# Testing your Aquaponic System Water: A Comparison of Commercial Water Chemistry Methods


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Aquaponics involves the dynamic interaction of fish, plants, bacteria, and their aqueous environment. The fish and plants are dependent on the balance of dissolved nutrients and quality of the water, as they generate and utilize metabolic products from each other. It is this unique balance that leads to healthy animals and a productive crop. Because of the symbiotic uptake and release of nutrients from fish to plants, periodic monitoring of your aquaponic system water is essential. There are a multitude of commercially available water testing systems ranging from water test strips and kits to electronic meters. Both strips and kits can be obtained at local aquarium shops, while multiparameter aquaculture kits and electronic meters must be mail ordered. The choice(s) of which method to use can be particularly daunting, especially for those who are just starting in aquaponics. Are test strips any good for measuring pH or should I purchase a meter? Do I have to know how much nitrate is in my system and which is the best method to measure it? These are typical questions being asked of extension personnel and unfortunately there are no simple answers. Every person will be faced with a different situation (*e.g.*, type and number of systems, beginner, advanced) This publication will help guide your decision to choose the best method(s) for your needs, and is based upon information regarding availability, ease of use, accuracy, precision, and cost.

## What parameters to test?

Prior to obtaining the items for water testing, you should ask yourself the following:

- What water parameters affect the fish the most?
- What water parameters affect the plants the most?
- What water parameters affect the bacteria the most?
- How much do I want to spend, without compromising how “accurate” I need to be?

## Fish Culture:

The following water quality parameters are typically of highest importance to freshwater fish being raised under aquaculture conditions:

- Water temperature, which is measured in units of degrees Farenheight (°F) or Centigrade (°C).
- Dissolved oxygen (DO) is the amount of oxygen ($O_2$) dissolved in water and is measured in units of percent saturation or parts per million (ppm).
- pH is a measure of how acidic or basic the water. pH ranges from 1 - 14. A pH of 7 is neutral, below that is acidic, above that is basic.
- Buffering capacity or alkalinity refers to water's ability to keep the pH stable and is highly dependent on the amount of minerals dissolved in the water.
- Ammonia is the first product in the nitrogen cycle (Figure 1). In water it exists in two forms and together is known as Total Ammonia Nitrogen (TAN) and measured in units of mg/L or ppm. The two forms of ammonia are unionized ammonia ($NH_3$ or UIA) and ionized ammonia ($NH_4^+$ ). You should learn the differences between the two forms of ammonia because it is the unionized ammonia (UIA) that is most toxic to fish. Which form of ammonia is present in water is highly dependent on both temperature and pH.

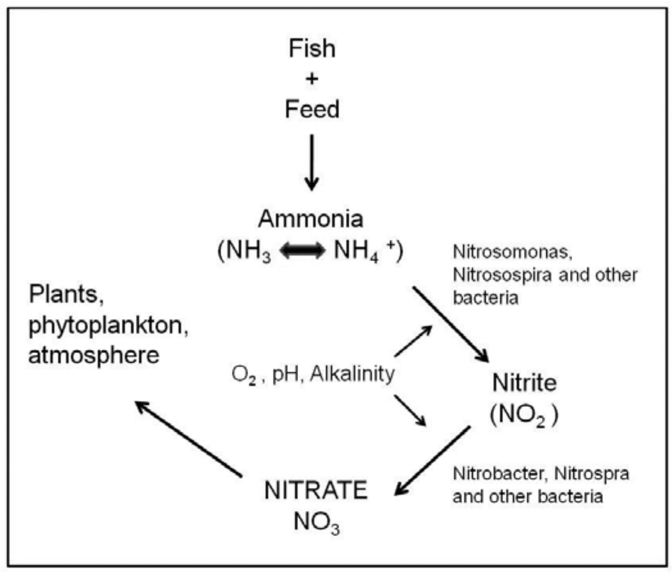


**Figure 1.** Schematic representation of the nitrogen cycle.

- Nitrite is the second product in the nitrogen cycle. Nitrite is a highly toxic substance that is produced by the oxidation of ammonia by bacteria. It is converted to the nontoxic form nitrate with biological filtration and measured as total nitrite or nitrite-nitrogen, dependent on the water chemistry test kit, in units of mg/Liter or parts per million (ppm).
- Nitrate, the final product in the nitrogen cycle, is usually not measured in an aquaculture setting as it is generally not toxic to freshwater fish and aquaculture test kits often do not carry the reagents to measure it.

## Plant Culture:

Sixteen chemical elements are known to be important to a plant's growth and survival. The sixteen chemical elements are divided into two main groups: non-mineral and mineral. The non-mineral nutrients are hydrogen (H), oxygen (O), & carbon (C) and these nutrients are found in the air and water. In a process called photosynthesis, plants use energy from the sun to change carbon dioxide ($CO_2$) and water ($H_2O$) into starches and sugars. These starches and sugars make up the plant's food.

The 13 mineral nutrients, which normally come from the soil, are dissolved in water and absorbed through a plant's roots. Not all of the mineral nutrients are routinely measured but are being presented to raise awareness of the essential elements necessary for plant growth. For a modest fee, the full spectrum of minerals from a water sample can be obtained by submitting sample(s) to an agricultural diagnostic service such as the one at the University of Hawaii at Manoa[1].

In an aquaponic setting, the majority of these mineral nutrients result from byproducts excreted by the fish. These mineral nutrients are divided into two groups: macronutrients and micronutrients. The macronutrients, required in large quantities, are:

- Nitrogen (N) - part of all living cells and a necessary component of all proteins.
- Phosphorus (P) - an essential part of the process of photosynthesis and in the formation of all oils, sugars and starches.
- Potassium (K) - helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.
- Calcium (Ca) - an essential part of plant cell wall structure and the transport and retention of other elements.
- Magnesium (Mg) - part of the chlorophyll in all green plants that is essential for photosynthesis.
- Sulphur (S) - essential for the production of proteins

Micronutrients, essential for plant growth but needed in small (micro) quantities are:

- Boron (B) - aids in the production of sugar and carbohydrates.
- Copper (Cu) - important for reproductive growth in plants.
- Iron (Fe) - essential for formation of chlorophyll.
- Chloride (Cl) - aids in plant metabolism.
- Manganese (Mn) - functions with enzyme systems involved in breakdown of carbohydrates, and nitrogen metabolism.
- Molybdenum (Mo) - helps in the use of nitrogen.
- Zinc (Zn) - essential for the transformation of carbohydrates.

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1 http://www.ctahr.hawaii.edu/site/adsc.aspx

In aquaponic systems, the ultimate source of both macro and micronutrients is fish food. The consumed food provides fish with energy and the essential building blocks for growth. The digestion and metabolic processes create waste products that are excreted via the fish's gills and digestive tract directly into the water. These waste products primarily consist of carbon dioxide and nitrogenous compounds, such as ammonia. In order to sustain a healthy environment, these substances must be removed from the aqueous environment. Most of the carbon dioxide is eliminated through aeration at the water surface and taken up by plants. The toxic nitrogenous compounds are converted to less toxic compounds via the nitrogen cycle (Figure 1). A group of bacteria known as nitrifiers (*e.g.*, Nitrosomonas and Nitrobacter) transform toxic ammonia into nitrite and then to nitrate via biochemical oxidation. The less toxic nitrate is the final end product after completion of biochemical oxidation that plants take up as fertilizer.

The complex inter-relationship between fish, plants and bacteria impact the water chemistry and are major reasons for periodically monitoring them, particularly when things appear "out of kilter". In an aquaponic setting total nitrate is added to the list of water chemistry parameters that are monitored most frequently:

- Water temperature (°F or °C)
- Dissolved oxygen (D.O.)
- pH
- Total Ammonia-Nitrogen or TAN
- Total Nitrite (see Box 1)
- Total Nitrate (see Box 1)

**Box 1.**

Both nitrite and nitrate are commonly reported as two kinds of values (units) with commercial test kits. Some kits measure the total nitrite ($NO_2$) and total nitrate ions ($NO_3$) while others measure the amount of nitrogen (N-) in the total nitrite or nitrate. Analogous to how temperature is measured in either degrees Fahrenheit or degrees Celsius, one must also be aware how your test kit measures these two nitrogen products. You can use the following equations to compare between the two reporting systems:

**Nitrite:**

*1 mg/L nitrite-nitrogen ($NO_2$ - N) = 3.3 mg/L* nitrite ($NO_2$)*

Atomic weight of nitrogen (the N in the $NO_2$) = 14.01

Atomic weight of nitrite (the N and the two O's that make up $NO_2$) = 46.01

*46.01/14.01 = 3.3

**Nitrate:**

*1 mg/L nitrate-nitrogen($NO_3$ - N) = 4.4 mg/L* nitrate ($NO_3$)*

Atomic weight of nitrogen (the N in the $NO_3$) = 14.01

Atomic weight of nitrate (the N and the three O's that make up $NO_3$) = 62.01

* 62.01/14.01 = 4.4

## Testing Frequency:

How often you test your water is also important. Start-up systems (at initial stocking of plants and animals) should be tested daily so adjustments can be made as soon as possible (*e.g.* decrease feeding, increase aeration, water exchange). After the nutrient cycles are relatively balanced (minimum of 4 weeks), weekly monitoring may be appropriate. Record (in pencil) all your readings in a data book or waterproof paper (see Appendix 1 for an example of a record log). This will aid you when fish stop eating, show signs of distress, or your plants look unhealthy; water chemistries may be out of normal range for optimal fish or plant health. You will know immediately if your daily regiment needs amending.

## Comparison of commercial water test kits:

The following is a comparison of various commercially available water test kits and electronic meters (Figure 2). Accuracy (ability of a measurement to be correct) and precision (how reliable a value is when measured repeatedly) were determined for each available method and aspect of water quality being tested (Tables 1 - 8). We also determined "ease of use" (Table 9), which included two conditions: 1) whether directions were simple to follow and 2) whether test time was quick (less than 10 minutes). Lastly, comparison of cost were made based on pricing from a local aquarium store and mail order items (Tables 10 - 13). It should be noted that an exhaustive search for the best price for each item tested goes beyond the scope of this handout. However, once a particular testing method has been decided, we recommend comparison "shopping" both locally or via the internet to obtain the most competitive price.

**Figure 2.** Various methods for measuring water quality parameters

a) Test strips

b) Aquarium Kits

c) Commercial aquaculture kit (individual)


d) Commercial aquaculture kit (multiparameter)


e) Individual parameter meter

f) Multiparameter meter

## Method Accuracy:

Disclaimer: Mention of any commercial products in this publication does not constitute endorsement of that product.

**Table 1.** Five methods testing pH at three commercial pH standards and an established aquaponics system.

| Method | Test Range | Increment | 4.0 pH | 7.0 pH | 10.0 pH | Aquaponic System |
|---|---|---|---|---|---|---|
| Accutest™ strips | 6.2 - 8.4 | 0.2 | <6.2 | 6.8 | >8.4 | <6.2 |
| Tetra® Aquarium kit | 5.0 - 10.0 | 0.5 | 5 | 6.5 | >10.0 | 5.0 |
| Hach® Multiparameter kit* | 4.0 - 10.0 | 0.5 | 4.0 | 6.5 | 10 | 4.5 |
| LaMotte™ Multiparameter kit* | 5.0 - 10.0 | 0.5 | <5.0 | 6.5 | 10 | <6.2 |
| PINPOINT® Electronic meter | 0.00 - 14.00 | 0.01 | 4.01 | 6.95 | 9.75 | 4.14 |

*part of a nine parameter test kit - drop color method

All pH test methods performed well for the three standards. Although the strips have a limited range compared to other methods, the strips measure the range observed in most aquaponics systems. The strips also displayed the smallest interval unit (0.2 pH unit) compared to other colorimetric tests (0.5 pH unit). The aquarium and aquaculture (Hach® and LaMotte™) multiparameter kits were 0.5 pH units lower for the 7.0 standard, but were highly accurate for the higher pH 10 standard. The electronic meter was consistently the most accurate (Figure 3).

**Figure 3.** Accuracy testing of pH methods

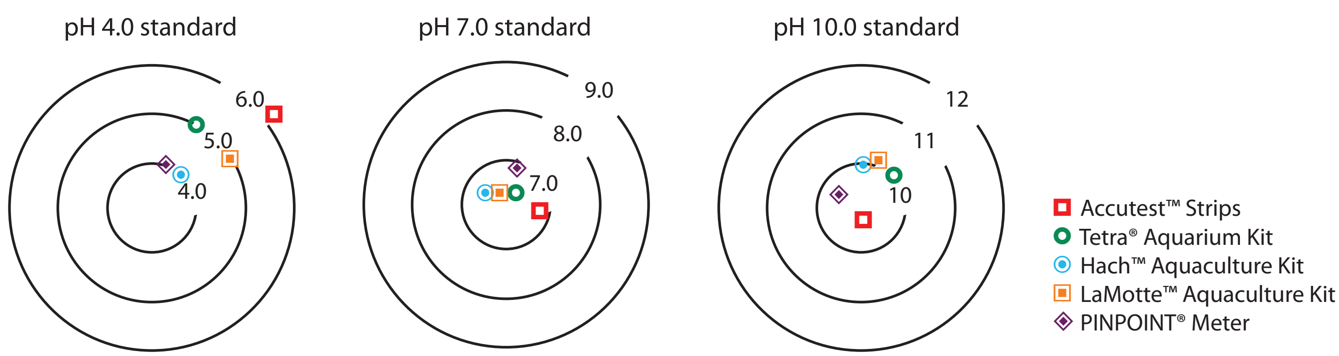



**Table 2.** Five methods testing total ammonia nitrogen (TAN) at three commercial standards and an established aquaponics system

| Method | Test Range (ppm) | Increment (ppm) | 1ppm | 10ppm | 100ppm | Aquaponic System |
|---|---|---|---|---|---|---|
| Accutest™ strips | 0.0 - 6.0 | 0.0, 0.25, 0.5, 1.0, 3.0, 6.0 | 0 | 0 | 0.5 | 0 |
| Tetra® Aquarium kit | 0.0 - 5.0 | 0, 0.25, 1.5, 3.0, 5.0 | 1.5 | 5 | >5.0 | 0 |
| Hach® Multiparameter kit* | 0.0 - 3.0 | 0.2 | 1.2 | >3.0 | >3.0 | 1.4 |
| LaMotte™ Multiparameter kit* | 0.0 - 2.0 | 0.0, 0.05, 0.10, 0.25, 0.50, 1.0, 1.5, 2.0 | 1 | >2.0 | >2.0 | 0.25 |
| YSI™ Electronic meter | 0.00 - ? | 0.01 | 1 | 10.05 | 101.67 | 2.05 |

*part of a nine parameter test kit - drop color method

Total ammonia nitrogen (TAN) values were also most accurate using the electronic meter. However, the colorimetric tests performed well particularly at the lower TAN readings. The more concentrated standards could not be accurately measured at the higher levels due to the limits on the upper ranges of most colorimetric tests (≤ 5.0 ppm). Test strips did not perform well in determining the appropriate value for any TAN standard (Figure 4).

**Figure 4.** Accuracy testing of TAN methods

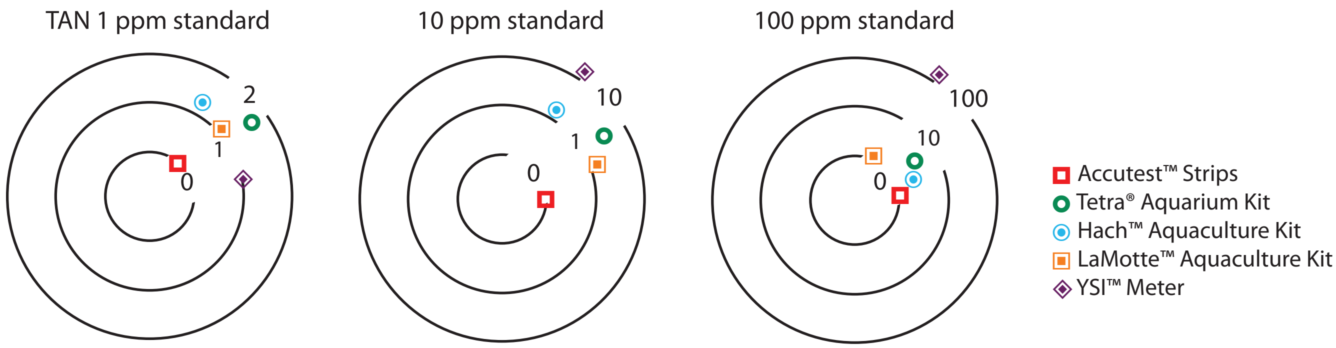



**Table 3.** Five methods testing total nitrate ($NO_3$) at three commercial standards and an established aquaponics system.

| Method | Test Range (ppm) | Increment (ppm) | 1ppm | 10ppm | 100ppm | Aquaponic System |
|---|---|---|---|---|---|---|
| Accutest™ strips | 0 - 200 | 0, 20, 40, 80, 200 | 200 | 200 | 200 | 40 |
| Tetra® Aquarium kit | 0 - 100 | 0, 12.5, 25, 50, 100 | 12.5 | 25 | 100 | 50 |
| Hach® kit* | 5 - 50 | 5, 10, 20, 35, 50 | 5 | 44 | 220 | 44 |
| LaMotte™ kit* | 0 - 15 | 0, 1, 2, 4, 6, 8, 10, 15 | 1 | 44 | 66 | 66 |
| YSI™ Electronic meter | 0.00 - 300.00 | 0.01 | 1 | 9.37 | 122.66 | 20.5 |

*measurements as nitrate-N and converted to total nitrate (see also box 1).

Nitrate results were similar to the determination of TAN in that the electronic meter performed best in hitting the mark for all of the standards tested. As with the TAN determinations higher (*e.g.*, >50 ppm) total nitrate levels could not be accurately measured due to the upper limits of the testing methods that were used. It should be noted that the strips were least accurate for any of the standards tested. The Tetra® aquarium kit performed especially well for the highest standard measured (*e.g.*, 100 ppm) (Figure 5).

**Figure 5.** Accuracy testing of Total Nitrate methods

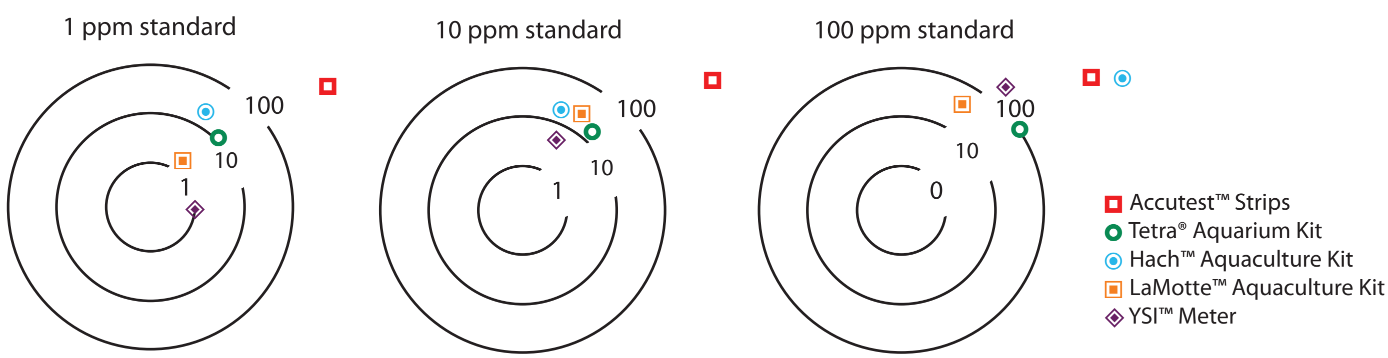
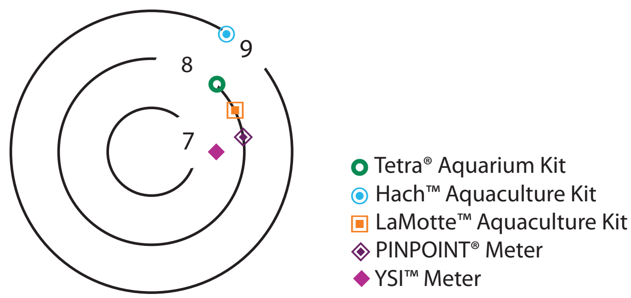


**Table 4.** Five methods testing dissolved oxygen (DO) of a bucket with an air stone (represents oxygen saturation at sea level) and an established aquaponics system.

| Method | Increment (ppm) | Bucket w/air stone (ppm) | Aquaponics system (ppm) |
|---|---|---|---|
| Tetra® Aquarium kit | 2, 5, 8, 11, 14 | 8.0 | 5.0 |
| Hach® Multiparameter kit | 1.0 | 9 | 4.0 |
| LaMotte™ Multiparameter kit | 0.2 | 8.0 | 4.0 |
| YSI™ Electronic meter | 0.01 | 7.48 | 4.2 |
| PINPOINT® Electronic meter | 0.1 | 8.0 | 3.8 |

The DO concentration for 100% air saturated water at sea level (our location) is 8.6 mg $O_2$/L. The kits performed on par with the electronic meters, even though the measurement interval is less (0.01 and 0.1 mg/L - meter vs. 0.2 and 1.0 mg/L - kits) (Figure 6).

**Figure 6.** Accuracy of Dissolved Oxygen methods (100% air saturated water at sea level = 8.6 mg $O_2$/L):




## Precision Testing:

Standards of pH, TAN, and total nitrate were tested by five people to determine the reliability of each method for each water chemistry parameter. Dissolved oxygen was also measured from a bucket aerated by an air stone, representing 100% air saturated water at sea level, and measured by four testers simultaneously.

**Table 5.** pH 7.0 standard measured by five methods.

| Tester | Accutest™ strip | Tetra® | Hach® | LaMotte™ | PINPOINT® meter |
|---|---|---|---|---|---|
| 1 | 6.8 | 6.0 | 6.5 | 6.5 | 7.00 |
| 2 | 6.8 | 6.0 | 6.0 | 6.5 | 6.99 |
| 3 | 6.8 | 6.0 | 6.5 | 6.5 | 6.98 |
| 4 | 6.8 | 6.5 | 6.5 | 6.5 | 6.95 |
| 5 | 6.8 | 6.0 | 6.5 | 6.5 | 6.98 |
| range | 6.8 | 6.0 - 6.5 | 6.0 - 6.5 | 6.5 | 6.95 - 7.00 |
| average | 6.8 | 6.1 | 6.4 | 6.5 | 6.98 |

**Table 6.** A 1 ppm commercial standard of total ammonia nitrogen (TAN) measured by five methods.

| Tester | Accutest™ strip | Tetra® | Hach® | LaMotte™ | YSI™ meter |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.3 | 0 | 0.88 |
| 2 | 0 | 0 | 0 | 0 | 0.53 |
| 3 | 0.25 | 0 | 0.2 | 0 | 0.78 |
| 4 | 0 | 0.25 | 0.8 | 0.5 | 0.88 |
| 5 | 0.25 | 0.25 | 0.5 | 0 | 0.55 |
| range | 0 - 0.25 | 0 - 0.25 | 0 - 0.8 | 0 - 0.5 | 0.53 - 0.88 |
| average | 0.10 | 0.10 | 0.36 | 0.10 | 0.72 |

**Table 7.** A 10 ppm commercial standard of Total nitrate ($NO_3$) measured by five methods.

| Tester | Accutest™ strip | Tetra® | Hach® | LaMotte™ | YSI™ meter |
|---|---|---|---|---|---|
| 1 | 40 | 25 | 44 | 26.4 | 8.60 |
| 2 | 80 | 25 | 44 | 17.6 | 9.60 |
| 3 | 40 | 25 | 44 | 4.4 | 11.55 |
| 4 | 40 | 35 | 44 | 66 | 20.50 |
| 5 | 40 | 25 | 22 | 4.4 | 12.87 |
| range | 40 - 80 | 25 - 35 | 22 - 44 | 4.4 - 66 | 8.60 - 20.50 |
| average | 48 | 27 | 40 | 22 | 12.62 |

**Table 8.** Dissolved oxygen (DO) measured from an aerated 5 gallon bucket by five methods.

| Tester | Tetra® | Hach® | LaMotte™ | YSI ™meter | PINPOINT® meter |
|---|---|---|---|---|---|
| 1 | 8 | 10 | 8.3 | 9.12 | 8.4 |
| 2 | 8 | 9 | 8.0 | 8.68 | 9.1 |
| 3 | 8 | 9 | 8.4 | 8.65 | 9.9 |
| 4 | 8 | 9 | 7.9 | 8.59 | 10.2 |
| range | 8 | 9 - 10 | 7.9 - 8.4 | 8.59 - 9.12 | 8.4 - 10.2 |
| average | 8 | 9 | 8.2 | 8.76 | 9.4 |

Based on precision alone, the pH measurements were very consistent among testers with all methods. TAN varied among the testers, but results were generally between two close benchmarks available for each method. Most testers were agreeable with all nitrate methods with strips, aquarium kit and Hach® kit, but inconsistencies arose among our testers for the LaMotte™ kit and electronic meter. Dissolved oxygen levels were consistent with all available methods among the testers (see also Figures 7 - 10).

**Figure 7.** Precision testing of pH methods using pH 7.0 standard.

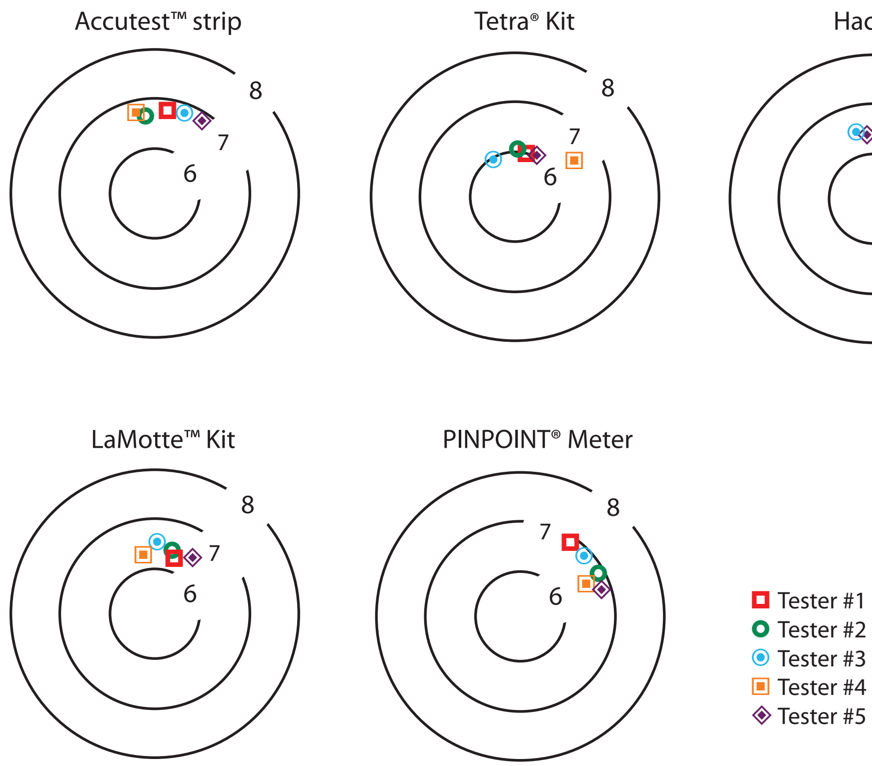



**Figure 8.** Precision testing of TAN methods using 1 ppm standard.

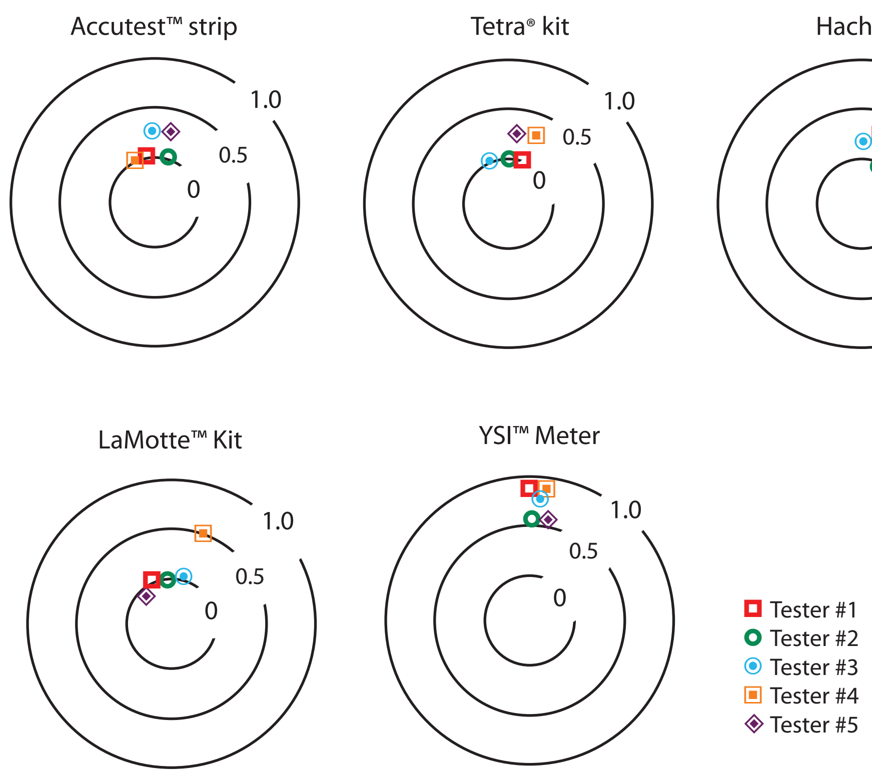


**Figure 9.** Precision testing of Nitrate methods using 10 ppm standard.

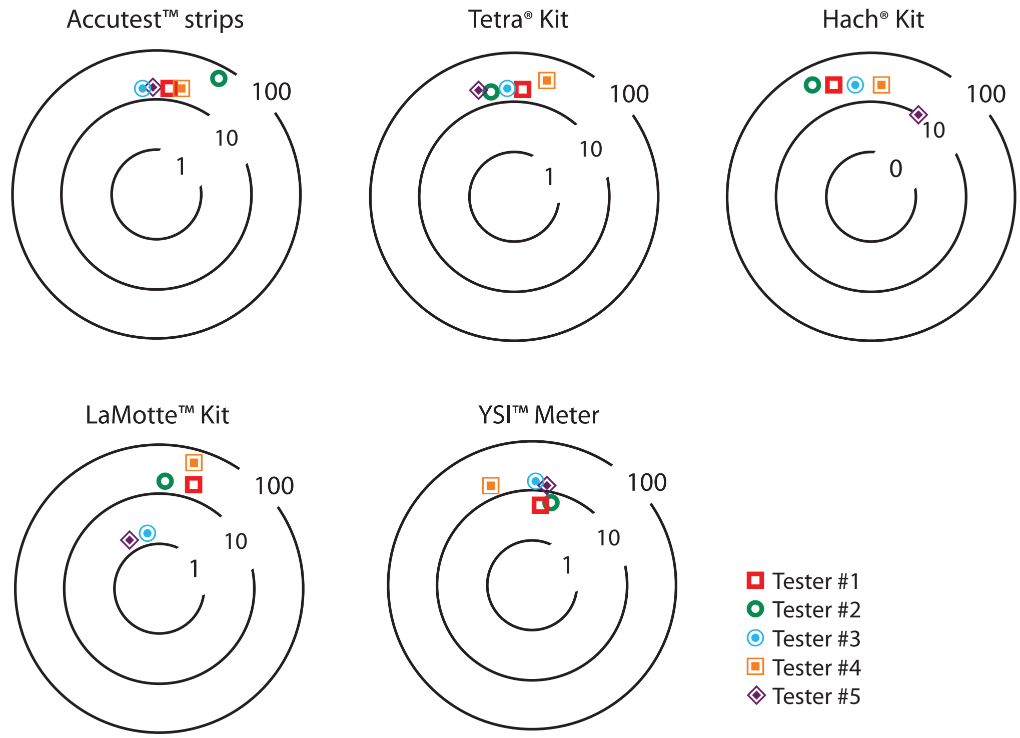
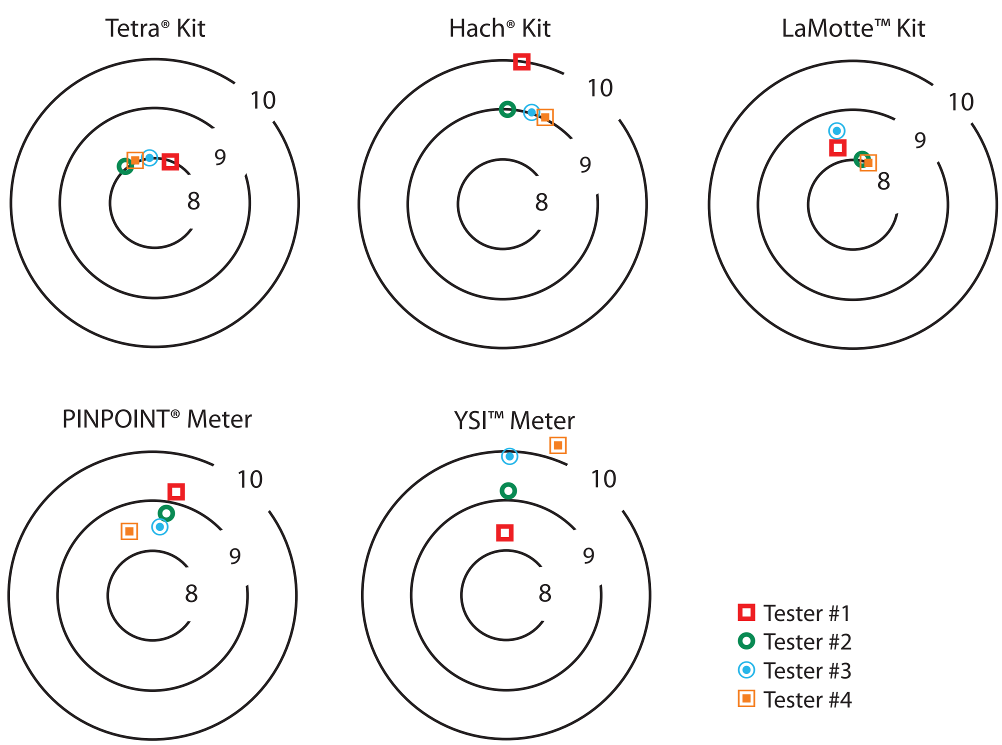



**Figure 10.** Precision testing of Dissolved Oxygen methods using an aerated 5 gallon bucket.
(100% air saturated water at sea level = 8.6 mg $O_2$/L)



## Ease of use:

**Table 9.** Tests were ranked as easy, fair, or difficult with regard to their use.

Easy = simple directions, less than ten minutes to record result; Fair = simple to moderate study of directions, with ten or more minutes to record; Difficult = directions hard to understand, and/or more than ten minutes for test result.

| Method | pH | TAN | Nitrate | Dissolved Oxygen |
|---|---|---|---|---|
| Accutest™ strips | Easy | Easy | Easy | n/a |
| Tetra® Aquarium kit | Easy | Fair | Fair | Easy |
| Hach® Multiparameter kit* | Easy | Fair | Fair | Fair |
| LaMotte™ Multiparameter kit* | Easy | Fair | Fair | Difficult |
| YSI™ Electronic meter | n/a | Easy | Easy | Easy |
| PINPOINT® Electronic meter | Easy | n/a | n/a | Easy |

With regard to ease of use, the Accutest™ strips was found to be the easiest to use. The electronic meters were easy to use once they were calibrated. Meters need to be calibrated before each use unless they are used daily, in which case weekly calibration is sufficient. Because of the required calibration of each water chemistry value, meters require more time initially to understand the directions found in their respective manuals. A varied response ranging from easy to fair was obtained for the multiparameter kits, where following directions were relatively easy, but the time required to obtain the results exceeded ten minutes (but less than 25 minutes). The LaMotte™ kit received a difficult rating with regard to measuring dissolved oxygen due to the multiple chemicals needed for testing. Some testers remarked they needed to repeat this test as they were unfamiliar with the kit and became confused by the instructions.

## Cost:

**Table 10.** Cost of each pH method by purchase price and price per test.

| Method | Number of tests | Cost** | Price/test |
|---|---|---|---|
| Accutest™ strips | 25 | $16 | $0.64 |
| Tetra® Aquarium kit | 50 | $8 | $0.16 |
| Hach® Multiparameter kit | 300 | $266 | $0.89a |
| Hach® individual kit | 300 | $62 | $0.21 |
| LaMotte™ Multiparameter kit | 50 | $235 | $4.70a |
| LaMotte™ individual kit | 50 | $45 | $0.90 |
| PINPOINT® Electronic meter | 100 | $99 | $0.99 |
| | 200 | $99 | $0.50 |
| | 500 | $99 | $0.20 |
| | 700 | $99 | $0.14 |

**Cost does not include shipping, handling, or hazardous materials charges.
a Cost is based on the individual test purchased with a multiparameter kit.

**Table 11.** Cost of each TAN method by purchase price and price per test.

| Method | Number of tests | Cost** | Price/test |
|---|---|---|---|
| Accutest™ strips | 25 | $13 | $0.52 |
| Tetra® Aquarium kit | 25 | $17 | $0.68 |
| Hach® Multiparameter kit | 300 | $266 | $0.89a |
| Hach® individual kit | 300 | $68 | $0.23 |
| LaMotte™ Multiparameter kit | 50 | $235 | $4.70a |
| LaMotte™ individual kit | 50 | $67 | $1.34 |
| YSI™ Electronic meter | 100 | $1,000 | $10.00 |
| | 200 | $1,000 | $5.00 |
| | 500 | $1,000 | $2.00 |
| | 700 | $1,000 | $1.43 |

**Table 12.** Cost of each $NO_3$ method by purchase price and price per test.

| Method | Number of tests | Cost** | Price/test |
|---|---|---|---|
| Accutest™ strips | 25 | $16 | $0.64 |
| Tetra® Aquarium kit | 25 | $20 | $0.80 |
| Hach® individual kit | 50 | $22 | $0.44 |
| LaMotte™ individual kit | 40 | $52 | $1.30 |
| YSI™ Electronic meter | 100 | $1,000 | $10.00 |
| | 200 | $1,000 | $5.00 |
| | 500 | $1,000 | $2.00 |
| | 700 | $1,000 | $1.43 |

**Table 13.** Cost of each DO method by purchase price and price per test.

| Method | Number of tests | Cost** | Price/test |
|---|---|---|---|
| Accutest™ strips | n/a | | |
| Tetra® Aquarium kit | 30 | $8.00 | $0.27 |
| Hach® Multiparameter kit | 100 | $266 | $2.66a |
| Hach® individual kit | 100 | $68 | $0.68 |
| LaMotte™ Multiparameter kit | 50 | $235 | $4.70a |
| LaMotte™ individual kit | 50 | $50 | $1.00 |
| YSI™ Electronic meter | 100 | $1,000 | $10.00 |
| | 200 | $1,000 | $5.00 |
| | 500 | $1,000 | $2.00 |
| | 700 | $1,000 | $1.43 |
| PINPOINT® Electronic meter | 100 | $99 | $0.99 |
| | 200 | $99 | $0.50 |
| | 500 | $99 | $0.20 |
| | 700 | $99 | $0.14 |

**Cost does not include shipping, handling, or hazardous materials charges.
a Cost is based on the individual test purchased with a multiparameter kit.

The local aquarium store's kit was the lowest in cost per pH test, but individual mail order kits at one company (Hach®) for the other water chemistry parameters earned a greater cost savings. Additionally, if you factor in the nine different parameters the multiparameter kits offer, the price of an individual test decreases considerably. Shipping and handling as well as possible hazard charges were not factored in for the mail orders, which would drive the price higher than locally available colorimetric kits. Meters only become cost effective if you have to regularly monitor water quality (*e.g.* >700 times). Therefore, when looking for a water chemistry method based on cost alone, factor in:

1.) the number of tests it can do

2.) the number you will be doing within the life of the method

3.) shipping/handling charges

4.) possible hazardous (*i.e.*, HAZMAT) charges

## What's the bottom line?

What water test kit you need for your aquaponics system depends on how many systems you are testing, how accurate you want to be, and how much money you want to spend. Strips were easy to use and moderately priced based on a cost per measurement. It should also be noted that with the exception of the electronic meters, the strips also had the highest upper limits for TAN and Nitrate. Unfortunately, the strips were also found to be highly inaccurate.

The local aquarium kit methodology varied in accuracy, range, ease of use, and cost. The other kits, both individual and multiparameter, were limited in their ability to measure in the higher ranges and typically took 20 minutes for the color to develop. But if time is not an issue and you can dilute your sample (*e.g.* one part sample to four parts distilled water would be a 1 to 5 dilution; multiply your result by 5), these kits could be cost effective. Also, since nitrate is not a threat to fish in aquaculture settings, it is not part of the commercial multiparameter aquaculture kits. Nitrate test kits must be purchased separately.

The electronic meters are very accurate but also the most costly, becoming only cost effective when many samples need to be routinely measured (research or commercial settings). It also requires greater degree of maintenance and care (*i.e.*, probes need special care and calibration standards must be purchased and properly stored).

For most backyard systems, the aquarium test kits appear to be adequate for most of your needs. However, if your parameters exceed the higher ranges, you will need to dilute your test sample to determine 1) how high that parameter is, and 2) if you need to rectify the situation immediately (*i.e.*, make a water change). If you are testing multiple parameters periodically (weekly at a minimum), the multiparameter kits available by mail order are convenient, accurate, and cost effective. The electronic meters are "top-of-the-line" in accuracy and many are equipped with an array of probes under one meter. If you operate a commercial-scale grade aquaponics system(s) or in need of assessing parameters in a large number of settings or in frequency, a meter may be your preferred choice. All the kits and meters are chemistry driven, which means they need to be properly stored. Use them within the expiration dates and store them as each kit directs for optimum usage. Whatever method you decide to use, following the storage procedures and directions will extend the life of your water chemistry monitoring system.

## References

Kratky, B.A, 2002. A simple hydroponic growing kit for short term growing vegetables. Cooperative Extension Service, College of Tropical Agriculture and Human Resources. Home Garden, June 2002 HG-42.

http://www.ctahr.hawaii.edu/site/downloads/adsc/price_list.pdf

## Addresses of Testing Manufacturers

Accutest™ strips and
Hach® Kits
Hach Company
P.O. Box 389
Loveland, Colorado
80539-0389
Phone: 800-227-4224
Fax: 970-669-2932
www.hach.com

LaMotte Company
802 Washington Avenue
PO Box 329
Chestertown, Maryland
21620 USA
Phone: 800.344.3100
Fax: 410.778.6394
www.lamotte.com

PINPOINT® Meters
American Marine Inc.
54 Danbury Rd. Suite 172
Ridgefield, CT 06877 USA
Tel: 914.763.5367
Fax: 914.763.5367
www.americanmarineusa.com

Tetra Headquarters
3001 Commerce St
Blacksburg, VA,
24060-6671
Tel:.540.951.5400
www.tetra.net

YSI Incorporated, World Headquarters
1700/1725 Brannum Lane
Yellow Springs, Ohio
45387-1107 USA
Tel:800-765-4974
Fax: 937-767-9353
www.ysi.com

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# APPENDIX

**Appendix 1.** Example of water chemistry data log

| Date | Tank | Temperature | DO | pH | TAN | $NO_2$ | $NO_3$ | Comments |
|---|---|---|---|---|---|---|---|---|
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