

A study of the composition of sterols in human milk and infant formulae with different lipid compositions

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Abstract. Analysis of the quantitative and qualitative characteristics of the composition of infant formula (IF) allows us to estimate their proximity to breast milk (BM), and identify a set of conditions affecting the formation of metabolic programming and the possibility of its modulation in infants. In particular, cholesterol (CHL) is present in BM in high concentrations from the onset of lactation, and appears to have a programming effect on its metabolism in the adult. The lipids in most IFs are represented mainly by vegetable oils containing mainly phytosterols (PTLs). Therefore it seems relevant to study the quantitative and qualitative composition of sterols in BM and IFs as a possible target for optimizing the IF lipid component.

Objective. Comparison of sterols in samples of BM and IFs.

Materials and methods. The study used samples of mature BM of women from the Moscow region (Russia), and samples of four IFs available on the Russian market, with different lipid components. In formula No.1, based on whole goat's milk, the lipid component was represented by dairy fat and vegetable oils in a ratio of 50:50; in formula No.2 (goat milk, mostly skimmed), formula No.3 (cow milk, skimmed), and formula No.4 (cow milk, skimmed, extensively hydrolysed casein), the lipid component was represented mostly by various vegetable oils. This study evaluated the sterol's composition in terms of CHL and PTLs which were extracted from the lipid fraction by the Folch method. Quantification was carried out using an Agilent 7890 gas chromatograph equipped with an autosampler connected to a mass spectrometer (capillary column of 30 cm × 0.25 mm × 0.25 μm) [1-2]. Quantification was done by comparing retention times with authenticated standards (Fig. 1).

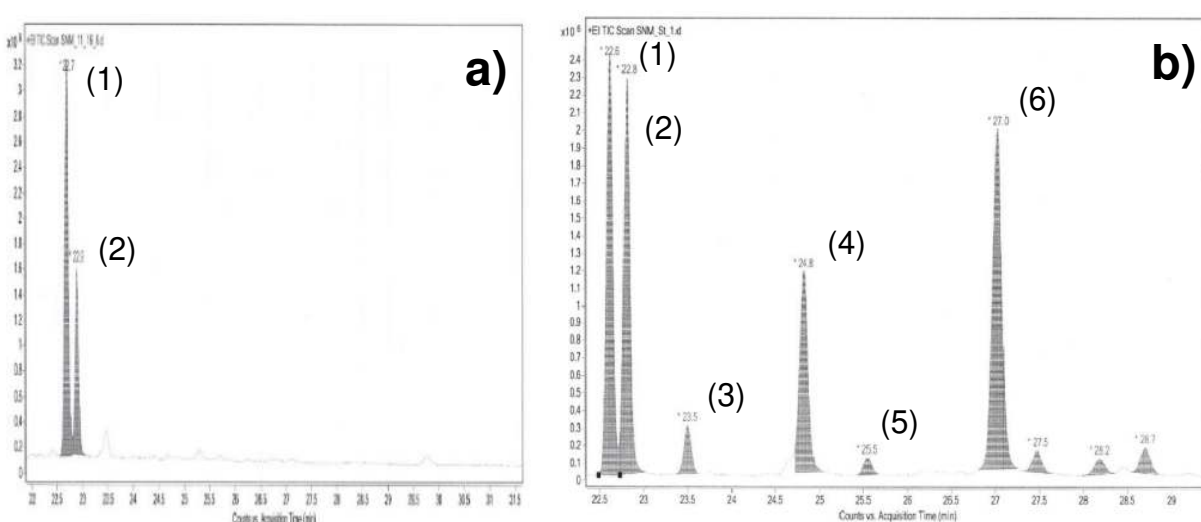


Fig. 1. Typical chromatograms of sterols obtained by gas chromatography-mass spectrometry showing the studied sterols in BM (a) and IFs (b). Peaks: (1) Cholesterol; (2) Cholestanol (internal standard, IS); (3) Brassicasterol; (4) Campesterol; (5) Stigmasterol; (6) β-Sitosterol.

References. 1. GOST R 51471-99 "Method of detection of vegetable fat by gas-liquid chromatography of sterols" (In Russian). 2. ISO 3594-76 «Milk fat. Detection of vegetable fats by gas-liquid chromatography of sterols» (In Russian).

Results. The highest levels of CHL were found in BM, in the range 2.3–2.5 mg/g fat, CHL being the only sterol found in BM. CHL counts in IFs differed significantly, the highest was found in formula No. 1 (1.4 ± 0.04 mg/g fat), the lowest in No. 4 (0.03 ± 0.002) (Fig. 2).

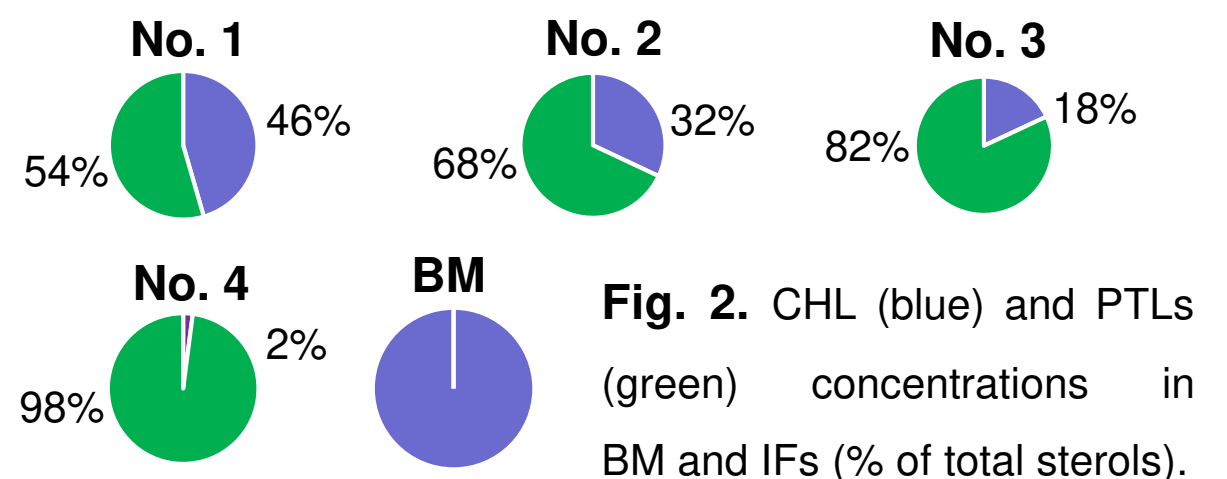


Fig. 2. CHL (blue) and PTLs (green) concentrations in BM and IFs (% of total sterols).

The following PTLs were found in the formulae: brassicasterol, campesterol, stigmasterol, sitosterol, 5-avenasterol, amyirin, 7-sitosterol. The main PTLs found in all the infant formulae were β-sitosterol and campesterol, detectable in the range from 0.5 to 1.5 mg/g fat. Concentration of CHL and β-sitosterol for BM and IFs are shown in Fig. 3.

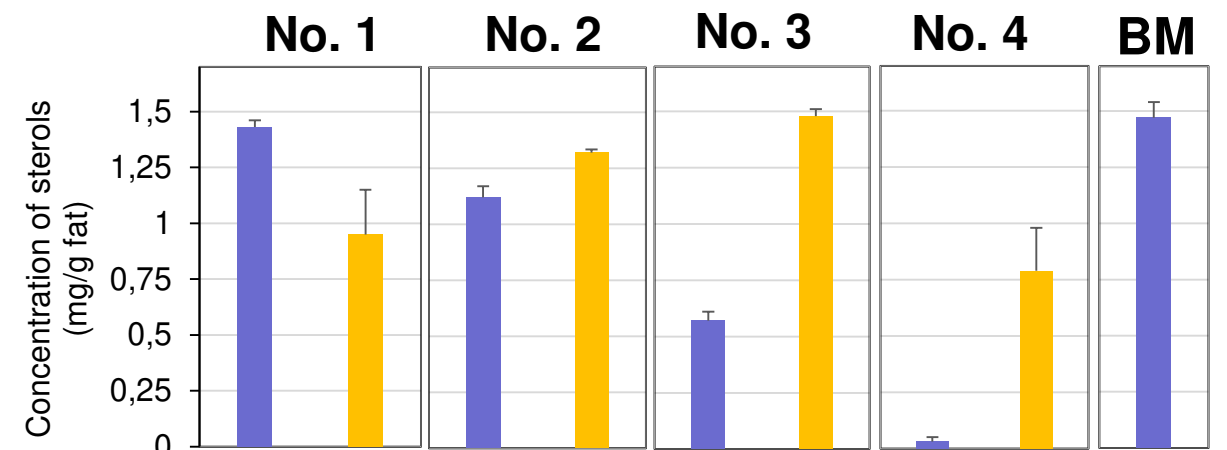


Fig. 3. CHL (blue) and β-Sitosterol (yellow) concentrations (mg/g fat) for BM and IFs (values are expressed as mean ± SD of three replicates).

The samples demonstrated a distinct differences in sterol composition (including CHL), depending on the type of formula, its lipid component, and manufacturing technology. The formula whose lipid component consisted of dairy fat and vegetable oils in the ratio 50:50 was characterized by an approximately equal CHL-PTLs ratio, and its CHL content was the closest to that of BM (Fig. 2, 3).

Conclusion. The retention of native dairy fat in IF approximates its lipid composition more closely to that of BM, in particular concerning CHL levels.

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