



The Cholesterol Concentration in Mammals' Milk - Is It a Real Content?

Anna Malwina Kamelska*

Clinic of Rehabilitation, Poland

*Corresponding author: Anna Malwina Kamelska, Clinic of Rehabilitation,, Poland

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Abbreviations: ChC: Cholesterol Concentration; GC: Gas Chromatography; HPLC: High Performance Liquid Chromatography; DAD: Diode Array Detector; FTIR-ATR: Fourier Transformed Infrared Spectroscopy

Mini Review

Recently the use of colostrum and mature milk derived from various mammals in feeding both infants and adults has been gaining more and more popularity. The reason for this is mainly its hypocholesterolemic action, better bioavailability, therapeutic properties (used in the gastro-intestinal disorders) and no allergies after consumption.

The composition of milk plays a crucial role for the newborn mammals' health. And one of its main components is cholesterol. There are many factors affecting the cholesterol concentration (ChC) in milk e.g. breed, species and the age of animals, milk yield, as well as the following lactation, lactation phase, animal's health status and diet. Moreover, even as minor detail as time of the day may have an impact on the ChC [1,2].

Animal's feeding (also maternal nutrition during pregnancy and/or lactation in humans) is highly important in the case of fetal programming and epigenetic regulation. Moreover, it is related to the adequate development of the fetus, infant and future adult [3]. Some research shows that feeding infants with high-cholesterol breast milk influences the metabolism of this steroid and prevents the occurrence of hypercholesterolemia in later life. High cholesterol exposure in infancy might lead to cholesterol decrease and permanently stimulate its catabolism in adulthood [4].

Furthermore, the differences in the ChC in the same sample may be associated with the use of different analytical methods. Some of the procedures have got several shortcomings. Routinely used methods are mainly based on the extraction of fat as the initial step, which is both time- and labor-consuming. Moreover, multiple reagents are required. In order to avoid tedious pre-treatment and extraction procedures some authors extracted cholesterol from milk and dairy products using direct saponification. Its duration's influence on cholesterol concentration was shown in previous study [5]. This paper addresses the hypothesis that the

ChC obtained using various analytical methods does not do justice to the real content of this sterol in the sample. This is due to the problems and shortcomings of recently used analytical methods and the knowledge gap in the regulatory processes.

Cholesterol concentration has been determined mostly using colorimetric methods [6,7], gas chromatography (GC) followed by thin layer chromatography separation [8] or GC alone [9], high performance liquid chromatography (HPLC) coupled to diode array detector (DAD) [10] and attenuated total reflectance Fourier transformed infrared spectroscopy (FTIR-ATR) [11]. The comparison of cholesterol concentration (ChC) in mammals' milk using different analytical methods has been shown in Table 1. Specific period of lactation (colostrum/mature milk) has been indicated [12-38].

Cholesterol concentration in mature human milk is lower than in cow's milk and higher than in infant formulas. Moreover, ChC in infant formulas (0.93-5.45mg/100 cm³) [39] is relatively low as compared to breast milk. Moreover, the content of this sterol in human milk is about 20% higher than that of bovine and caprine milk [40]. However, the comparison of the cholesterol concentration in mammals' milk is way more difficult because different authors use different analytical methods. Furthermore, different methods are associated with different units, which complicate the proper cholesterol concentration comparison. Moreover, according to some authors, pasteurized milk was characterized by reduced ChC compared to mature milk and colostrum [19]. The concentration of this compound in the colostrum of mammals is generally higher than in mature milk or is at a constant level. What is more, no scientific studies determined the concentration of cholesterol in human colostrum, which could become a future research aim. Also, the comparison of the cholesterol concentration in various mammals using the same analytical method is needed.

**Table 1:** The comparison of the cholesterol concentration (ChC) in different mammals' milk and the analytical methods used.

Milk Samples		ChC [mg dL ⁻¹]	Method	Reference
Cow (<i>Bos taurus</i>)	Collostrum	9,49	Precht [12]	Precht [12]
	mature (pasteurized)	11,78	IDF Standard	Pikul [13]
	mature (pasteurized)	2,37-3,06	Cerutti et al. [14]	Cerutti et al. [14]
	mature	16,25 - 18,63	Šterna et al. [15]	Šterna & Jemeljanovs [15]
	mature	14,94	Fletouris et al. [16]	Talpur et al. [17]
Mare (<i>Equus caballus</i>)	collostrum	19,33	Bao-Shyung et al. [18]	Pikul [19]
	mature	7,23	Bao-Shyung et al. [18]	Pikul [19]
Goat (<i>Capra hircus</i>)	collostrum	9,43	Direct saponification	Zaharia et al. [20]
	mature (pasteurized)	8,51	IDF Standard	Pikul [13]
	mature	16,23 (summer), 11,30 (autumn)	Balice Animal Husbandry Institute	Wolanciuk [21]
	mature	9,8	Ulberth et al. [22]	Mayer et al. [23]
	mature	15,68-19,10	Fletouris et al. [16], Searcy et al. [24]	Strzałkowska et al. [25]
	mature	14	Folch et al. [26], Rudel et al. [27]	Park [28]
Sheep (<i>Ovis aries</i>)	mature	11,6	Ulberth et al. [22]	Mayer et al. [23]
Buffalo (<i>Bubalus bubalis</i>)	collostrum	12,93-9,02 (summer-autumn), 12,68-7,88 (winter-spring)	Borkovcová et al. [29]	Coroian et al. [30]
	mature	8	Kovacs et al. [31]	Zotos et al. [32]
Yak (<i>Bos mutus</i>)	mature	14,25	Fletouris et al. [16]	He et al. [33]
Human (<i>Homo sapiens</i>)	mature	12	Park et al. [34]	Scopesi et al. [35]
	mature	10,57	Paradkar & Iruyuida [36]	Kamelska et al. [11]
	mature	9,88	IDF Standard	Kamelska et al. [11]
	mature	7,06	IDF Standard	Kamelska et al. [37]
	mature	5,38	Kamelska, Bryl 2012 [38]	Kamelska, Bryl [38]

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