**Vitamin-targeted metabolomics methods**

The samples were analyzed by UPLC-MRM/MS on a Dionex UltiMate 3400 RSLC system coupled to an AB Sciex 4000 QTRAP triple-quadrupole mass spectrometer equipped with an electrospray ionization source. The standard substances of vitamin A (retinal, retinol, retinoic acid), B1 (thiamine), B2 (riboflavin), B3 (niacinamide), B6 (pydidoximine, pyridoxine, pyridoxal, pyridoxal-mono-phosphate), B7 (biotin), B9 (folic acid), D2, D3, E (α-tocopherol, δ-tocopherol, and δ-tocotrienol), K1 and K2, were purchased either from Sigma-Aldrich or from Cayman Chemicals Inc. The MRM transitions of individual analytes were optimized by direct infusion of a standard solution of each compound into the MS instrument. Each sample was added with a methanolic BHT (2 mg/mL) solution at a ratio of 15 μL per mg of the small intestine digestate. Vitamins were extracted by homogenizing the samples at a shaking frequency of 30 Hz for 1 min twice using a Retsch MM400 mixer mill and with the aid of two 3-mm stainless steel metal balls, followed by 5-min sonication in an icy water bath. The samples were then centrifuged in a micro-centrifuge at 12,500 rpm and 4oC for 10 min. A 300-μL aliquot of the supernatant was transferred into a 3-mL borosilicate glass test tube and mixed with 300 μL of water and 900 μL of hexane. After 1 min vortex mixing, the tubes were centrifuged at 4000 rpm and 10 oC in a Beckman R22 centrifuge to separate the supernatant organic phase from the lower aqueous phase. The supernatants were carefully pipetted out to another sets of 3-mL test tubes. The fat-soluble vitamins were further extracted from the aqueous phase with 900 μL of hexane two more times. After liquid-liquid extraction, the pooled organic phase for each sample was dried down in a speed-vacuum concentrator at room temperature. The dried residue was reconstituted in 100 μL of ethanol. A 20-μL aliquot was injected for quantitation of the fat-soluble vitamins by LC-(+)ESI-MRM/MS on Waters BEH C18 (2.1 x 50 mm, 1.7 μm) UPLC column and with 0.1% formic acid in water and acetonitrile as the mobile phase for binary solvent gradient elution. An efficient elution gradient was 50% to 100% B in 10 min. The column temperature was 50oC and the flow rate was 300 μL/min. The aqueous phases were loaded onto reversed-phase polymeric HLB cartridges (60 mg/1mL, Waters Inc.), which have been activated with 1 mL of methanol and equilibrated with 1 mL of 50% methanol before use. Under a 5-inch Hg vaccum, the flow-throw fractions were collected and the resins were washed with 1 mL of 50% methanol with the flow-through fractions collected. The pooled flow-through fractions were dried in a nitrogen evaporator at 30 oC. The residue from each sample was reconstituted in 100 μL of 2% methanol. A 20-μL aliquot was injected for quantitation of the water-soluble vitamins by UPLC-MRM/MS with (+) or (-) ESI and on a Waters BEH C18 (2.1 x 150 mm, 1.7 μm) UPLC column and using 0.01% formic acid in water and methanol as the mobile phase for binary solvent gradient elution. The efficient elution gradient was 2% B for 0.5 min and 2% to 50% B in 8 min. The column temperature was 30 oC and the flow rate was 250 μL/min. The concentrations of all the detected vitamins were calculated from the standard calibration curves of individual vitamins, which were prepared with the use of their authentic compounds.