Electronic Supplementary Material (ESI) for Analyst.

Electronic Supplementary Material

Highly sensitive and selective optosensing of quercetin based on novel complexation with yttrium ions

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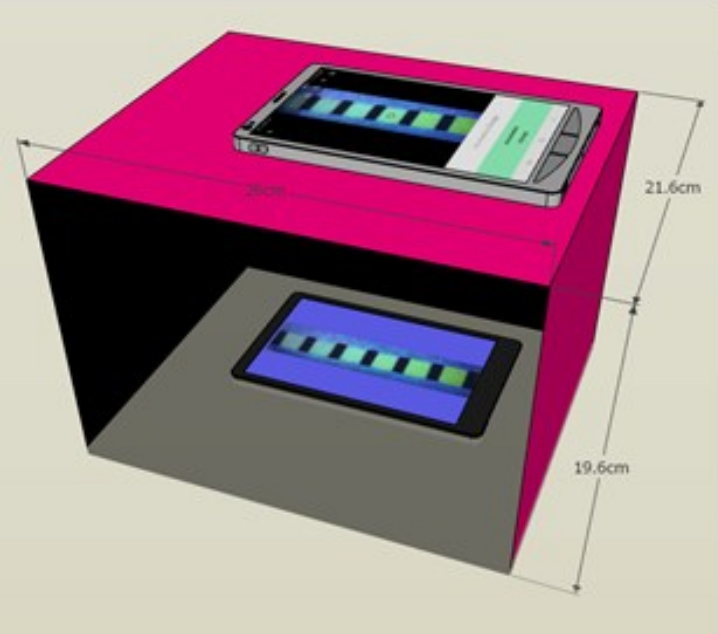


Figure S1: Illustration for the detection of QC using a smartphone.

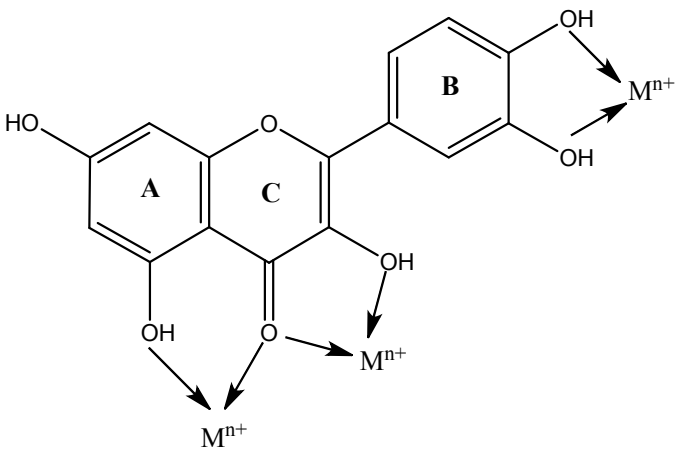


Figure S2. Possible chelating sites of quercetin.

^{1}H-NMR spectra of the samples

Ligand/Complex	19-OH	22-OH	17-OH	20-OH	21-OH	11-H	16-H	18-H	9-H	10-H
Quercetin	12.5	10.80	9.62	9.35	9.33	7.68	7.54	6.8	6.41	6.19
Quercetin-Y^{3+}	12.49	11.03	9.71	9.37	_	7.68	7.56	6.92	6.48	6.23

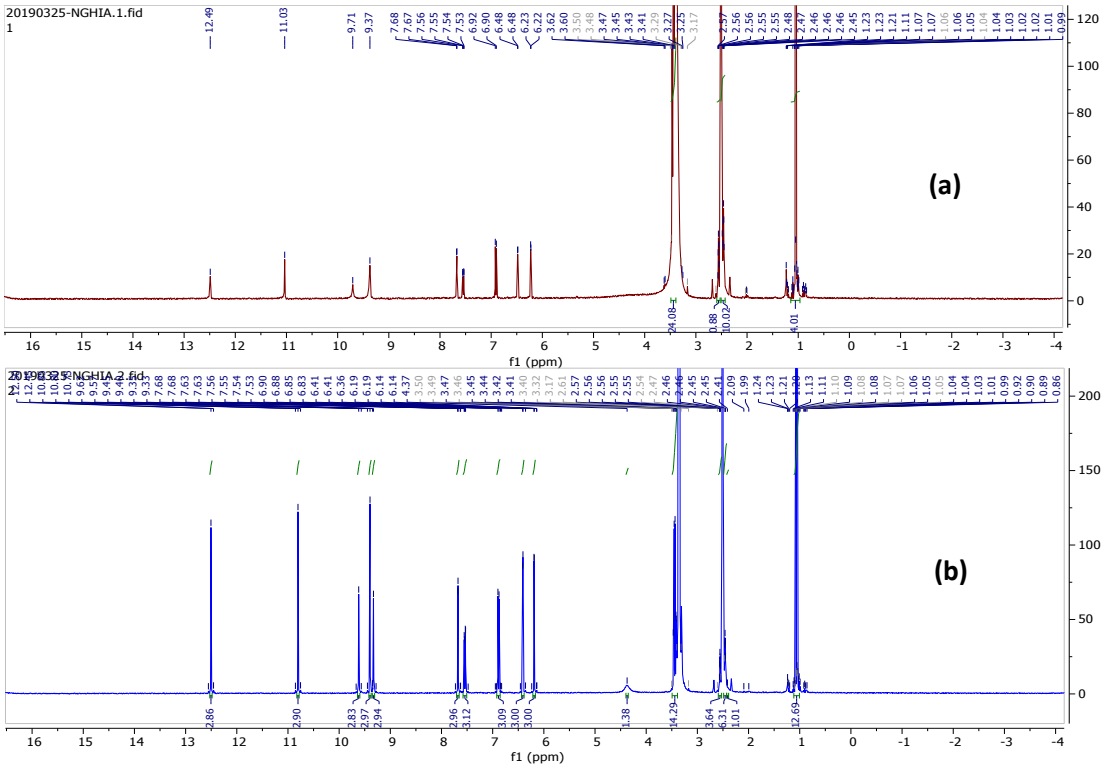


Figure S3. ^{1}H- NMR spectra of quercetin (a) with, and (b) without Y(III).

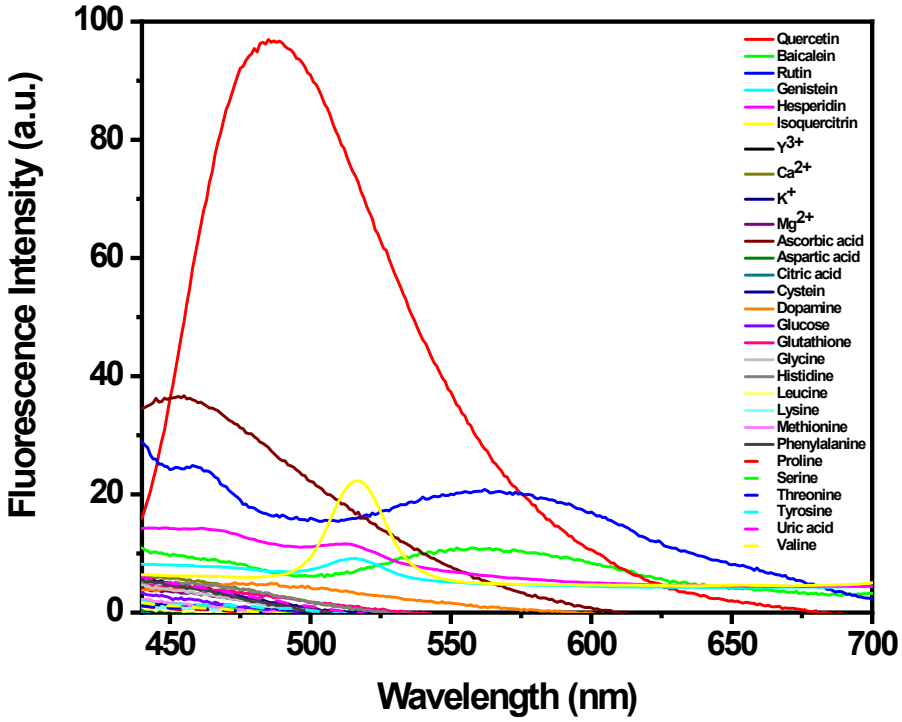
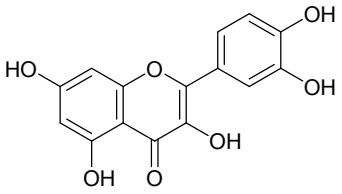
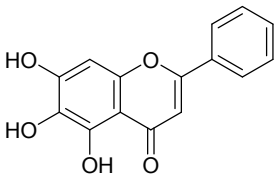


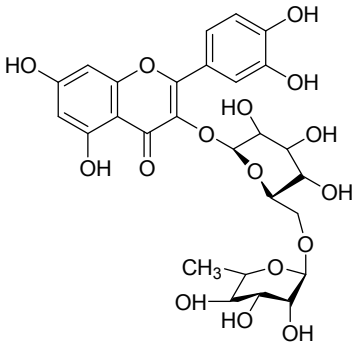
Figure S4: Selectivity of method for quercetin in the presence of Ca^{2+}, K^{+}, Mg^{2+}, Ascorbic acid, Aspartic, Citric acid, Glucose, Glutathione, Histidine, Leucine, Lysine, Methionine, Phenylalanine, Proline, Threonine, Tryptophan, Tyrosine, Serine, Valine, uric acid, dopamine, Cysteine, Glycine, Bacailein, Rutin, Hesperidin, Genistin, and Isoquercetin.



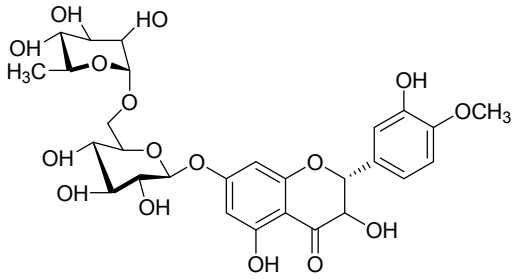
Quercetin



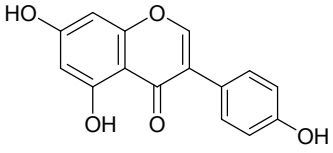
Baicalein



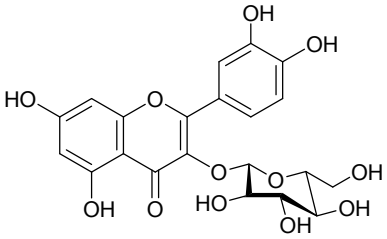
Rutin



Hesperidin



Genistein



Isoquercetin

Chemical structure of quercetin and other flavonoids.

Design device measuring fluorescence intensity based on photodiode-Arduino

A photodiode (FDS100, Thorlab company, USA) was used to measure fluorescence intensity from PADs by converting optical power to electrical current. The photodiode circuit was set up as user manual with anode and cathode connection. The photodiode anode generates a current that is a function of the incident light intensity and the wavelength. A load resistor (R_L) is placed from the photodiode anode to the circuit ground to convert this current to voltage. By measuring the voltage of R_L uses Arduino voltmeter circuit. The result of voltage is monitored on LCD screen.

Under the excitation of UV-LED, the fluorescence intensity from PADs will change in the case of different concentration of quercetin. This optical signal will be converted to voltage values, which are observed on LCD monitor. As a result, the quercetin concentration is proportional to the voltage signal.

Additionally, a longpass filter with cut-on wavelength of 395 nm (Edmundoptics, Korea) was inserted between PAD and FDS100 to reject light with wavelength of 365 nm from UV-LED to FDS100. Using this filter, the obtained optical signal relates to the fluorescence of PAD. A switch was installed to turn on/off the power supply of FDS100 and a cover part was designed to ensure the dark space while measurement.

Information for the custom-built homemade reader

Table S1 and S2 list the components and their usage for the proposed system.

Table S1. Hardware components used in custom-built homemade reader.

Icon	Hardwarde	Description	Use
	Arduino Uno R3	A board based on the ATmega328P microcontroller, having 14 digital input/output pins (6 analog inputs, a quartz crystal of 16 MHz, a USB connection, a power jack, an ICSP header and a reset button)	Programming and connecting the board to control UV LED, photodiode and measure the voltage value from load resistor (R_L)
	20x4 LCD with I2C	A liquid-crystal display (LCD) is a flat panel display, digital visual display. It connects to Arduino Uno via an I2C	Display the values of measurement on it

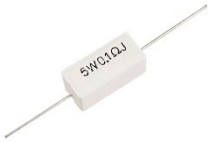
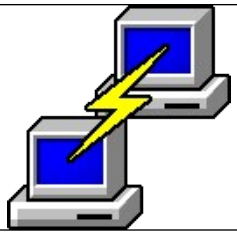
	FDS100	Si photodiode	Convert optical power to electrical current
	Resistor 1kΩ (R_1)		Reduce voltage levels, also current flow in circuits
	Load resistor 5W0.1ΩJ (R_L)		Where the electrical current from FDS100 is converted to a voltage
	Ceramic capacitor 0.1μF		Store electrical energy in an electric field
	AA Duracell battery		Supply power for FDS100
	Longpass filter Schott GG-395 (Edmundoptics company in Korea)	Cut-On Wavelength (nm): 395	Transmit longer wavelengths than the cut-on wavelength and reject shorter wavelengths by using either absorption or reflection

Table S2. Software for the custom-built homemade reader.

Icon	Software	Description	Use

	Arduino Software (IDE)	The open-source Arduino Software (IDE) to write code and upload it to the board.	To write the code for Arduino board
	PuTTY	PuTTY is a client program for the SSH, Telnet and Rlogin network protocols.	Export data from Arduino Uno to CSV file

The detailed electrical connections are as follows:

I2C LCD Display to Arduino Uno

Pin GND (I2C LCD) to pin GND (Arduino Uno).

Pin VCC (I2C LCD) to pin 5V (Arduino Uno).

Pin SDA (I2C LCD) to pin A4 (Arduino Uno).

Pin SCL (I2C LCD) to pin A5 (Arduino Uno). *UV led to Arduino Uno*

Positive charge (UV led) to pin 13 (Arduino Uno).

Negative charge (UV led) to pin GND (Arduino Uno).

Photodiode (FDS100) to Arduino Uno

Positive charge (FDS100) to pin A0 (Arduino Uno).

Negative charge (FDS100) to pin GND (Arduino Uno).

Code

The Arduino is controlled by code written with the open-source Arduino Software (IDE). To use the I2C LCD, select Tools/Manage Libraries from menu of the Arduino IDE and then install LiquidCrystal_I2C.

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27,20,4);  // set the LCD address to 0x27 for a 16 chars and 2 line display

const int analogIn = A0;

int RawValue= 0;
```

```
float Voltage = 0;
int LED1 = 13;
void setup()
{
  pinMode(LED1, OUTPUT);
  digitalWrite(LED1, HIGH);    // turn on LED1
   lcd.init();                    // initialize the lcd
  lcd.init();
  lcd.backlight();
  lcd.setCursor(3,0);
  lcd.print("ANASTRO LAB");

  pinMode(analogIn, INPUT);
  Serial.begin(9600);
}
void loop(){
//digitalWrite(LED1, HIGH);    // turn on LED1
  RawValue = analogRead(analogIn);
  Voltage = (RawValue * 5.0 )/ 1024.0; // scale the ADC
  Serial.print("Raw Value = " );  // shows pre-scaled value
  Serial.print(RawValue);
```

```
Serial.print("\t Voltage = "); // shows the voltage measured

Serial.println(Voltage,5); //3 digits after decimal point

 lcd.setCursor(0,1);

lcd.print("Voltage=");

lcd.print(Voltage,5);

delay(500);   // 1/2 sec so your display doesnt't scroll too fast

}
```

Performing experiment

- Connect device with computer by USB cable.
- Turn on the power supply of FDS100.
- Insert PAD into a slit between FDS100 and UV LED to measure voltage values, then insert a cover part to assure the dark space for measurement.
- Using PuTTY software to export data to CSV file.