

Supplementary Information

Smartphone for Point-of-Care Quantification of Protein by Bradford Assay

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Analytical curve

As highlighted in the article, we deployed a homemade Android app in Java programming language for the accomplishing two steps in the smartphone: construction of the analytical curve from standards of protein and application to real samples. The equations related to the accomplishment of the analytical curves and their parameters were calculated by the smartphone as:¹

$$a = \overline{Y_{(i)}} - b\overline{X_{(i)}} \quad (S1)$$

$$b = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sum X^2 - \frac{(\sum X)^2}{n}} \quad (S2)$$

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left(\sum X^2 - \frac{(\sum X)^2}{n}\right)\left(\sum Y^2 - \frac{(\sum Y)^2}{n}\right)}} \quad (S3)$$

$$R^2 = r^2 \quad (S4)$$

$$Dp = \sqrt{\text{Variance}} \quad (S5)$$

$$\text{LOD} = \frac{3 \times Dp}{b} \quad (S6)$$

$$\text{LOQ} = \frac{10 \times Dp}{b} \quad (S7)$$

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where a, b, X, Y, n, R² and Dp represent the following parameters: linear and angular coefficients of the analytical curve, protein concentration, analytical signal, number of measurements for each standard, coefficient of determination, and standard deviation, respectively.

Application

Tables S1 to S3 display the resulting concentrations of protein in human plasma samples obtained by the commercial spectrophotometer and smartphone (conditions A and B according to the main text of the article). Each table refers to analyses in different days. In addition, Tables S4 to S6 present the accuracy data for the analyses recorded by the smartphone in relation to the conventional method in different days. Lastly, Tables S7 and S8 show the relative standard deviations that were observed in the analytical curve parameters for the different days of analyses.

Table S1. Concentrations of protein in human plasmas achieved by the conventional method and smartphone. Confidence intervals were calculated for $\alpha = 0.05$ and $n = 3$ (day 1)

Sample	Spectrophotometer / (mg mL ⁻¹)	Smartphone / (mg mL ⁻¹)	
		Condition A ^a	Condition B ^a
S ₁	0.59	0.44 ± 0.01 and 0.51 ± 0.04	0.42 ± 0.01 and 0.47 ± 0.01
S ₂	0.58	0.55 ± 0.06 and 0.60 ± 0.05	0.46 ± 0.01 and 0.50 ± 0.01
S ₃	0.76	0.67 ± 0.01 and 0.69 ± 0.01	0.68 ± 0.01 and 0.67 ± 0.01
S ₄	0.46	0.48 ± 0.08 and 0.54 ± 0.06	0.39 ± 0.04 and 0.45 ± 0.03
S ₅	0.40	0.30 ± 0.02 and 0.40 ± 0.01	0.42 ± 0.04 and 0.47 ± 0.11
S ₆	0.55	0.45 ± 0.02 and 0.52 ± 0.01	0.53 ± 0.04 and 0.56 ± 0.03

^aThe content values relative to wide and short linear ranges are presented, respectively.

Table S2. Concentrations of protein in human plasmas achieved by the conventional method and smartphone. Confidence intervals were calculated for $\alpha = 0.05$ and $n = 3$ (day 2)

Sample	Spectrophotometer / (mg mL ⁻¹)	Smartphone / (mg mL ⁻¹)	
		Condition A ^a	Condition B ^a
S ₁	0.61	0.49 ± 0.05 and 0.50 ± 0.04	0.47 ± 0.02 and 0.53 ± 0.02
S ₂	0.60	0.59 ± 0.14 and 0.58 ± 0.12	0.52 ± 0.03 and 0.57 ± 0.03
S ₃	0.76	0.67 ± 0.06 and 0.66 ± 0.05	0.70 ± 0.02 and 0.72 ± 0.02
S ₄	0.55	0.59 ± 0.10 and 0.58 ± 0.09	0.54 ± 0.13 and 0.59 ± 0.10
S ₅	0.48	0.40 ± 0.02 and 0.42 ± 0.01	0.37 ± 0.02 and 0.46 ± 0.01
S ₆	0.56	0.49 ± 0.03 and 0.50 ± 0.03	0.49 ± 0.04 and 0.55 ± 0.03

^aThe content values relative to wide and short linear ranges are presented, respectively.

Table S3. Concentrations of protein in human plasmas achieved by the conventional method and smartphone. Confidence intervals were calculated for $\alpha = 0.05$ and $n = 3$ (day 3)

Sample	Spectrophotometer / (mg mL ⁻¹)	Smartphone / (mg mL ⁻¹)	
		Condition A ^a	Condition B ^a
S ₁	0.62	0.55 ± 0.01 and 0.57 ± 0.01	0.45 ± 0.03 and 0.50 ± 0.03
S ₂	0.59	0.70 ± 0.03 and 0.67 ± 0.02	0.47 ± 0.02 and 0.53 ± 0.02
S ₃	0.80	0.86 ± 0.01 and 0.78 ± 0.01	0.78 ± 0.01 and 0.75 ± 0.01
S ₄	0.51	0.73 ± 0.02 and 0.69 ± 0.01	0.58 ± 0.04 and 0.59 ± 0.03
S ₅	0.47	0.40 ± 0.04 and 0.47 ± 0.02	0.34 ± 0.01 and 0.41 ± 0.01
S ₆	0.56	0.58 ± 0.11 and 0.60 ± 0.07	0.50 ± 0.02 and 0.53 ± 0.01

^aThe content values relative to wide and short linear ranges are presented, respectively.

Table S4. Accuracy for the analyses recorded by the smartphone in relation to the conventional method. The data that were consistent with those of the spectrophotometer according to Student's *t*-tests at 95 and 99% confidence level are highlighted in blue and green, respectively (day 1)

Sample	Accuracy / %	
	Condition A ^a	Condition B ^a
S ₁	74.6 and 86.4	71.2 and 79.7
S ₂	94.8 and 103.4	79.3 and 86.2
S ₃	88.2 and 90.8	89.5 and 88.2
S ₄	104.3 and 117.4	84.8 and 97.8
S ₅	75.0 and 100.0	105.0 and 117.5
S ₆	81.8 and 94.5	96.4 and 101.8

^aThe content values relative to wide and short linear ranges are presented, respectively.

Table S5. Accuracy for the analyses recorded by the smartphone in relation to the conventional method. The data that were consistent with those of the spectrophotometer according to Student's *t*-tests at 95 and 99% confidence level are highlighted in blue and green, respectively (day 2)

Sample	Accuracy / %	
	Condition A ^a	Condition B ^a
S ₁	80.3 and 82.0	77.0 and 86.9
S ₂	98.3 and 96.7	86.7 and 95.0
S ₃	88.2 and 86.8	92.1 and 94.7
S ₄	107.3 and 105.5	98.2 and 107.3
S ₅	83.3 and 87.5	77.1 and 95.8
S ₆	87.5 and 89.3	87.5 and 98.2

^aThe content values relative to wide and short linear ranges are presented, respectively.

Table S6. Accuracy for the analyses recorded by the smartphone in relation to the conventional method. The data that were consistent with those of the spectrophotometer according to Student's *t*-tests at 95 and 99% confidence level are highlighted in blue and green, respectively (day 3)

Sample	Accuracy / %	
	Condition A ^a	Condition B ^a
S ₁	88.7 and 91.9	72.6 and 80.6
S ₂	118.6 and 113.6	79.7 and 89.8
S ₃	107.5 and 97.5	97.5 and 93.8
S ₄	143.1 and 135.3	113.7 and 115.7
S ₅	85.1 and 100.0	72.3 and 87.2
S ₆	103.6 and 107.1	89.3 and 94.6

^aThe content values relative to wide and short linear ranges are presented, respectively.

Table S7. Relative standard deviations for linear coefficients related to the analytical curves obtained in different days of analyses

Analytical curve	Smartphone / %	
	Condition A	Condition B
Wide linear range	-29.1	-12.5
Short linear range	-11.6	-13.6

Table S8. Relative standard deviations for angular coefficients (analytical sensitivity) related to the analytical curves obtained in different days of analyses

Analytical curve	Smartphone / %	
	Condition A	Condition B
Wide linear range	10.4	4.3
Short linear range	3.5	5.7

Reference

1. Skoog, D. A.; Holler, F. J.; Nieman, T. A.; *Princípios de Análise Instrumental*, 5^a ed.; Bookman: Porto Alegre, 2002.