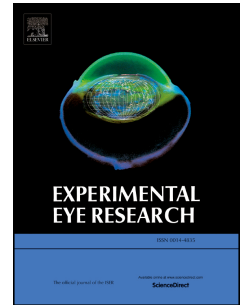


# Accepted Manuscript

Determination of water-soluble and fat-soluble vitamins in tears and blood serum of infants and parents by liquid chromatography/mass spectrometry

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PII: S0014-4835(16)30544-9

DOI: [10.1016/j.exer.2016.12.007](https://doi.org/10.1016/j.exer.2016.12.007)

Reference: YEXER 7076

To appear in: *Experimental Eye Research*

Received Date: 24 May 2016

Revised Date: 15 December 2016

Accepted Date: 16 December 2016

Please cite this article as: Khaksari, M., Mazzoleni, L.R., Ruan, C., Kennedy, R.T., Minerick, A.R., Determination of water-soluble and fat-soluble vitamins in tears and blood serum of infants and parents by liquid chromatography/mass spectrometry, *Experimental Eye Research* (2017), doi: 10.1016/j.exer.2016.12.007.

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1 **Determination of Water-Soluble and Fat-Soluble Vitamins in Tears and Blood Serum of**  
2 **Infants and Parents by Liquid Chromatography/Mass Spectrometry**

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11

12 **Abstract**

13 Tears serve as a viable diagnostic fluid with advantages including less invasive sample to collect  
14 and less complex to prepare for analysis. Several water-soluble and fat-soluble vitamins were  
15 detected and quantified in human tears and compared with blood serum levels. Samples from 15  
16 family pairs, each pair consisting of a four-month-old infant and one parent were analyzed;  
17 vitamin concentrations were compared between tears and blood serum for individual subjects,  
18 between infants and parents, and against self-reported dietary intakes. Water-soluble vitamins B<sub>1</sub>,  
19 B<sub>2</sub>, B<sub>3</sub> (nicotinamide), B<sub>5</sub>, B<sub>9</sub> and fat-soluble vitamin E ( $\alpha$ -tocopherol) were routinely detected in  
20 tears and blood serum while fat-soluble vitamin A (retinol) was detected only in blood serum.  
21 Water-soluble vitamin concentrations measured in tears and blood serum of single subjects were  
22 comparable, while higher concentrations were measured in infants compared to their parents.  
23 Fat-soluble vitamin E concentrations were lower in tears than blood serum with no significant  
24 difference between infants and parents. Serum vitamin A concentrations were higher in parents  
25 than infants. Population trends were compiled and quantified using a cross correlation factor.  
26 Strong positive correlations were found between tear and blood serum concentrations of vitamin  
27 E from infants and parents and vitamin B<sub>3</sub> concentrations from parents, while slight positive  
28 correlations were detected for infants B<sub>3</sub> and parents B<sub>1</sub> and B<sub>2</sub> concentrations. Correlations  
29 between infants and parents were found for the concentrations of B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, and E in tears, and  
30 the concentrations of B<sub>2</sub>, A, and E in blood serum. Stronger vitamin concentration correlations  
31 were found between infants and parents for the breast-fed infants, while no significant difference  
32 was observed between breast-fed and bottle-fed infants. This work is the first to demonstrate  
33 simultaneous vitamin A, B, and E detection and to quantify correlations between vitamin  
34 concentrations in tears and blood serum. Our results suggest that tears are a viable biofluid to  
35 monitor nutritional health because they sufficiently mirror blood serum data and may enhance  
36 the speed of deficiency diagnoses.

37 **Keywords:** tears, blood serum, water-soluble vitamin, fat-soluble vitamin, infant, parent<sup>1</sup>

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<sup>1</sup> ACN: acetonitrile; APCI, atmospheric pressure chemical ionization; D<sub>2</sub>O: Deuterium Oxide,  
DMSO: Dimethyl Sulfoxide, ESI: Electrospray Ionization, FA: Formic Acid, IS: Internal

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