The Oklahoma Cooperative Extension Service
Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; home economics; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and based on factual information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

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Choosing and using a pH meter for food products

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Introduction

Monitoring the pH of foods during production may be a vital step in producing a safe, high quality food. Proper pH range is often essential in many of the physical and chemical reactions that take place during food processing. For example, pH control is required to insure proper gel formation in jelly making. The correct pH is also needed to achieve successful fermentations in the production of many cheeses, pickles and other foods.

In addition to food quality concerns, control of a food's pH may also be a serious food safety issue. A low pH, below 4.6, will prevent the growth of potentially deadly spoilage bacteria in canned foods. This principle is rigorously applied in the production of certain preserved foods such as pickled vegetables. For these and other types of foods, accurate monitoring of pH during production may be mandated by state or federal regulations. Fortunately, accurate monitoring of food pH is possible using relatively inexpensive pH meters. However, it is important to understand how to choose and how to use a pH meter to be sure that the results are truly accurate.

Choosing a pH meter

There are four main considerations to keep in mind when selecting a pH meter that would be well suited for use in monitoring production of acidified foods:

Resolution and accuracy of the meter

The cost of a pH meters may range from $50 to $1,000 or more. A major factor in determining cost is the accuracy and resolution of the meter. Smaller numbers indicate better resolution and accuracy. The cheapest meters typically feature a resolution of 0.1 pH units. Federal agencies typically require that pH readings be reported to the nearest tenth (0.1) unit. Most units therefore technically offer sufficient resolution to meet government standards. However, it is important to also consider the accuracy range of the meter. Some of the least expensive meters may have an accuracy of plus or minus 0.2 units. In other words, if the meter reads 4.3, the actual pH of the product could be anywhere from 4.1 to 4.5. This might present a problem if the pH of your product approaches the legal limit of 4.6. It

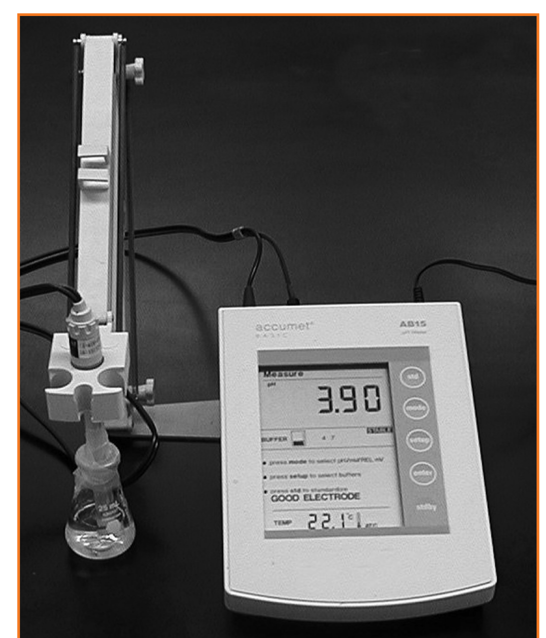

Figure 1 – Typical pH meter with detachable probe

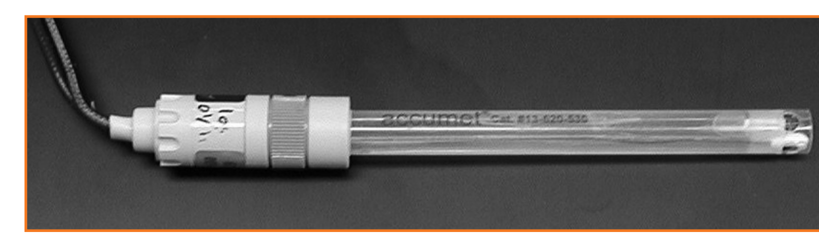

Figure 2 – Typical pH meter probe

Figure 3 – Typical all-in-one pH meter

is generally advisable to invest in a pH meter/electrode combination that offers resolution and accuracy of 0.1 pH units or better.

Detachable or all in one probe

Meters may come either with detachable, replaceable probes (Figures 1 and 2) or they may be an all in one unit with an integral probe (Figure 3). Both types may work equally well. The units with detachable probes typically cost a bit more. The all-in-one units are more convenient and may require less maintenance. The important consideration is that all pH probes have a finite lifespan. The useful life of a probe is strongly influenced by the use, or abuse, it receives. But even in the best case, one may expect a probe to have a useful lifespan of about one to three years. Units with a detachable probe allow a user to replace only the probe as needed. All in one type units will need to be completely replaced.

Electrode type

Meters with detachable probes typically offer a choice of pH sensing units, called electrodes. Most probes feature a glass bulb type electrode located at the tip of the probe. These may be sealed or refillable. Sealed electrodes require less maintenance and are easier to set up and use. Refillable types may have a longer life since their design allows them to be cleaned and "rejuvenated" when performance begins to suffer. Other electrode specifications, such as reference type and junction type, are typically not important in food testing. It is always important, however, to be sure that the electrode type matches the meter with which it is to be used. Always consult the meter documentation when choosing a new probe. New meters are now available with probes featuring solid state electrodes. These systems offer the advantage of being easily cleanable and requiring very little liquid to sense pH. This makes them especially suitable for oily or semi-solid food testing. Currently, however, these probes are much more expensive than a comparable probe with a glass bulb electrode. They may also be sensitive to static charges and electromagnetic fields such as those generated by magnetic stirring units. Solid-state electrodes may also have a relatively small sensing pore that can easily be obstructed by small particles in the food.

Auto calibration and temperature compensation

Many pH meters now come with automatic sample temperature compensation and/or automatic calibration buffer sensing. These are conveniences that make it easier to calibrate the meter and to test the pH of samples. Users of meters without these features will need to manually adjust the meter either during calibration, sample measurement or both.

Summary of features to look for in a pH meter

- Sufficient resolution and accuracy, typically 0.1 pH units or better.
- All-in-one or detachable probe as desired.
- Automatic temperature compensation and calibration buffer sensing are a plus.

Using a pH meter to test food samples

Calibrating the pH meter

A properly calibrated meter is essential to obtain accurate pH readings. The pH meter MUST be calibrated at least daily, or once per shift, if multiple production shifts are scheduled. It is important to follow the manufacturer's instructions for proper calibrations; exact procedures will vary. A typical calibration procedure will involve the use of standardized buffer solutions, often pH 4 and pH 7 buffers. It is important to use freshly dispensed buffer for calibration. The pH of buffer solutions exposed to air will eventually change due to evaporation and absorption of carbon dioxide from the air.

Note that calibration will likely involve drying the probe between sample readings. This is usually done by blotting the probe dry with lint-free tissue paper. It is important not to rub the probe with the tissue since this may physically damage the delicate membrane of the probe and/or generate a static charge that can damage the probe or interfere with accurate pH measurements. After calibration, check the accuracy of the meter by testing the pH of a standard buffer solution, such as a pH 4 buffer. If the probe is very slow to respond or refuses to calibrate properly, it may need to be cleaned. See "Cleaning a dirty pH probe."

Preparing food samples for pH testing

Note that food samples should be at a constant temperature, preferably room temperature, when tested for pH. Recommendations for specific types of food follow.

1. Homogeneous foods:
   If a food is homogeneous, that is of uniform consistency, then the pH of any portion may be considered to be representative of the whole. This is typically true of food products that are wholly liquid or contain only very small particles. Examples of this type of food include most barbecue sauces and salad dressings. No special preparation is required for this type of food unless the samples are oily (see No. 4 below).
2. Liquid and solid food mixtures:
   Many food products, such as chunky salsas and pickled vegetables, consist of a mixture of solid particles in a liquid brine or syrup. In these foods, the solid portion may differ in acidity from the covering liquid. Therefore, it is necessary to test both components. It is also important to know the overall pH of the uniformly mixed ingredients. This is termed the "equilibrium pH." Following are the recommended procedures for preparing these foods for testing:
   - Separate the liquid and solid components by draining the contents of the container for two minutes on a screen or sieve. Regulations specify a U.S. standard No. 8 sieve (available from scientific supply companies), inclined at a 17 to 20 degree angle. Save each portion separately and be sure to record the weight of both the liquids and the solids if these will be used in determining the equilibrium pH.
   - Determine the pH of the liquid portion as described in "Testing food samples." If the liquid is very oily, see No. 4 below.
   - Rinse the drained solids with deionized or distilled water to remove any remaining covering liquid. Blend the solids to a uniform paste and measure the pH as described in "Testing food samples." If additional liquid is required to blend the samples, up to 20 parts deionized or distilled water may be added per 100 parts food sample.
   - To determine the "Equilibrium pH" of the food either blend fractions of both solid and liquid portions in the same ratio as found in the original container or simply blend the entire contents of the container to a uniform paste. Test the pH as described in "Testing food samples."
3. Semi-solid foods:
   Examples of semi-solid foods include puddings and very thick sauces. These foods should be blended to a uniform paste before testing. If additional liquid is required to blend the samples, up to 20 parts deionized or distilled water may be added per 100 parts food sample. Following blending, the pH should be measured as described below in "Testing food samples."
4. Oily foods:
   Oil and/or grease in a food can coat and seal the membrane of the pH electrode and interfere with proper pH measurement. If possible, any oil layer present in the food should be removed before pH testing. Allow the oil to rise to the surface, and then remove it by skimming or pouring. If the oil cannot be easily separated, freezing and thawing the samples may break an emulsion and allow the oil to separate. Cooling the samples in a refrigerator may solidify the separated oil and facilitate oil removal. Be sure to allow samples to return to room temperature before testing the pH.

Testing food samples

1. After the meter has been turned on, allowed to stabilize as necessary and properly calibrated, begin by rinsing the probe with deionized or distilled water and blotting the probe dry with lint-free tissue paper.
2. Immerse the sensing tip of the probe in the sample and record the pH reading to the nearest 0.05 pH unit (or the nearest 0.1 unit depending on the resolution of the meter). Allow at least one minute for the meter to stabilize.
3. Rinse the probe, blot dry and repeat step 2 on a fresh portion of sample. The two readings should agree to within the accuracy limits of the meter.

Cleaning a dirty pH probe

If the pH meter is slow to respond or erratic in its readings, this may indicate that the pH electrode is fouled with oil or otherwise dirty. The following procedure may be used to attempt to clean and rejuvenate the probe.

1. Turn the pH meter off and remove the pH probe from the meter if possible.
2. Rinse the sensing tip of the probe in tap water for about three minutes.
3. Using as little force as possible, remove visible dirt from the pH probe with a very soft brush or sponge. Use care not to scratch or otherwise damage the electrode.
4. Re-rinse the probe tip with tap water for about two minutes.
5. Inspect the probe and repeat step 3 if necessary.
6. Immerse the probe tip in a 0.1 molar (0.1 M) sodium hydroxide (NaOH) solution for one minute. Transfer the probe tip to a 0.1 molar (0.1 M) hydrochloric acid (HCl) solution for one minute. Repeat this cycle two times, ending with the probe tip in the HCl solution.

A 0.1 M NaOH solution may be purchased directly or may be made by mixing four grams solid NaOH in one liter water, or about 0.15 ounces NaOH in one quart water. A 0.1 M HCl solution may be made by mixing one part concentrated HCl (11 Normal) to 100 parts water.

NOTE: Always add concentrated NaOH or HCl to pre-measured volumes of water. Directly adding water in small quantities to a strong acid such as HCl or a strong base such as NaOH may result in a violent reaction and the release of highly corrosive spray or fumes. Always use protective eyewear and clothing when working with strong acids and bases.

7. Rinse the probe tip for at least one minute using tap water.
8. If the probe is coated with oil or grease, carefully wipe the probe, including the sensing tip, with acetone.
9. Rinse the probe tip with distilled or deionized water for at least one minute. Alternatively, dip the probe tip in distilled or deionized water for at least five minutes. Reattach the probe to the meter if needed and calibrate.

Summary of tips for using a pH meter

1. DO make sure that food samples are at a consistent temperature when testing.
2. DO calibrate your pH probe frequently to insure accurate results.
3. DO rinse the pH probe thoroughly with distilled or deionized water before measuring food samples or returning the probe to storage.
4. DO store the pH probe sensing tip in a soaking solution, never in plain water. The proper solution may be a pH 7 or pH 4 buffer or a potassium chloride (KCl) solution as recommended by the manufacturer. Change the storage solution periodically to prevent contamination. Note that some solid-state electrode probes are intended to be stored dry.
5. DO turn pH meter off or to standby before disconnecting the probe.
6. DO NOT touch the sensing tip of the probe with your hands.
7. DO NOT scratch or damage the pH electrode bulb. This bulb is fragile and can break completely or give erroneous readings if damaged.
8. DO NOT allow food samples to dry on the pH probe. Keep it clean to extend its useful life.

References

"Acidified Foods, Subpart E—Production and Process Controls, Methodology," Title 21, Part 114, Sec. 114.90 (21CFR114.9) in Code of Federal Regulations, Government Printing Office, Washington D.C. 1999.