Testimony to the
Senate Agriculture and Natural Resources Committee
Kansas State University, College of Agriculture and K-State Research and Extension
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Chairman Kerschen, and members of the Senate Agriculture and Natural Resources Committee, my name is Randall Phebus and I am a professor of food safety at Kansas State University, a position that I have held for 28 years. My university role within the College of Agriculture's Food Science Institute and the K-State Research and Extension program is to conduct food microbiology-based research, teaching and outreach. I am appearing before you today on SB 300, an act concerning agriculture; relating to milk and dairy products; prohibiting the on-farm retail sales of milk or milk products. My testimony today is presented relative to the proposed legislation (SB 300), but is also relevant to a second piece of proposed legislation (SB 308) currently before your committee, both regarding the on-farm retail sales of raw milk and food products manufactured from raw milk. For both bills, my testimony is provided as a neutral party at the request of the dairy industry to provide factual scientific information to the committee on the subject of raw milk safety, which also supports the K-State Research and Extension mission as a land grant institution.

Milk has played a major public health role in this country since its founding, but it was not until the 1870s that milk was linked to the transmission of critical human diseases of the time. This is the same historical time period where we saw the emergence of the concept of "germ theory", whereby, an actual minority of scientists believed that diseases were attributable to microorganisms as opposed to a weakness or imbalance of the specific organism (animal/human/insect) becoming ill. Louis Pasteur in France had the scientific acumen in the mid-1860s to hypothesize that microorganisms were the cause of wine, beer and milk spoilage, and he and others felt they were the cause of terrible diseases including anthrax, cholera and rabies. Pasteur demonstrated that heating liquids in containers to specific temperatures would inactivate microorganisms, thus reducing spoilage.[1] This process became known as "pasteurization" and has been applied over the generations to many food products and public health areas including municipal water chlorination treatment and medical equipment sterilization. Proper food pasteurization is now mostly utilized to ensure product safety, and undoubtedly, pasteurization technology should be (and is) recognized as one of the most important concepts in the advancement of human health over the last 150 years. As an example, the annual infant mortality rate in the United States and Europe approached 300 deaths per 1,000 live births during the mid-1800s. In the late 1880s and early 1900s, milk pasteurization gained significant recognition as a critical approach to advancing public health and larger dairies in the United Kingdom, United States and Canada began pasteurizing their milk, and Chicago and New York mandated the process in 1911. Concurrently, infant mortality rates precipitously dropped during this period of time to 5 to 6 deaths per 1000 today due to several contributing societal factors, but milk pasteurization is prominent among them.[2]

Scientific and public health data indicate that raw milk, having undergone no antimicrobial control process prior to consumption, namely heat pasteurization, poses a substantially elevated risk for harboring and transmitting both zoonotic (transferrable from animals to humans) and environmentally derived disease agents to consumers. It has been estimated using publicly available disease outbreak data in the United States from 2009 to 2014 that dairy products caused 760 illnesses and 22 hospitalizations per year. Even though only 3.2 percent of the public consumes unpasteurized milk and only 1.6 percent consumes cheese manufactured from raw milk, these unpasteurized dairy products caused 96 percent of all dairy related illnesses attributed to *Campylobacter*, *Salmonella*, Shiga toxin-producing *Escherichia coli* (STEC) and *Listeria monocytogenes* during this timeframe. This study indicated that unpasteurized dairy products caused 840 times more illnesses and 45 times more hospitalizations than pasteurized dairy products.[3] Certain cheese products made using raw milk pose a 50 to 160 times greater risk for transmitting a *Listeria monocytogenes* infection, one of the deadliest foodborne pathogens, compared to similar products manufactured from pasteurized milk, according to the Centers for Disease Control.[4] Of significant relevance when considering public policy around raw dairy product sales and access, the estimate model developed in the study above suggests that a 20 percent increase in raw milk consumption in the United States to 3.8 percent and raw milk cheeses to 1.9 percent would result in a 19 percent increase in the number of illnesses and 21 percent increase in hospitalizations.[3]

Why are there so many microbiological disease agents associated with raw milk? Contamination with these agents happens due to 1) healthy cattle, goats, sheep and other milk-producing animals harboring human pathogens in their gastrointestinal tracts and being a source of fecal contamination via equipment, udders, bulk storage units, etc.; 2) unhealthy animals such as those with mastitis passing a human pathogen directly into the milk; and 3) human pathogens from the dairy production and/or processing environment contaminating consumer products.

Historically, scarlet fever (Group A *Streptococcus*), diphtheria (*Corynebacterium diphtheriae*) and typhoid fever (*Salmonella* Typhi and *S.* Paratyphi) were notable human pathogens borne by unpasteurized milk, causing epidemics and fatalities. Inadequately pasteurized milk led to 10,000 cases of streptococcal sore throat with 19 fatalities in Chicago in 1911. Important human milk-borne diseases resulting from animal diseases were tuberculosis (*Mycobacterium bovis* and *M. tuberculosis*) and brucellosis (*Brucella abortus* and *B. melitensis*).[2] Brucellosis is a disease carried by many animals, and the CDC states that the most common way of a person becoming infected is through the consumption of raw dairy products. The *Brucella* bacteria are passed from the infected animal through its milk leading to severe and prolonged human infections.[5]

Today, with the availability of modern diagnostic and epidemiological tools, we know much more about the elevated health risks posed by a cadre of human and animal pathogens that are transmissible through raw dairy products consumption. In addition to the milk-borne pathogens mentioned above, important hazards would include *Salmonella* (many serotypes), *Campylobacter*, *Bacillus cereus*, *Bacillus anthracis*, STEC, *Coxiella burnetii*, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Staphylococcus aureus*, Group B streptococci, and *Toxoplasma gondii*. These pathogens are capable of causing a variety of illnesses with disease outcomes ranging from very mild to deadly, and many factors play into the ultimate disease manifestations. These factors include, but are not limited to, the presence and combination of virulence genes harbored by the particular pathogen isolate, the health/immune status of the person consuming the contaminated product, the concentration of the pathogen in the product, the amount of contaminated product consumed by an individual, and lifestyle of the consumer (e.g., alcoholics or people taking antacids are more susceptible to infection). As we continue to learn more about many of these pathogens, we must note that there are often prolonged health impacts stemming from the acute illnesses that occur. For example, a person consumes *Campylobacter jejuni* contaminated raw milk and becomes ill with bloody diarrhea and nausea but recovers after one week. Several weeks later, this person develops Guillain-Barré Syndrome (GBS), an autoimmune disorder damaging nerves, causing muscle weakness and often paralysis that can last for years. Up to 40 percent of GBS cases in the United States are linked to *Campylobacter* infections, and about 1 in 1,000 *Campylobacter* infections lead to GBS.[6]

As a veteran food microbiologist working extensively with several of the above mentioned milk-borne pathogens, all of the pathogens warrant consideration; however, two stand out in my opinion as primary targets for surveillance, public education efforts, and need for control (currently, only by use of pasteurization) due to their extreme human health impacts, and their frequent association with dairy-related illness outbreaks and market recalls (almost exclusively related to raw milk and raw milk products as opposed to pasteurized dairy products). Shiga toxin-producing *E. coli* (notoriously *E. coli* O157:H7 but other serogroups as well) are carried by healthy ruminant animals and shed in their feces, ultimately resulting in a contamination risk during milking and bulk raw milk handling. As few as 1 cell of STEC can lead to human infection, and this particular infection often manifests itself as vomiting, diarrhea rapidly developing into profusely bloody diarrhea with severe abdominal cramping. Approximately 10 percent of people diagnosed with STEC progress to a severe condition called hemolytic uremic syndrome (HUS) characterized by acute renal failure with permanent damage or death as the outcome.[7] HUS is a hideous disease most notably observed in young children and adolescents, but also elderly and immunocompromised individuals. *Listeria monocytogenes* is one of the deadliest foodborne pathogens, with 1,600 people being infected each year in the United States and 260 dying. *L. monocytogenes* is most severe in pregnant women (causing miscarriages and stillbirths) and their newborns, elderly, and people with weakened immune systems. Pregnant women are 10 times more likely to contract a *Listeria* infection, and pregnant Hispanic women are 24 times more likely. Listeriosis outbreaks recently have been linked to consuming raw milk, raw chocolate milk, and raw milk cheeses.[8] Another key feature of *L. monocytogenes* in dairy is the fact that it is one of the few pathogens that can grow under chilled conditions, thus, posing an significant threat of increasing from extremely low initial levels to infectious levels in dairy products during storage. This is particularly a concern in raw milk manufactured cheeses.

How do we minimize the risks posed by these public health disease agents in raw milk and raw milk products? It is a daunting proposition to undertake. Key elements of a program must include 1) a verifiable animal health program from which the milk is derived; 2) documentable sanitation and hygiene procedures during milking, bulk handling and storage, and retail packaging of consumer products; 3) vigorous regulatory health inspection of processing and sales facilities; 4) documentation of adequate cold chain management activities from the processor to the consumer; 5) a scientifically defined shelf-life (consumer use-by dating) statement; 6) extensive processor, retail and consumer educational outreach initiatives for processing, retailing and consuming raw milk products; and 7) a prominent detailed consumer safety label on all retail packages stating risks and emphasizing elevated risks for certain consumer segments such as young children, pregnant women, elderly and immune-compromised individuals.

Some people discuss the use of microbiological testing as a means of ensuring raw milk safety. Microbiological testing has its place in all food manufacturing, but testing will not ensure safety because raw milk processors cannot afford to test for all of the aforementioned pathogens, and many of the pathogens are likely to be present in raw milk below sampling and detection limits (but can still be a public health hazard). Some would suggest using less expensive and more rapid testing for "indicator organisms" such as coliforms or total aerobic plate count. This would give a processor an indication of the hygiene level of their operation, however, several of the milk-associated pathogens are NOT correlated to the presence or level of the indicator organisms (i.e., raw milk with low indicator bacterial counts can still harbor a variety of human pathogens at infectious levels). The raw milk public health discussion is not only occurring in the United States. A 2013 study surveying the rate of raw milk contamination on 183 dairies known for high hygienic standards in Finland, for example, found 5.5 percent positive for *L. monocytogenes*, 2.7 percent for STEC, and 34.5 percent for coagulase positive *Staphylococcus*. The researchers noted that there was no relationship between indicator organisms and the presence of pathogens. They concluded that, despite high hygienic standards during processing, the presence of pathogenic microorganisms in raw milk cannot be avoided.[9]

Kansas has seen illness outbreaks in the past. In 2007, the Kansas Department of Health and Environment (KDHE) investigated a community-based outbreak of campylobacteriosis which was epidemiologically linked to consumption of a raw "fresh" cheese product during a county fair event. Nineteen citizens were stricken by *Campylobacter jejuni*. In the CDC report on this outbreak, it was noted that Kansas had experienced an outbreak of campylobacteriosis in 2002 involving 65 preschoolers who visited a dairy and consumed raw milk. Again in 2007, a Kansas outbreak occurred involving 25 persons who had purchased unpasteurized raw milk and raw milk products from a local dairy.[10] In 2012, KDHE reported a raw milk related outbreak of campylobacteriosis in Whitewater, Kansas involving at least 18 individuals from several families. In this outbreak, raw milk was procured from a single dairy whose milking procedures met or exceeded the FDA's Pasteurized Milk Ordinance regulations.[11]

In a detailed scientific review addressing common health misconceptions and associated health dangers of raw milk consumption, the U.S. Food and Drug Administration concluded that raw milk consumption does not cure lactose intolerance, cure or treat asthma or milk protein allergies, reduce osteoporosis risk due to differences in calcium concentration or bio-availability, increase ingestion levels of probiotic bacteria, nor build the immune system.[12] These are commonly encountered health claims to which citizens are frequently exposed. Scientifically, most public health experts and food safety authorities do not promote the consumption of raw milk because of the significantly elevated health risks involved, and because milk pasteurization is such an effective and proven safety measure. Politically, the issue of raw milk sales is contentious and, as a neutral contributor to this discussion, I will refrain from commenting. However, as policy decisions are made in Kansas and elsewhere, careful consideration should be given to citizens' rights to consume foods of their choice, their right to free expression, the need for agricultural based businesses to seek financial opportunities, the costs associated with implementing and managing a safe raw milk state-wide enterprise (as I listed two paragraphs above), the public and private costs associated with potential increases in foodborne illness rates, and the emotional burden that is likely to be encountered by an yet undetermined number of severe and possibly deadly raw milk-linked illnesses in our state.

Thank you, Mr. Chairman, for your attention I am happy to stand for questions.

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