Donor Milk: What's in It and What's Not

Douglas B. Tully, Frances Jones and Mary Rose Tully

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Douglas B. Tully, PhD, Frances Jones, RN, BScN, IBCLC, and Mary Rose Tully, MPH, IBCLC

Abstract

Breastfeeding and human milk are widely recognized as optimal for human infants. However, if donor milk is used when mother's own milk is not available, some questions arise concerning the effects of storage, handling, and heat processing on the unique components of human milk. Holder pasteurization (62.5°C for 30 minutes) of banked human milk is the method of choice to eliminate potential viral contaminants such as human immunodeficiency virus, human T-lymphoma virus, and cytomegalovirus, as well as tuberculosis and other bacterial contaminants, while maintaining the greatest possible complement of its unique bioactive factors. This article reviews some of the critical components of human milk and what is currently known about the effects of Holder pasteurization on their biological activity.

Keywords: milk banking, prematurity, nutrition, human milk, donor milk, pasteurization

There is little question that human milk is uniquely suited to the human infant, including the preterm infant. It offers easy digestibility and rapid gastric emptying.[1] It provides nutrients with optimal bioavailability as well as bioactive components that provide immune and nonimmune protection against pathogens.[2] The composition of human milk also compensates for the infant's inability to produce certain substances including digestive enzymes, secretory IgA (sIgA), IgA, taurine, nucleotides, and long-chain polyunsaturated fatty acids.[3,4] Schanler and colleagues, in studying premature infants fed human milk, concluded that "the unique properties of human milk promote an improved host defense and gastrointestinal function compared with the feeding of formula."[2]

Douglas B. Tully is an adjunct assistant professor in the Department of Biology and Health Sciences at Meredith College, Raleigh, North Carolina. **Frances Jones** is Coordinator of C&W Lactation Services and Milk Bank at BC Children's and Women's Hospital, Vancouver, British Columbia. **Mary Rose Tully** is Director of lactation services at UNC Women's Hospital and an adjunct clinical instructor in the Department of Pediatrics at the University of North Carolina at Chapel Hill. Address correspondence to Mary Rose Tully, UNC Women's Hospital, CB #7600, 101 Manning Dr., Chapel Hill, NC 26514, USA.

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However, the use of pasteurized donor milk when mother's own milk is not available raises some significant questions concerning the effects of storage, handling, and heat processing on the unique components of the milk. Some concerns arise from information based on outdated references that outline practices no longer in use and clinical situations that are no longer common.[5] Most countries have guidelines for screening, storage, and handling of donor milk that optimize the composition of the donor milk while ensuring its safety for the recipient.[6-18]

In the past when mothers were unable to provide milk for their babies, nonrelated donors' milk was often fed to the infants. With increased understanding about disease transmission and the advent of viruses such as human immunodeficiency virus (HIV), human T-lymphoma virus (HTLV), and cytomegalovirus (CMV), the use of untreated, fresh donor milk for preterm infants is almost nonexistent. (One exception is Germany, where donors' health is closely monitored by milk bank personnel and serum screening is repeated every 2 months.) Use of pasteurized human milk from screened donors removes the concerns about disease transmission[19-21] and provides the next best alternative to mother's own milk, since many of the unique and valuable components of

human milk remain intact after heat treatment as long as the temperature is carefully controlled.

Optimizing Quality

Some studies suggest that donor milk from mothers of full-term infants cannot foster the same growth rate as mother's own milk in preterm infants.[22,23] However, some of these studies were done on donor "drip milk," or milk collected from the dripping of the opposite breast while the donor was breastfeeding her own full-term infant. Drip milk has long been recognized to have lower fat content than expressed or pumped milk, since there is no active removal of the hind milk.[24] There is also some question with regard to whether weight gain is the best measure of optimal outcome. One large study found that even with slower weight gain, the human milk fed preterm infants had significantly higher IQ scores at school age.[22] Most donor milk banks today recognize the importance of using milk actively expressed or pumped to optimize fat content. Additionally, milk from mothers of preterm infants (gestational age 36 weeks or less) is designated as preterm milk for the first 4 weeks of pumping. It is processed in special batches, since it is higher in protein,[23,25,26] which is important for the preterm infant. Because mothers of preterm infants are being more actively encouraged to provide milk for their own babies, often they have excess to donate when their babies go completely to breast.

Effects of Pasteurization

Human milk protects the infant from pathogens in the environment through both specific antibody-targeted mechanisms (IgA, IgG, and IgM) and several distinct, broad-spectrum mechanisms, including the bacteriocidal effects of lactoferrin and lysozyme, the specific ligand action of κ-casein against *Helicobacter pylori*, and the antiviral and antiprotozoan effects of free fatty acids and monoglycerides produced by the lipolysis of milk triglycerides.[4,27] However, as a safeguard against the transmission of certain viral pathogens that may occur in some mothers' milk, Holder pasteurization (62.5°C for 30 minutes) is now required by the Human Milk Banking Association of North America,[6] the United Kingdom Association for Milk Banking,[7] and many other national milk banking guidelines for donor milk. While Holder pasteurization virtually eliminates the threat of viral contaminants, such as HIV,[21] HTLV-1,[28] and CMV,[20,29] as well as common bacterial contaminants,[19] it also destroys the B- and T-cell components of milk.[30,31] Because B lymphocytes give rise to antibodies targeted against specific pathogens to which the mother has been exposed, and T lymphocytes both attack infected cells and send out chemical signals to mobilize other immune defenses, their loss is regrettable. However, another interesting thought comes to mind. Theoretical questions have been raised about the possibility of graft-versus-host reaction with the use of donor milk, and yet there has never been a suspected or documented report of this occurring.[32] Because the cell-mediated immune response is a principal factor in tissue recognition, loss of the B- and T-cell components from heat-processed donor milk would further ensure that this would not occur. Even though the lymphocytes are lost, many of the other protective components of human milk are unaffected or only minimally affected by pasteurization (Table 1). IgA and sIgA, which constitute the majority of the antibodies in human milk, are unaffected by freezing for 4 weeks, but Holder pasteurization reduces immunoglobulin concentration by 20% to 30% and significantly reduces specific antibody titer against *Escherichia coli*.[30,33,34] Still, Carbonare and colleagues[35] found that the decreased titers of IgA and sIgA did not diminish pasteurized milk's reactivity against enteropathogenic *E. coli*.[35] Holder pasteurization has only a minimal effect on lysozyme activity but decreases lactoferrin iron-binding capacity by as much as 60% depending partly on the pH of the particular milk sample.[32,33,36] It is also important to note that microorganisms that could contaminate the milk after pasteurization will grow faster than they can in raw milk owing to damage to the bacteriostatic systems in the milk.[32,33] However, standard care in handling feedings of high-risk patients should minimize any risk of contamination.

In addition to its immunoprotective functions, human milk is a rich source of long-chain polyunsaturated fatty acids (LC-PUFA), including the two essential fatty acids linoleic (18:2n6) and α-linolenic (18:3n3) acids, which humans and other mammals are unable to synthesize. These essential fatty acids are precursors for more complex LC-PUFA, which have specific physiological functions and must be present in the diet for normal growth and development.[3] Docosahexaenoic acid (22:6n3), often referred to as DHA, is derived from the α-linolenic acid and plays a critical role in retinal and

Table 1. Selected Components of Human Milk After Freezing and Pasteurization

	Function	*Percentage Activity*	*References*
IgA and sIgA*	Binds microbes in the baby's digestive tract to prevent their passage into other tissues	67-100	19,27,30
IgM*	Antibodies specifically targeted against pathogens to which the mother has been exposed	0	30,33
IgG*	Antibodies specifically targeted against pathogens to which the mother has been exposed	66-70	30,34
Lactoferrin (iron-binding capacity)*	Binds iron required by many bacteria and thus retards bacterial growth	27-43	19,33,34
Lysozyme*	Attacks bacterial cell walls and thus destroys many bacteria	75	33,34
Lipoprotein lipase*	Partly responsible for lipolysis of milk triglycerides to release monoglycerides and free fatty acids	0	23,38
Bile salt activated lipase*	Partly responsible for lipolysis of milk triglycerides to release monoglycerides and free fatty acids	0	23,38
Monoglycerides produced by lipolysis of milk triglycerides*	Disrupts the membrane coating of many viruses and protozoans, destroying them	100	37,38,39
Free fatty acids produced by lipolysis of milk triglycerides**	Disrupts the membrane coating of many viruses and protozoans, destroying them	100	37,38,39
Linoleic acid (18:2n6)**	Essential fatty acid; metabolic precursor for prostaglandins and leukotrienes	100	37,38,39
α-linolenic acid (18:3n3)**	Essential fatty acid; metabolic precursor for docosahexaenoic acid; important for eye and brain development	100	37,38,39

* These biologically active components do not occur in commercial formula.
** Some manufacturers are now adding docosahexaenoic acid and other supplemental fats to selected infant formula preparations.

brain development, whereas arachidonic acid (20:4n6) is derived from the linoleic acid and is the precursor for prostaglandins and leukotrienes, which are critical regulators of metabolism.[3]

Holder pasteurization has little effect on the relative proportions of LC-PUFA in human milk, although there is a slight (6%) decrease in total triglycerides and corresponding increase in free fatty acids due to lipolysis.[37-39] However, human milk lipases, including lipoprotein lipase and bile salt-activated lipase, are completely inactivated by pasteurization; this has been postulated to account for decreased absorption of fats in the gut of the preterm infant.[23,38] Nonetheless, although milk lipases are destroyed by pasteurization, a lingual lipase secreted from serous glands at the posterior part of the tongue has been found in gastric contents of preterm infants from the 26th gestational week and may play an import role in lipolysis of milk triglycerides.[40,41]

Conclusion

There are still more questions to be answered with regard to optimal nutrition for the preterm and very low birth weight infant. Preservation of the unique components of human milk during storage of mother's own milk, storage and processing of donor milk, and the most effective fortification methods for human milk to meet the extraordinary needs of preterm infants are important areas for continued investigation. Our current state of knowledge indicates that human milk is optimal for full-term, as well as preterm, infants, although any milk may require fortification to meet the special nutritional needs of the very low birth weight infant. When mother's own milk is not available, processed human milk from appropriately screened donors contains many of the immunoprotective and bioactive factors absent from commercial formula and is clearly the next best option for feeding both full-term and preterm infants.

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