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Measuring the pH of Food Products

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pH is the scientific scale for measuring how acidic or basic a substance is when it is dissolved in water. The pH scale runs from 0 to 14. A measurement of 0 means the substance is very acidic; 7 means it is neither acidic nor basic but right in the middle like plain water (neutral); and 14 means it is very basic. If you are producing a food product that depends on the acidic components or ingredients of the product to extend shelf life and ensure safety, monitoring the pH is very important. Food safety is the biggest reason for monitoring pH, but pH also influences the quality of food products.

Figure 1. Two types of pH meters: the pen-like all-in-one unit (left), and the tabletop version (right).

pH Measurement

Food is a complex network of biological and chemical ingredients, and the unstable interactions between these ingredients make it challenging to get the best estimate when measurements are made. Since pH influences two major attributes of food—safety and quality—it is important for consumer health and acceptability to ensure such measurements are the best possible estimates. When considering which tools or methods to use to measure pH in food, accuracy, precision, and sensitivity are important.

Accuracy refers to how close the measured pH value is to the real value. Certain federal requirements require accuracy to be in the range of 0.1 units—that is, within the nearest tenth. For example, if the pH of a food product is 3.5, the pH meter should read 3.4 or 3.6. Some less expensive equipment can have reduced accuracy in the range of 0.2 units, which could create trouble when dealing with products that have pH close to certain critical limits established by the FDA. For example, the FDA defines an acidified food as one with a pH less than or equal to 4.6 and water activity (amount of free water available for microorganisms to grow) of greater than 0.85. In such a case, having a testing tool with an accuracy to 0.1 units becomes very critical if, for example, your product pH is normally between 4.5 and 4.7.

Precision refers to the repeatability of the measurement. For example, if we were to take three different measurements of the pH on one sample, a precise measurement would be close to the same reading all three times. The highest level of precision is to have the same reading all three times.

Sensitivity refers to how small a change in pH can be detected by the instrument. Sensitivity comes in handy when the slightest addition of an acid or base can influence the flavor of a product.

Choice of Meter

pH meters range from simple pen-like devices to table top meters. The pen-like pH meter is an all-in-one unit; the tabletop version has two pieces with a detachable probe (Figure 1). The life of pH probes depends on how they are used and stored. The all-in-one pen-like unit must be replaced completely when the meter begins to show a lapse in accuracy, precision, or sensitivity. Only the probe on the tabletop device requires replacement when indicated. Processors may use either a tabletop pH meter or pen-type pH meter, as long as they test to make sure the instrument is accurate and reliable.

Potentiometric meter. For the sake of accuracy and reliability, a tester should use a potentiometric pH meter, which takes readings by measuring electrical voltage developed on the electrodes when the probe touches a sample.

Colorimetric meter. This method measures pH levels using indicator dyes that change color when exposed to the food sample. Measurements are not as accurate and reliable as the potentiometric meter. FDA regulations allow colorimetric meters to be used on products with a pH level of less than 4.00, which is well below the critical limit of 4.6.

Electrode Maintenance and Usage

To avoid damage of expensive equipment and to prevent inaccurate readings, read all of the manufacturer's instructions before using the electrode.

When not in use, keep the electrode immersed in pH 4 buffer, which will prevent drying. This simple practice will extend the life of the electrode.

Cleaning. Before measuring the pH of the food sample, rinse the electrode thoroughly with distilled water and gently blot the electrode. Do not wipe the electrode; wiping can build static charges and result in inaccurate readings.

Temperature affects the accuracy of the pH measurement, so keep the buffers between 68°F and 86°F (20°C–30°C). Samples should be at the same temperature as the buffers. Cold and hot product samples should be allowed time to warm or cool into the range of the buffer temperatures.

Probe Handling. Unbreakable electrodes should be used while measuring pH of food samples to avoid creating a food safety hazard if something breaks off into the sample. When using glass electrodes, do not to let the electrode touch the sides or the bottom of the sample container. Hold the electrode in the center of the container to keep from scratching or breaking the electrode, which may affect accuracy or keep the pH meter from working correctly. This practice also yields the most representative readings, because the reading is taken from the center of the food product. Check the probe from time to time to make sure it is not broken or clogged with food.

Standardization is the procedure of checking the pH meter to make sure it is working properly before the actual food sample is tested. First, turn on the pH meter and let it warm up to allow all of the parts to stabilize. Next, dip the electrode into standard buffers of known pH. Two standard pH buffers normally used are pH 4 and pH 7. If the food samples you are working with could be in the pH range of more than 7, then pH 10 buffer could be used. Standardize the pH meter at the start of the day before measuring the pH of samples, and hourly after that.

Food Sample Preparation

Food is a complex mixture of ingredients. The sample you are analyzing for pH could be liquid, such as a sauce or condiment; a combination of liquid and solid ingredients, such as salsa or pickled peppers in brine; or a semi-solid such as potato salad. Or your sample may be made up of solid ingredients in oil. Each type of sample requires slightly different handling.

Liquid Samples. Measuring the pH of homogenous (blended or uniform) liquid samples is simple. Dip the rinsed, standardized electrode into the center of a well-mixed sample until the reading stabilizes on the pH meter, which takes about a minute.

Solid-liquid mixtures. Some food samples are chunks of fruits or vegetables in liquid and are more complicated to measure. Because the solid pieces may differ in pH from the brine or syrup they are immersed in, it is important to know the pH of the liquid and the solid components separately, as well as the pH of the product mixture.

- Drain to separate the solid and liquid parts using a number 8 sieve.
- Using a blender, blend the drained sample into a homogenous (even-textured) paste. If your sample is dry or difficult to blend into a paste, a maximum of 20 milliliters of distilled water can be added to 100 grams of the product without changing the pH of the product.
- Dip a clean, standardized electrode into the blended mixture and take a pH measurement.
- Take two additional readings at different spots in the sample.

Semisolid Food Products. Thick sauces, puddings, and potato salad are good examples of semi-solid food products that need to be brought to a paste-like consistency to get a pH reading that represents the whole sample. As mentioned before a small amount of distilled water (20 ml/ 100 grams of the product) can be added if necessary to create a paste-like consistency.

Food products with oil. Oil hampers pH measurements, so it needs to be separated from the solid pieces of food. Use a small amount of distilled water to blend the solids into a paste and measure the pH by dipping the electrode into the paste. Oil does not acidify and can prevent the necessary acidification of foods. For example, for garlic packed in oil, you would want to remove the garlic cloves, blend them, and test for a pH of less than 4.4, which can only be achieved before they were put into the oil.

Additional Information

The approximate pH of various food products can be found at the website of the U.S. Food and Drug Administration's Center for Food Safety and Applied Nutrition at http://www.webpal.org/SAFE/aaarecovery/2_food_storage/Processing/lacf-phs.htm.

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