



# PORTABLE SPECTROPHOTOMETERS

7 APPLICATIONS WHERE PORTABLE MAKES YOUR LAB  
MORE ACCURATE, MORE PRODUCTIVE, MORE  
FRUGAL, AND MORE FUN.



SINCE 1889



# INTRODUCTION

A spectrophotometer is an instrument that measures the amount of photons (the intensity of light) absorbed after it passes through sample solution. It is used to measure concentrations of samples in solutions.

Spectrophotometers may be used to estimate the number of cells suspended in a medium - like yeast cells in a solution. As all particles in suspension scatter light, yeast cells in solution will also scatter light as they grow, causing the solution to appear cloudy. As the turbidity (cloudiness) of the solution increases, less light will reach the photodetector.

A spectrophotometer is typically a heavy (20-30 Kg) shoe box sized piece of equipment that uses an outlet and adapter to power itself. You find a spot in your lab for it and call that home base for every test you need to run through it.



But there are inefficiencies inherent in every lab instrument that needs to spend its entire working life in one location, and with large spectrophotometers in general.

- Technicians have to transport samples from one location to the test location.
- High-traffic instruments create bottlenecks in the lab.
- Lab space is limited and choosing what instrument takes up valuable benchtop space is challenging.
- (Relatively) large volumes of sample are required and often wasted in the tests.



Most labs can overcome these challenges, however, by investing in unique and powerful portable spectrophotometers. They're new on the market and few manufacturers make them as of January 2022. But these instruments can perform the same tests as larger instruments - but consume less space in the lab and less sample per test. And they streamline the workflow of every operator using them.

Instead of using a 30 Kg benchtop spectrophotometer, equip technicians in your lab with a portable and lightweight spectrophotometer at around 200 grams and see how efficiency and job satisfaction improves.

This guide will explore the common applications where a portable spectrophotometer has the largest impact on lab operations, and help you figure out if your operators' jobs can be made easier by switching from a benchtop unit to a portable spectrophotometer.

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# FEATURES TO LOOK FOR IN A PORTABLE SPECTROPHOTOMETER



Spectrophotometers, both benchtop and portable, should meet certain standards of operation.

Spectrophotometers are required to perform concentration analyses with high accuracy and precision.

Benchtop spectrophotometers, although commonly known and visible in public and private labs across the planet, will likely phase out entirely over the next two decades as portable spectrophotometers become increasingly versatile and robust, and are proven effective in an increasing number of applications.

Portable spectrophotometers can perform the same high quality tests that benchtop spectrophotometers perform, with:

- Easier handling
- Lower power consumption
- Equal or faster data processing

A benchtop spectrophotometer might take 15 minutes to warm up. Big gains in productivity in your lab can come from the portable spectrophotometer being ready to perform tests now. A unit like Yamato's PiCOEXPLORER can perform tests as needed as long as the work environment is:

- Between 5°C and 35°C
- At an altitude lower than 2000m
- Indoors
- With a pollution degree 2 environment (your lab already is).



## SENSITIVITY

Look for a highly sensitive absorbance sensor with a built-in LED light. How do you know a portable spectrophotometer can perform at the high sensitivity it claims? Look at the manufacturer's website for any mention of Silicon Optical Technology (SOT). This is a new type of data transfer technology that uses optical rays instead of electrical semiconductors. SOT means:

- More data.
- Faster.
- Lower power consumption.
- Lower weight.
- Higher sensitivity

A built-in LED light, instead of a traditional halogen light as found in many benchtop instruments, keeps power consumption and instrument weight down while supporting the high sensitivity of the sensors and SOT architecture.



# CONNECTIVITY

The latest portable spectrophotometers offer bluetooth connection to mobile phones and computers, for easy data transferring.



## WHY BLUETOOTH INSTEAD OF WIFI? BLUETOOTH IS SIMPLE AND HIGHLY SECURE IN YOUR LAB.

- Bluetooth doesn't require a password for data transfer, making it simple for operators.
- Bluetooth only has a range of about 30 feet so despite not requiring a password, it remains a safe and secure format for your sensitive data.
- Bluetooth is universal. Very few devices do not support Bluetooth.
- Bluetooth is stable. WiFi signals can vary in strength and shut down unexpectedly (like during your Friday night binge of season 3 of The Office on Netflix). Bluetooth doesn't.



# SPEED

Standing around waiting for test results is a poor use of time, and it makes most operators feel like their days are dragging on. Slow measurements take momentum out of the workflow and actually increase the potential of operator error.

So the faster measurements come in, the better off everybody in the lab is. A fast portable spectrophotometer:

- Reduces operator error
- Increases workplace productivity
- Keeps operators happy and engaged
- Adds to your labs profitability

A portable spectrophotometer should take measurements in under 5 seconds. The best of them can measure samples right out of the PCR tube in under 1 second. This should include all the raw data, including:

- Absorbance
- Concentration
- Intensity



## POWER CONSUMPTION

Power consumption doesn't come into the equation for most benchtop spectrophotometers. Some draw marginally less energy to perform tests and save your lab budget through long-term savings vs competing models, but generally the savings are small.

A portable spectrophotometer has to draw very small amounts of energy. You can't go around carrying a Ghostbuster-sized battery pack to get your job done around the lab or in the field.

So look for simple things like:

- Does it use batteries?
- Does it charge via USB or micro-USB or USB-C?
- Does it come with a wall adapter?

Yamato's PiCOEXPLORER portable spectrophotometer, for example, uses 3 AAA batteries or runs via micro-USB connector connected to a power source like a computer or a wall adapter.

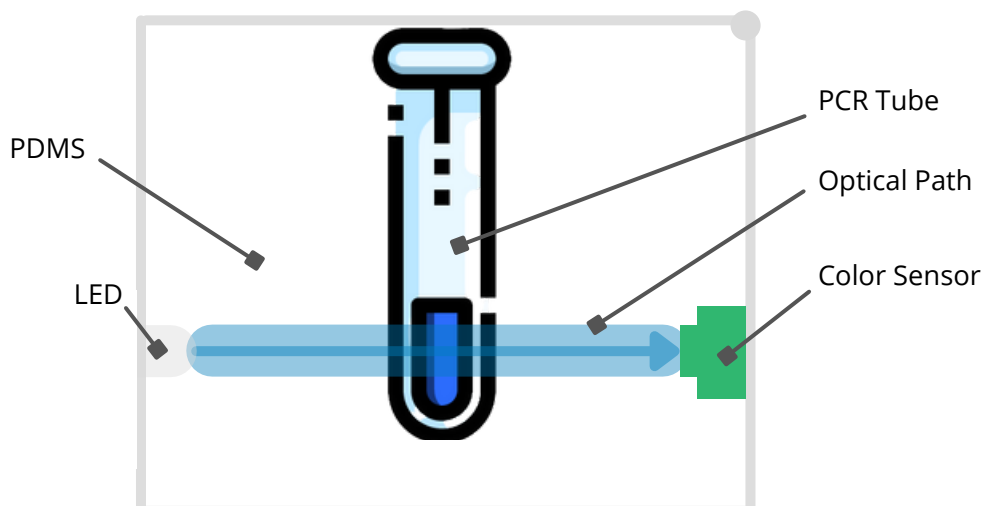
# SAMPLE PRESERVATION

The ability to perform measurements on unopened PCR tubes is a major determining factor for many labs. If your samples can stay closed for your tests, you don't waste any precious sample.

Plus...

- You can perform unlimited repetitive measurements of the same sample.
- You prevent 100% of contamination risks to your sample.
- You reduce sample losses by 100%.
- You decrease overall pollution and environmental errors.
- You eliminate operator contamination of precious samples when collecting them back from the spectrophotometer.
- You take steps out of the testing workflow, increasing overall productivity in the lab.

## DETECTOR





## ADVANTAGES AND DISADVANTAGES OF GOING PORTABLE IN YOUR APPLICATION



## MEASUREMENT OF BACTERIAL TURBIDITY

The turbidity measurement of microbial cultures is a widely used method to determine the cell number of growing microorganisms in a culture. These studies are important for several industries, ranging from food to patient care.

Portable spectrophotometers have been shown to excel in studying the optical density of microbial cultures and taking turbidity measurements with a high degree of accuracy.

In fact, recent studies say new portable spectrophotometers are more accurate and efficient for bacterial turbidity measurements than “one-drop” and traditional spectrophotometers. Yamato’s PiCOEXPLORER, for example, has greater accuracy than “one-drop” spectrophotometers, without the need of dilution, unlike conventional spectrometers.

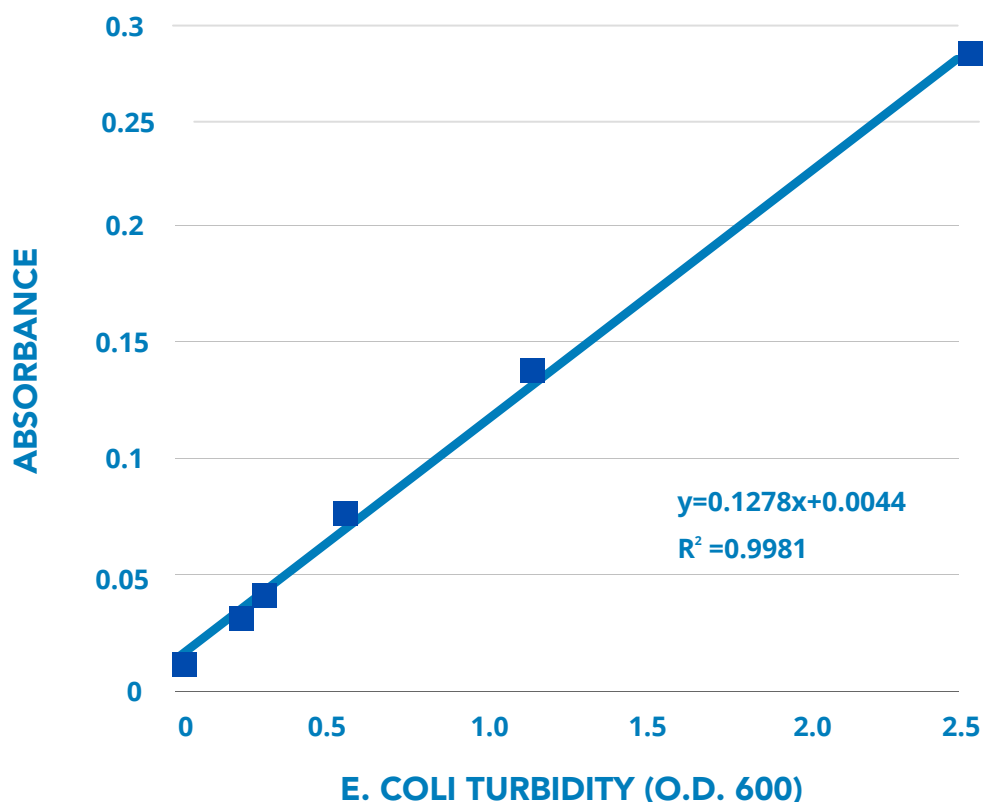
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Yurika Takahashi, of the Biotechnology Research Center and Department of Biotechnology at Toyama Prefectural University, with the help of PiCOEXPLORER in her routine work in measuring optical density, found that:



**“SINCE PCR TUBE HAS SHORT LIGHT PATH, I INFERRED THAT IT WOULD BE ABLE TO MEASURE DENSE SUSPENSION. HYPOTHESIS WAS PROVED, THAT PICOEXPLORER HAD AN ADVANTAGE OVER CONVENTIONAL SPECTROMETERS IN MEASURING DENSE SUSPENSION, AND IT WAS SUPERIOR TO “ONE-DROP” SPECTROMETERS IN THE ACCURACY.”**

If your portable spectrophotometer doubles as an accurate turbidity meter, you can expect calibration curves resembling this:





# PROTEIN QUANTIFICATION

Protein quantification is necessary to understand the total protein content in a sample or in a formulated product. Since proteins absorb light at a specific wavelength, a spectrophotometer can be used to directly measure the concentration of a purified protein in solution.

There are several ways to quantify proteins, but due to its ability to provide accurate determination of protein concentration and its compatibility with most protein sample types, protein laboratories around the world prefer the BCA assay over any other detergent-compatible assays.

However, there are circumstances when a Bradford assay is preferable to your application - maybe your sensitivity requirements are low or you want to perform a greater volume of tests faster. Your portable spectrophotometer should be equipped to perform both the:

- BCA assay
- Bradford Assay

## BCA METHOD

The principle of this method is that proteins can reduce  $\text{Cu}^{+2}$  to  $\text{Cu}^{+1}$  in an alkaline solution (the biuret reaction) and result in a purple color formation by bicinchoninic acid, thus changing its absorbance for the spectrophotometer to measure.

A portable spectrophotometer must be able to measure color sensors for green, blue, and red using the BCA method, with minimal variation between colors. Portable spectrophotometers have been tested in academic settings doing protein quantification with a high degree of confidence.

Norishige Yamada from the Center for Anatomical, Pathological and Forensic Medical Researches at the Graduate School of Medicine, Kyoto University commends Yamato's PiCOEXPLORER after noting increases in efficiency in his lab.

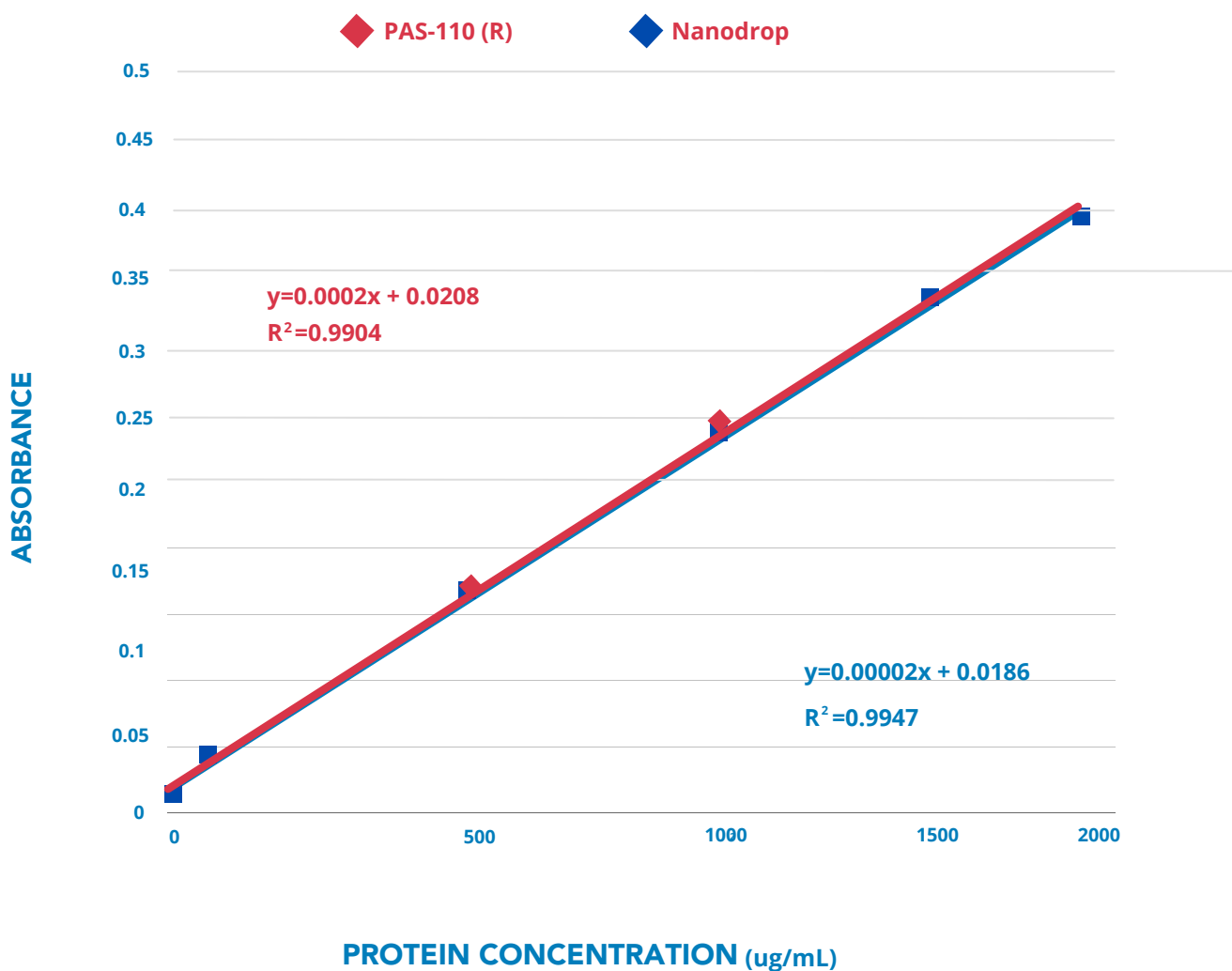


**"FORMERLY, I HAD TO PREPARE CALIBRATION CURVES AND CALCULATE SAMPLE CONCENTRATIONS USING EXCEL ETC., BUT THE PICOEXPLORER CAN PREPARE CALIBRATION CURVES AUTOMATICALLY, AND SAMPLES CAN BE QUANTIFIED IN JUST 1 OR 2 SECONDS. THIS IS EXTREMELY USEFUL. I ALSO LIKE THAT THE MINIMUM SAMPLE VOLUME REQUIRED FOR MEASUREMENT IS JUST 30 ML."**

## BRADFORD METHOD

The principle of this assay is that the binding of protein molecules to Coomassie dye under acidic conditions results in a color change from brown to blue, allowing for the spectrophotometer to measure the change in wavelength.

Accuracy is the challenge with the Bradford method. A portable spectrophotometer working in the wavelength range of 400-660nm will have the accuracy your lab requires. Your calibration curves should look something like this.





## MEASUREMENT OF ANTIOXIDANT ACTIVITY

With the modern environment containing several oxidative stressors, the food industry focuses on the antioxidant properties of their products.

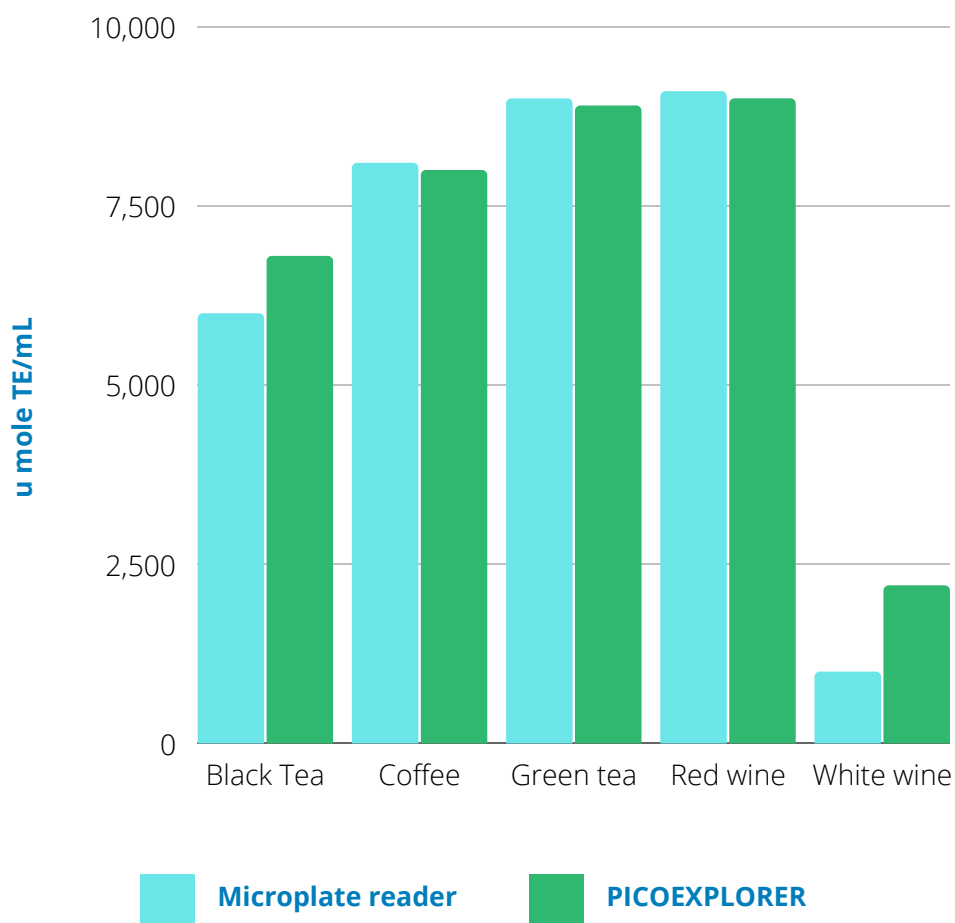
The DPPH assay is used to predict antioxidant activities by mechanism in which antioxidants act to inhibit lipid oxidation by the scavenging of DPPH radical and determining free radical scavenging capacity. This method results in a purple to yellow color change.

Using the DPPH radical elimination method and its color change, spectrophotometers are able to accurately and precisely quantify antioxidants in a sample.

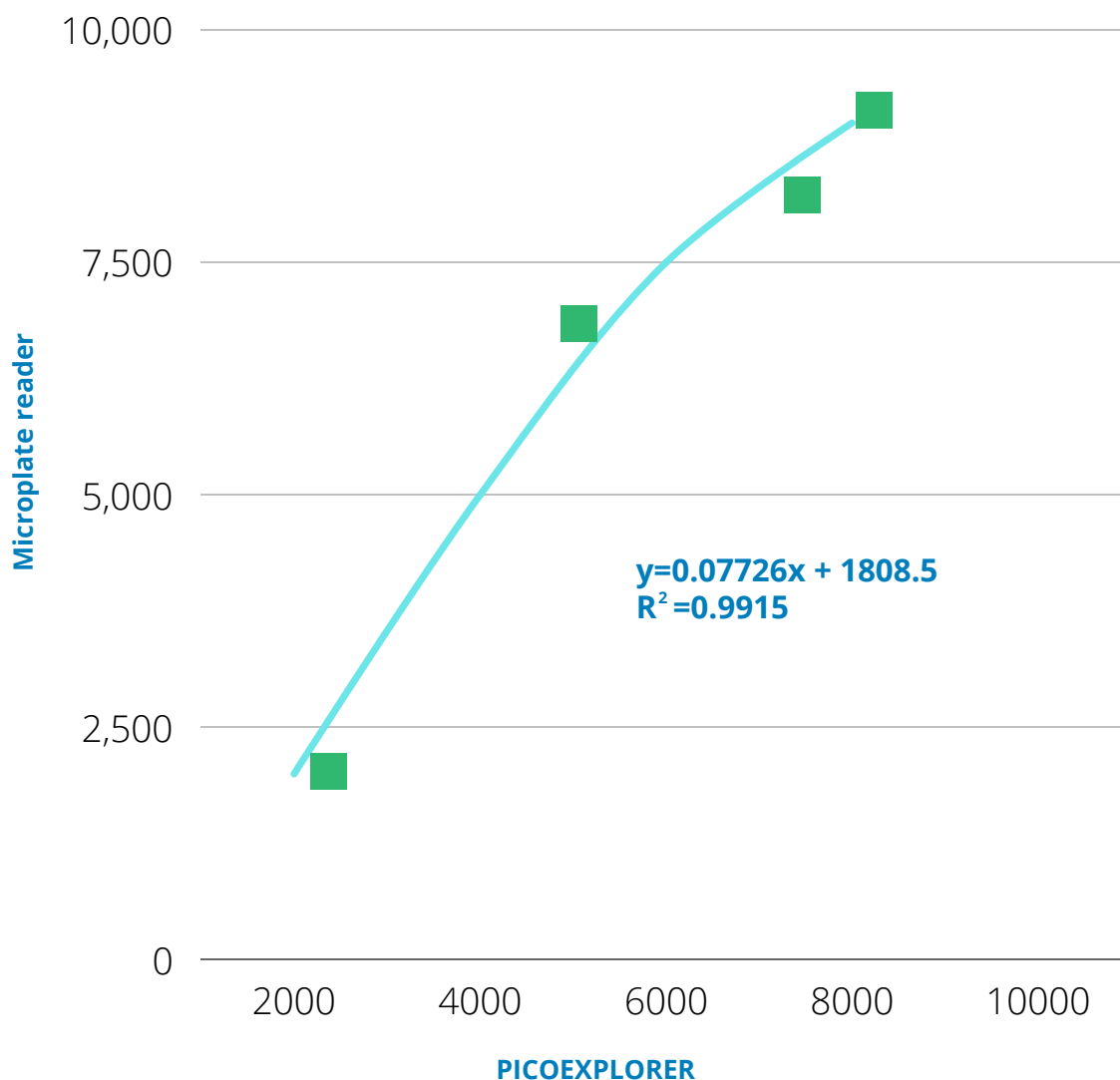
A portable spectrophotometer allows operators to perform these tests anywhere in the food industry quality control lab, reducing the potential for sample spoilage or contamination by technicians transporting samples carelessly.

Not all portable spectrophotometers are verified to work with antioxidant activity in food samples. To test your new portable unit, verify the quality of its results with a microplate reader. Some manufacturers already have this information available publicly. Always look for data on manufacturer website or in academic papers verifying your portable spectrophotometer's suitability to work with tea, coffee, wine, or other food samples:

## ■ RESULTS OF RADICAL ELIMINATION MEASUREMENT OF THE SAMPLES



## MEASUREMENT CORRELATION BETWEEN PICOEXPLORER AND MICROPLATE READER (u mole TE/mL)



Yuko Nakamura, of The Department of Food Research Institute at Tottori Institute of Industrial Technology, chooses Yamato's PiCOEXPLORER over more expensive equipment with similar performance benchmarks.

**"THE PRICES OF MEASUREMENT EQUIPMENT REMAIN HIGH. DUE TO THE HIGH PRICE, THE MICROPLATE READER THAT OUR LABORATORY OWNS IS UTILIZED. FROM THE RESULTS OF THIS EXPERIMENT, MEASUREMENT RESULTS OF ANTIOXIDANT PROPERTIES OF EACH FOOD SAMPLE WERE OBTAINED USING A PORTABLE PICOEXPLORER, AND IT WAS CONFIRMED THAT THERE WAS A HIGH DEGREE OF CORRELATION BETWEEN THE RESULTS OBTAINED BY THE PORTABLE UNIT AND THE EXPENSIVE MICROPLATE READER."**



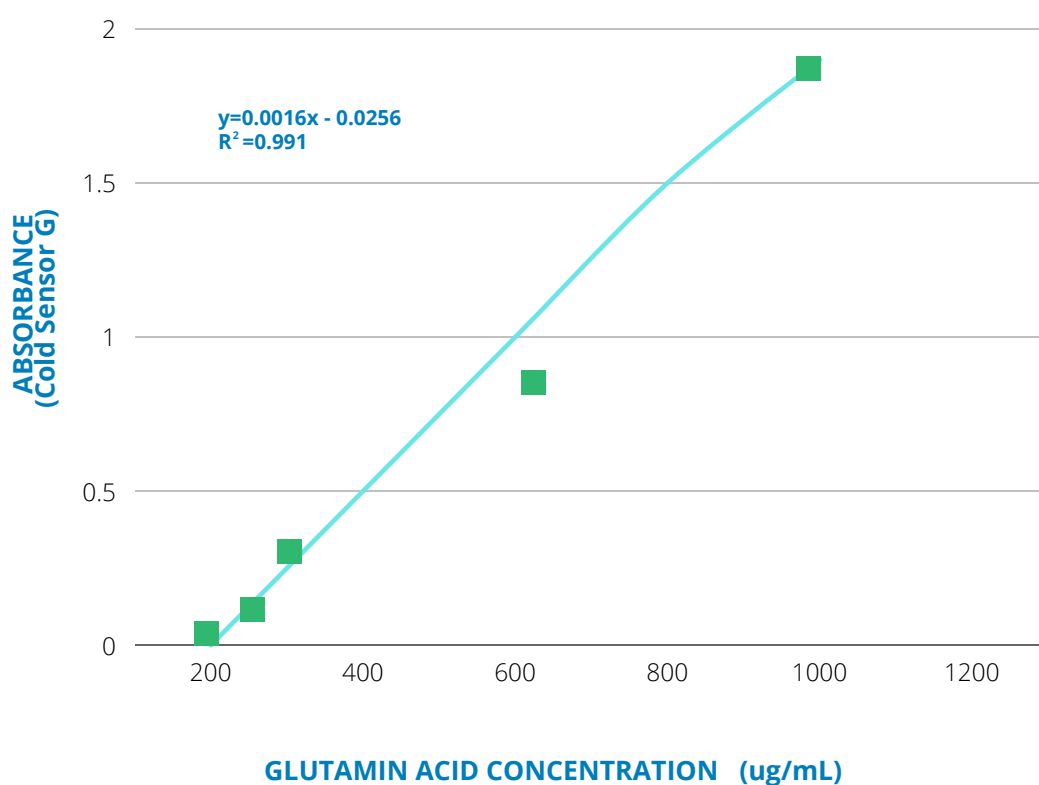
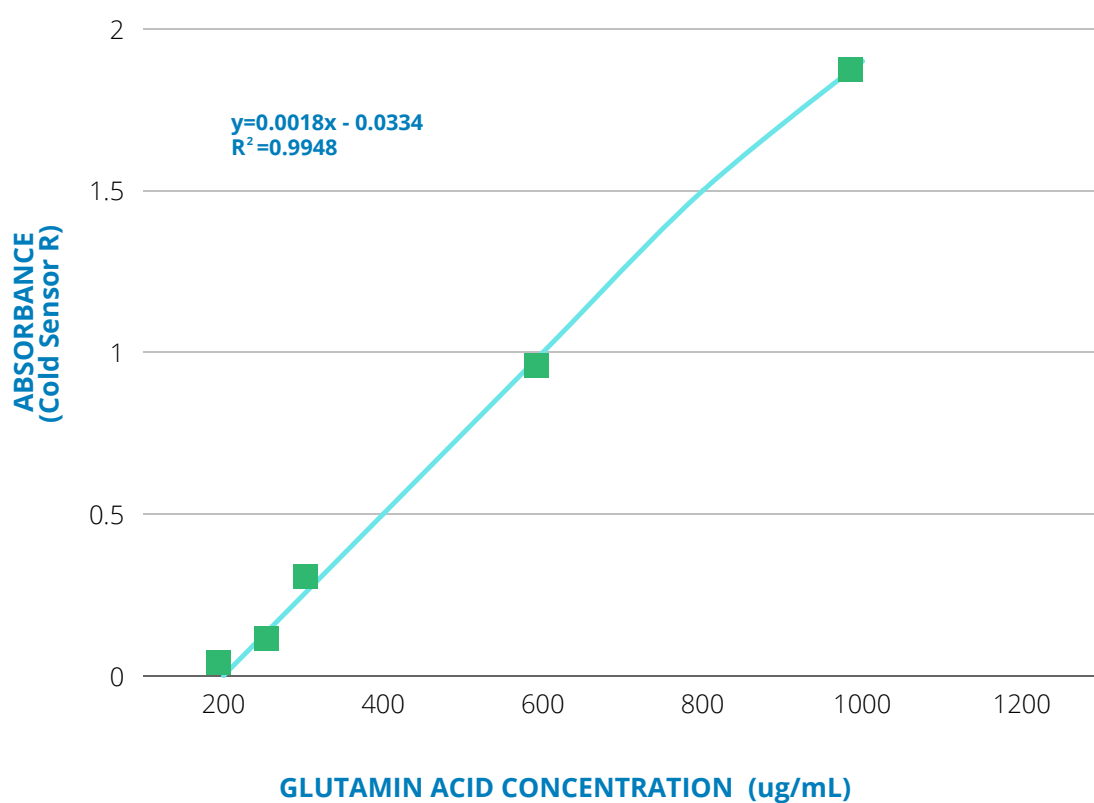
## AMINO ACID MEASUREMENT

Amino acid quantification has several uses in a laboratory. Protein and peptide-containing samples reveal the metabolic states of cells in several biological fluids. Accurately measuring the concentration of amino acids in any given sample is a delicate and important process.

A spectrophotometric method to quantify amino acids is based on the reaction between amino acids and syringaldehyde at pH 9.0, by which a color is developed with maximum absorption at 420 nm in aqueous methyl alcohol.

A portable spectrophotometer's absorbance sensor should be able to measure amino acids like glutamic acid with both red and green wavelength ranges, resulting in calibration curves like:

## CALIBRATION CURVES



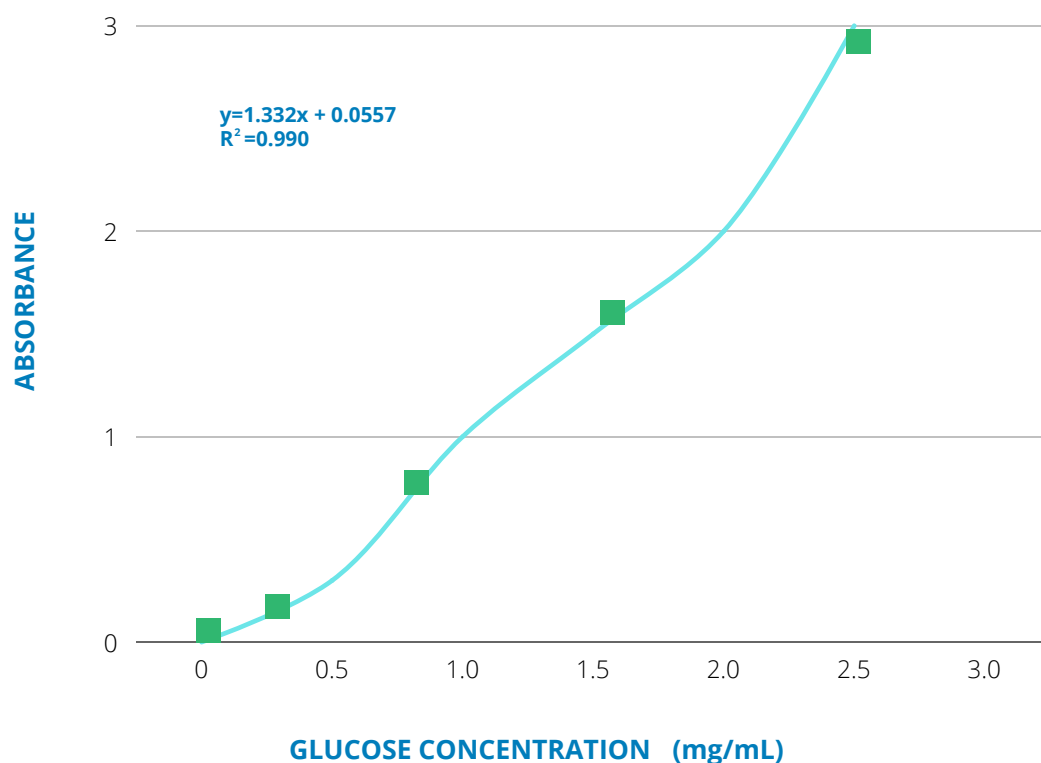
With a high sensitivity to trace residues of amino acids, both the forensics and micromolecule studies fields can benefit greatly from a portable spectrophotometer's advanced technology.



## QUANTIFICATION OF GLUCOSE

With 34.2million people in the USA suffering from diabetes, reducing sugar and glucose quantification studies are both common and important.

Portable spectrophotometers are used in small independent labs and large research institutions as highly sensitive absorbance meters for standardized glucose testing. Accuracy of a portable instrument like Yamato's PICOEXPLORER should be high, as demonstrated below:




Yukihiro Ito, an Associate Professor from the Environmental Biotechnology Lab, Environmental Bioscience Department at Tohoku University Graduate School of Agricultural Science, encourages students to get comfortable with portable spectrophotometers as they will be increasingly common as students enter the workforce.



**"WHILE OUR LAB IS EQUIPPED WITH A DROPLET-TYPE ABSORBANCE METER, WE OFTEN USE IT FOR DNA AND RNA MEASUREMENT, SO INTRODUCTION OF A PORTABLE INSTRUMENT FOR QUANTIFICATION OF GLUCOSE LETS US INCREASE THE OVERALL EFFICIENCY OF LABORATORY WORK. I THINK IT IS VERY IMPORTANT TO PROVIDE STUDENTS WITH AN ENVIRONMENT IN WHICH THEY CAN DEVOTE GREATER ATTENTION TO THEIR RESEARCH."**

Students also prefer working with a portable instrument that helps them perform tests quickly.

"When quantifying glucose, sometimes we will measure more than 100 samples at a time. Previously we had to do this using the droplet-type absorbance meter, so it was physically very challenging. Also, since the droplet-type absorbance meter was shared by everybody in the lab, users hesitated to monopolize it for two hours at a time. A portable unit enables measurements that are comparable to the droplet-type absorbance meter, and the way in which it enables measurement in tubes rather than measurement of a drop at a time makes the work much easier. Measurements are simple to take, don't require a lot of time, and measurement data can be managed in Excel, all of which contributes to greater work efficiency."



# ENVIRONMENTAL WATER AND HEAVY METAL ANALYSIS

## ENVIRONMENTAL WATER POLLUTION

Eighty percent of the world's wastewater is dumped back into the environment. The pollution affecting rivers, lakes, and oceans is jeopardizing human health. Unsafe water kills more people each year than war and all other forms of violence combined.

Studies further reveal the chemicals responsible for the pollution: "The sources that cause water environmental risks include mainly agricultural pollution, industrial pollution, and anthropogenic pollution. The main pollutants of agricultural pollution include nutrients such as nitrogen and phosphorus, organic pesticides, chemical fertilizers, and other organic or inorganic pollutants."

## HEAVY METALS

The heavy metals most commonly associated with poisoning of humans are lead, mercury, arsenic and cadmium. Heavy metal poisoning may occur as a result of industrial exposure, air or water pollution, foods, medicines, improperly coated food containers, or the ingestion of lead-based paints.

Heavy metals are associated to different degrees with a wide range of conditions, including kidney and bone damage, developmental and neurobehavioral disorders, elevated blood pressure and potentially even lung cancer.

# PORTABLE SPECTROPHOTOMETERS AND ENVIRONMENTAL TESTING



From classifying exact chemical components in a water source, to identifying the toxic levels of heavy metals, which can be detrimental at high doses. A portable spectrophotometer is as accurate as any tool in your lab. But with a few key differences:

- It's more affordable to operate than your existing testing instruments.
- It's better for your testing workflow as you move around the lab.
- Inexperienced operators can use it without the worry of skewed test results.

Yamato's PiCOEXPLORER is preferred among environmental testing labs because it quickly identifies toxic substances with a great degree of confidence and accuracy, and allows labs to act quickly in the case of toxic samples.



## CONCLUSION

You use your spectrophotometer for all kinds of daily tests in the lab. But you're limited by the speed of each test, the number of operators who share each one, and the space in your lab.

Portable spectrophotometers open up endless possibilities for your lab.

- More tests completed.
- Happier operators.
- Less wasted sample.
- Less rework.

They're already proven in some of your most common applications. Yamato's PICOEXPLORER, the emerging leader, already enables labs like yours to do more with less.

Whether you are ready to make a purchase or still need to do more research, Yamato Scientific America is here to help. Contact us at 1-800-292-6286 or email us at [customerservice@yamato-usa.com](mailto:customerservice@yamato-usa.com).