which was the last legal retail raw milk dealer in Ohio at the time, voluntarily relinquished its license to sell raw milk products.

In 2007, illnesses attributed to raw milk consumption included a *Salmonella* outbreak that sickened 29 in Pennsylvania (19), a *Campylobacter* outbreak that affected 25 in Kansas (20) and another *Campylobacter* outbreak that affected 26 in Utah (21). In 2008 *Campylobacter* was again responsible for 16 becoming ill in California after consuming milk from a cow-leasing program, 2 of whom were hospitalized, one with a form of Guillain-Barré Syndrome (22); and an outbreak in Pennsylvania with 25 culture confirmed cases where a licensed dealer was implicated (23). Illnesses due to *E. coli* O157:H7 were also reported in 2008. An outbreak of 7 cases, 6 with HUS, was associated with a Connecticut retail raw milk source (24). A single case of *E. coli* O157:H7 HUS in Missouri involved a one year old child who was given raw goats milk after the mother was encouraged to do so at a local market (25).

Consumption of cheese made from raw milk has also been associated with a number of illness outbreaks since 2000. In 2007, a *Campylobacter* outbreak affected 67, most of whom consumed cheese made at a social event in Kansas (26). *Salmonella* was to blame for an outbreak in Illinois in 2006-7 with 85 ill where illegally produced Latin-style cheese was implicated (27) and an outbreak of 26 illnesses in Connecticut associated with fresh cheese made from heated milk that was not legally pasteurized (28). Since 2000, *Listeria monocytogenes* has been the causative agent in 4 cheese related outbreaks. In 2007 raw milk cheese was implicated in listeriosis infections among four pregnant women in North Carolina, which resulted in three miscarriages and a premature delivery (29). A larger cluster of listeriosis, also in North Carolina, occurred in 2001; 11 women were infected resulting in 5 stillbirths, 3 premature deliveries, 2 infected newborns and 1 case of meningitis; a 70 year old immuno-compromised man also developed a listerial brain abscess. (30) Two other listeriosis outbreaks were reported in Texas (11,12). Although tuberculosis associated with dairy has become rare in the US, 35 cases caused by *Mycobacterium bovis* were reported in the NY City area, where consumption of fresh cheese illegally imported from Mexico was implicated as the possible cause in a large percentage of the cases (31). Imported cheese has been suspect in similar cases in California and Texas.

Health Benefits of raw and pasteurized milk.

Milk is good source of high quality protein and essential amino acids; vitamins such as vitamin A, thiamin and riboflavin; and minerals such as calcium and phosphorous. Advocates of raw milk consumption suggest that pasteurization reduces the nutritional quality of the milk, destroys important enzymes, kills beneficial bacteria and actually promotes pathogens by destroying natural inhibitors. Some claims associate consumption of pasteurized milk with increased risks of heart disease, cancer, tooth decay, arthritis and other ailments (32, 33). Current scientific data does not support the implied

conclusions of these statements, many of which are based on anecdotal evidence. The benefits of raw milk consumption and the negative claims for pasteurized milk consumption have been disputed (34, 35). Under conventional pasteurization conditions, the significant nutrients in milk remain intact; major milk proteins are resistant to heat and fat soluble vitamins such as A, D and E are stable. During pasteurization, some water soluble vitamins may be lost (0-10%), but not at levels predicted to have human health consequences; for example, milk is not considered a significant source of vitamin C. Most pasteurized milk is fortified with vitamin D beyond that which is present in raw milk. The vitamin D fortification practice for fluid milk has contributed greatly to preventing diseases associated with deficiencies of this vitamin (i.e., rickets). Certain enzymes in milk are destroyed by pasteurization, but there is no evidence that they play a significant role in human digestion or nutrition. Natural bactericidal agents in milk that may indeed act against pathogens and other bacteria, such as lactoferrin, lactoperoxidase, and lysozyme are not destroyed by minimal pasteurization conditions, although higher heat conditions may degrade or destroy these agents. Destruction of these agents is irrelevant from a food safety perspective in properly pasteurized and handled milk. Raw milk may contain "beneficial" or probiotic bacteria, but the actual strains and numbers in any given raw milk are variable, random and irreproducible. The numbers of these bacteria present in freshly harvested milk are too low to promote human health or to out-compete pathogen growth. Based on the prevalence of food borne pathogens in raw milk, and the number of documented outbreaks associated with its consumption, it is clear that natural inhibitors present in milk do not ensure raw milk safety.

We conclude that the perceived benefits of raw milk consumption do not outweigh the risks associated with exposure to potential foodborne pathogens. This risk is a particular concern for those who are at greater risk of illness from foodborne pathogens, e.g., pregnant women, infants and children, the immunocompromised, and the frail elderly.

Cornell University staff members supporting this position statement:

Robert Ralyea, M.S., Sr. Extension Associate, Food Science Department (rdr10@cornell.edu)

Jason R. Huck, M.S., Dairy Operations Manager, Cornell University (jrh63@cornell.edu)

Martin Wiedmann, Dr. Med. Vet/Ph.D., Professor, Food Science Department (mw16@cornell.edu)

Kathryn J. Boor, Ph.D., Professor and Food Science Department Chair (kjb4@cornell.edu)

Steven C. Murphy, M.P.S. Sr. Extension Associate, Food Science Department (scm4@cornell.edu)

Contact information:
Food Science Department
Stocking Hall
Cornell University
Ithaca, NY 14853
607-255-7643

For comprehensive information on foodborne illnesses, please visit the Centers for Disease Control (CDC) website: http://www.cdc.gov/foodborneoutbreaks/outbreak_data.htm. To reduce the risk of contracting foodborne illnesses, consumers should avoid raw milk products. *References follow*.

References

1. Johnson, E. A., J. H. Nelson, and M. Johnson. 1990. Microbial safety of cheese made from heat-treated milk. Part II. Microbiology. J. Food Prot. 53:519-540.

2. U.S. Dept. of Health and Human Services, Public Health Service and Food and Drug Admin. 2003. Grade "A" Pasteurized Milk Ordinance. 2003 Revision.

3. IOM/NRC. 2003. Scientific criteria to ensure safe food. National Academic Press, Washington, DC. pp. 242-243.

4. Boor, K. J. 1997. Pathogenic microorganisms of concern to the dairy industry. Dairy Fd. Environ. Sanit. 17:714-717.

5. Jayarao, B. M., & D. R. Henning. 2001. Prevalence of foodborne pathogens in bulk milk. J. Dairy Sci. 84:2157-2162.

6. McManus, C., and J. M. Lanier. 1987. *Salmonella, Campylobacter jejuni,* and *Yersinia enterocolitica* in raw milk. J. Food Prot. 50:51.

7. Padhye, N. V., and M. P. Doyle. 1991. Rapid procedure for determining enterohemorrhagic *Escherichia coli* O157:H7 in food. Appl. Environ. Microbiol. 57:2693-2698.

8. Steele, M. L., W. B. McNab, C. Poppe, and M. W. Griffiths. 1997. Survey on Ontario bulk tank raw milk for food-borne pathogens. J. Food Prot. 60:1341-1346.

9. Rohrbach, B. W., F. A. Draughon, P. M. Davidson, and S. P. Oliver. 1992. Prevalence of *Listeria monocytogenes, Campylobacter jejuni, Yersinia enterocolitica,* and *Salmonella* in bulk tank milk: Risk factors and risk of human exposure. J. Food Prot. 55:93-97.

10. Oliver, S.P., B. M. Jayarao and R. A. Almeida. 2005. Foodborne pathogens in milk and the dairy farm environment: food safety and public health implications. Foodborne Pathogens and Disease 3:115-129.

11. Centers for Disease Control and Prevention. 2008d. Outbreak Surveillance, Annual listing of Foodborne Disease Outbreaks, United States: 2000-2006. Available at http://www.cdc.gov/foodborneoutbreaks/outbreak_data.htm. Accessed on November 28, 2008.

12. Center for Science in the Public Interest. 2008. Outbreak alert database. CSPI, Washington, D.C Available at: http://www.cspinet.org/foodsafety/outbreak/pathogen.php Accessed November 28, 2008.

13. Centers for Disease Control and Prevention. 2007. *Escherichia coli* O157:H7 infection associated with drinking raw milk --- Washington and Oregon, November--December 2005. MMWR March 2, 2007 / 56(08);165-167. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5608a3.htm. Accessed on November 24, 2008.

14. Centers for Disease Control and Prevention. 2008. *Escherichia coli* 0157:H7 infections in children associated with raw milk and raw colostrum from cows --- California, 2006, MMWR June 13, 2008 / 57(23);625-628. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5723a2.htm. Accessed November 24, 2008.

15. *E. coli* Lawsuit Filed Against Organic Pastures. Posted on Marler & Clark LLP, PS on Feb. 8, 2008. http://www.ecoliblog.com/2008/02/articles/e-coli-legal-cases/e-coli-lawsuit-filed-against-organic-pastures Accessed Mar 6, 2008. http://www.ecoliblog.com/articles/e-coli-legal-cases

16. Int. Soc. for Infectious Diseases. 2006. *E. coli* O157, Unpasteurized milk USA (Washington): Recall. A ProMED-mail post, Sept. 29, 2006. Accessed Mar. 6, 2008. http://www.promedmail.org/pls/otn/f?p=2400:1202:2517207500593079::NO::F2400_P1202_CHECK_DISPLAY,F2400_P1202_PUB_MAIL_ID:X,34624

17. Centers for Disease Control and Prevention. 2002. Outbreak of *Campylobacter jejuni* infections associated with drinking unpasteurized milk procured through a cow-leasing program - Wisconsin, 2001. MMWR June 28, 2002 / 51(25):548-549. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5125a2.htm. Accessed on November 24, 2008.

18. Centers for Disease Control and Prevention. 2003. Multi-state outbreak of *Salmonella* Serotype Typhimurium infections associated with drinking unpasteurized milk --- Illinois, Indiana, Ohio, & Tennessee, 2002—2003. MMWR July 4, 2003 / 52(26);613-615. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5226a3.htm. Accessed on November 24, 2008.

19. Centers for Disease Control and Prevention. 2007. Salmonella Typhimurium infection associated with raw milk and cheese consumption --- Pennsylvania, 2007. MMWR November 9, 2007 / 56(44);1161-1164. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5644a3.htm. Accessed November 24, 2008.

20. KDHE - Kansas Department of Health and Environment. 2007b. Campylobacteriosis outbreak associated with unpasteurized milk - Reno County and Butler County, August–December 2007. Available at: http://www.kdheks.gov/epi/download/BU_RN_Campy_Nov07_final_report.pdf Accessed November 26, 2008.

21. Report to the Natural Resources, Agriculture & Environment Interim Committee and the Health & Human Services Interim Committees. 2008. Unpasteurized Milk-Associated Diseases in Utah. Utah Department of Agriculture and Food and the Utah Department of Health. Available at: http://hlunix.ex.state.ut.us/els/FINAL%20Report%20to%202008%20Interim%20Committees%20-%20Raw%20Milk-Associated%20Disease%2010.30.08.pdf. Accessed November 26, 2008.

22. CDPH – California Department of Public Health. 2008. Campylobacteriosis among persons consuming unpasteurized milk from a cow leasing program, Del Norte County, May-June 2008. California Department of Public Health. Infectious Diseases Branch, Division of Communicable Disease Control, Center for Infectious Diseases. Report issued to "The Record" October 2, 2008. A. Karon, T. Martinelli. D.J. and Vugia.

23. Pennsylvania Department of Health, Raw Milk Update. September 2008. Available at: http://www.dsf.health.state.pa.us/health/lib/health/epidemiology/Raw_Milk_Update.pdf. and 9/12 Press Release at http://www.dsf.health.state.pa.us/health/cwp/view.asp?A=190&Q=251618. Accessed December 4, 2008.

24. Kasacek, W., Connecticut Department of Agriculture. 2008. July 2008 food borne illness investigation. Connecticut Weekly Agricultural Report, Vol LXXXVIII, No. 33, Wednesday, August 20, 2008. Marketing & Technology Bureau. Connecticut Department of Agriculture. Jessey Ina-Lee, Editor. F. Philip Prelli, Commissioner. Robert R. Pellegrino, Bureau Director. Accessed December 4, 2008 and available at: http://www.ct.gov/doag/lib/doag/marketing_files/bulletin/Wednesday_August_20_2008_issue.pdf.

25. Marler-Clark. July 29, 2008. *E. coli Lawsuit Filed Against Missouri Raw Milk Distributor*. Available at: http://www.marlerblog.com/2008/07/articles/legal-cases/e-coli-lawsuit-filed-against-missouri-raw-milk-distributor/index.html. Lawsuit document available at: http://ozarksfirst.com/media/pdf/Pedersonlawsuit.pdf. Accessed December 4, 2008.

26. Centers for Disease Control and Prevention. 2009. *Campylobacter jejuni* Infection associated with unpasteurized milk and cheese --- Kansas, 200735 MMWR January 2, 2009 / 57(51);1377-1379. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5751a2.htm?s_cid=mm5751a2_e Accessed on January 2, 2009.

27. Centers for Disease Control and Prevention. 2008b. Outbreak of multidrug-resistant *Salmonella* enterica serotype Newport infections associated with consumption of unpasteurized Mexican-style aged cheese --- Illinois, March 2006--April 2007. MMWR April 25, 2008 / 57(16):432-435. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5716a4.htm. Accessed November 24, 2008.

28. McCarthy T, Phan Q, Mshar P, Mshar R, Howard R, and Hadler J. 2002. Outbreak of multidrug-resistant *Salmonella* Newport associated with consumption of Italian-style soft cheese, Connecticut. International Conference on Emerging Infectious Diseases. Atlanta, GA, March 2002. Available at: http://cdc.gov/enterics/publications/184-mccarthy_2002.pdf. Accessed November 24, 2008.

29. North Carolina: Listeriosis results in stillbirths, premature birth. Posted on Marler & Clark LLP, PS on Dec.19, 2007. http://www.foodpoisonblog.com/articles/food-poisoning-watch/. Accessed Mar. 6, 2008.

30. Centers for Disease Control and Prevention. 2001. Outbreak of Listeriosis associated with homemade Mexican-style cheese --- North Carolina, October 2000--January 2001. MMWR July 06, 2001 / 50(26):560-562. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5026a3.htm. Accessed on November 24, 2008.

31. Centers for Disease Control and Prevention. 2005. Human tuberculosis caused by *Mycobacterium bovis* - New York City, 2001-2004. June 24, 2005 / 54(24);605-608. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5424a4.htm. Accessed November 24, 2008.

32. A campaign for real milk. What is real milk? The Weston A. Price Foundation. Washington, DC. Available at: http://www.realmilk.com/what.html Accessed on January 20, 2009.

33. Organic Pastures – Frequently asked questions. Available at: http://www.organicpastures.com/faq.html Accessed on January 20, 2009.

34. On the safety of raw milk. John F. Sheehan, FDA/CFSAN. Accessed on December 7, 2009 and available at: http://www.fda.gov/downloads/Food/FoodSafety/Product-SpecificInformation/MilkSafety/ConsumerInformationAboutMilkSafety/UCM166067.ppt

35. LeJeune, J. T. and P. J. Rajala-Schultz. 2009. Unpasteurized milk: a continued public safety threat. Clinical Infectious Diseases. 48:93-100.