

CHAPTER 2. PHYSICAL EXAMINATION OF MEAT AND POULTRY PRODUCTS

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2.1 Introduction

Microorganisms associated with meat and poultry products can be placed in three categories, beneficial, spoilage and pathogenic. Each product has a characteristic microbial profile called its "normal flora". Frequently information on changes in the "normal flora" can be obtained rapidly by simple observations. These observations can be grouped into a category called organoleptic observations. The term "organoleptic" refers to the use of the senses in determining the acceptability of a product. This would also include a direct microscopic examination.

Organoleptic analyses are of particular importance during investigations of certain food production problems such as detecting deleterious pre- or post-processing changes of canned products. Changes brought about by abusive handling and storage also may be detected by organoleptic observation.

In order to make a valid judgment, based upon one or more organoleptic observations, the analyst must know the physical characteristics of a "normal" product. This knowledge can be gained by experience and specialized training. Each laboratory should have Standard Operating Procedures (SOPs) describing the organoleptic standards for the acceptance or rejection of samples.

When judging a product to be abnormal, if possible, the decision should be based on a comparison of the suspect product with one that is normal, if readily available. This minimizes the subjectivity of the decision that a product has an "off odor", "off color", or other sensory abnormality. Tasting products as part of a microbiological examination is a dangerous practice and should be avoided. When the question to be answered is related to spoilage, odor is of primary importance; chemical and/or bacteriological results are corroborative and substantiating.

2.2 Examination

The following guideline establishes a standardized inter-laboratory procedure for characterizing samples.

- a. Appearance: Changes in color; degradation of fat; presence of foreign materials such as metal, hair, feathers, sand, charcoal, etc.
- b. Texture: Change in consistency; development of slime; breakdown of structure (proteolysis), etc.

- c. Odor: Examples of words used to describe off-odors are: sour (acidic), moldy, musty, fishy, rancid, fruity, yeasty (beer-like) and putrid. However, if the analyst cannot decide how to classify an odor it is acceptable and appropriate to say simply: "off-odor" or "taint". Notations as to whether the off-odor is strong or slight are also in order.

2.21 Odor Examination By a Panel

In some cases results of odor examinations are equivocal and an odor detection panel, consisting of at least three members must be formed. The purpose of this panel is to evaluate aroma only, and its judgement must not be swayed by appearances. Only people with a good sense of smell can be assigned to it. The coordinator, who is not a panel member, will prepare the samples and ensure that the following procedures are followed:

- a. The test must be conducted in a well-ventilated area free of strong odors.
- b. At least 15 - 20% of the samples in the test group should be normal, wholesome, product-counterparts of the samples being examined. The normal controls should be as similar to the test product as possible with respect to ingredients, processing, packaging, size, age and handling procedures.
- c. All samples should be presented to the smell panel in sequentially coded glass jars or polyethylene bags of the same size and shape, similar in weight and at the same temperature (usually 35°C). Both the normal and questionable products should be presented in a random order with a rest between samples. Do not decontaminate cans by flaming since heating and/or burning the contents could alter or mask any other odors that might be present.
- d. Before beginning the examination, the panel members should smell and discuss the characteristic aroma of a normal product. They should be made aware that it is for general reference only, since normal products may vary slightly in odor and intensity. They then should rest until the samples are presented to allow recovery of the sense of smell which tires easily.
- e. During the actual sample analysis, each panel member should remove the jar lid or open the bag, sniff the contents without glancing at them, replace the lid/close the bag and return the container to the panel coordinator. The panelist's sensory perceptions should

be entered on a score pad containing a list of appropriate terms with notations about whether the odor was strong or weak.

- f. During the examination the panel members must not comment, exclaim or use body language that conveys their impression of the odors to other members of the panel.

Caution: It is not to be assumed that a smell panel composed of laboratory personnel will have the degree of skill attained by professional odor analysts. The purpose of a panel of laboratory personnel is to detect the odors of decomposition or product contamination with an odorous compound.

2.3 Determination of pH in Meat and Poultry Products

Potentiometric measurements should be used to determine the pH of a food product. The accuracy of most pH meters is approximately 0.1 pH units and reproducibility should be approximately ± 0.005 pH units. Both the glass and reference electrode are usually housed in a single tube, called the combination electrode. To obtain accurate results the same temperature should be used for standardization with the buffers and the sample. Measurements should be taken within the temperature range of 20 to 30°C.

2.31 Equipment and Reagents

- a. Blender
- b. Beaker, 100 ml
- c. Separatory funnel
- d. pH meter, suitable for reading pH from 0 to 14 in 0.1 unit increments. A rugged, designated combination electrode should be used for pH measurement of meats and poultry. A flat combination electrode works well for determining the surface pH of canned foods.
- e. Distilled water
- f. Certified buffer solutions of pH 7.00, and either pH 4.00 or 10.00. The buffers chosen should bracket the desired pH.

2.32 Procedure

- a. Calibrate the pH meter, according to manufacturer's instructions, using certified buffers pH 7.00 and either pH 4.00 or 10.00.
- b. Most products will be solid and require blending. A 1:5 or 1:10 dilution should be made with distilled water in a clean blender jar. Blend to a thin uniform consistency and perform the pH measurement. If fat or oil causes fouling of the electrode, transfer a portion

of the homogenate to a separatory funnel and draw off a portion of the aqueous phase. On certain products centrifugation may be required in order to recover a measurable aqueous phase.

- c. Adjust the temperature control on the pH meter to that of the sample (ideally 25°C) and immerse the pH electrode into the liquid phase.
- d. A surface electrode may be used with certain low fat products that present a flat, solid core surface. If a surface measurement is taken, ensure that the electrode has good contact with the product surface.
- e. Record pH to the nearest 0.1 unit.

2.4 Determination of Water Activity (A_w) of Meat and Poultry Products

The free moisture level in food is called water activity (a_w). This is the water available to support microbiological growth in the food. It can be lowered by dehydration or by the addition of binding agents such as salt or sugar. The growth of different types and genera of microorganisms is controlled by the water activity level in a specific product. Much information exists on the water activity limits of growth for microorganisms. For example, the limit of growth for *Clostridium botulinum* occurs between an a_w of 0.935 and 0.945. Canned foods with an a_w of ≤ 0.85 are exempt by the FDA from the canned food regulations and cured meats without nitrates must have an a_w of ≤ 0.92 . It is important, therefore, that the a_w in foods be measured very accurately. A detailed list of growth limiting a_w values can be found in Chapter 8 of the Compendium of Methods for the Microbiological Examination of Foods.

Measurement of the a_w in a food sample is affected by both time and temperature. It is dependent upon allowing enough time for the water vapor of the sample to reach equilibrium with the air space in a closed container, such as a closed jar, at a constant temperature. When incubation is required for equilibration, it is absolutely necessary to maintain accurate temperature control of the food samples inside the incubator used for a_w . It is equally important to allow ample time for the humidity of the air space above the sample to reach equilibrium with the food sample.

2.41 Decagon

The Decagon CX-2 will measure a_w in less than 5 minutes. The instrument has rapid vapor equilibration, does not require temperature equilibration and requires only a small sample (approximately 5 grams of food). The instrument does not have to be calibrated, but quality control samples, consisting of deionized water and various salt slushes, must be included in an analysis. When a very wet sample and a very dry one follow one another, two interim readings should be taken of the second sample before collecting data with the third reading. When a reading is completed, the instrument will "beep" continuously. The only reported material to interfere with a Decagon reading is propylene glycol. Foods containing propylene glycol should not be analyzed by this method.

2.42 Equipment and Materials

- a. Decagon, Model CX-2 manufactured by Decagon Devices, Inc., Pullman, WA 99163-0835.
- b. Blender and blending jars
- c. Transfer pipettes

2.43 Procedure

- a. In order to obtain a representative sample, approximately 100-200 grams of food should be blended.
- b. Remove at least two samples, approximately 5 grams each, for a_w determination; the cup should never be filled above the fill level line molded into the side of the plastic cup.
- c. Follow the manufacturer's directions contained in the Decagon Manual very carefully when performing this analysis.
- d. Saturated salt solutions should be used for reference controls. The following saturated salt mixes and their expected a_w at 25°C normally are used:

NaCl -----0.755
KBr -----0.811
KCl -----0.845
(NH₄)H₂PO₄-----0.934

Note: Never leave a sample in the instrument after a reading has been taken.

2.44 American Instrument Electronic Hydrometer

Another method for determining a_w is the American Instrument Electronic Hydrometer. Reportedly, it is an accurate instrument for measurement of the a_w in food products, provided the manufacturer's directions are followed carefully. The instrument measures the changes in electrical resistance of specially coated lithium chloride sensors. The electronic part of the instrument is very rugged and needs no special care. The sensors, like pH electrodes, are very sensitive and can be affected permanently by water condensation, desiccation, corrosive chemicals such as mercury vapor, unstable hydrocarbons such as ketones; halogen gases; and sulfur compounds such as hydrogen sulfide and sulfur dioxide. Sensors can be affected reversibly by polar vapors such as ammonia, amines, alcohols, glycols and glycerols. The response of sensors will return to normal, from slightly higher readings, if the polar vapors are removed by aeration.

2.45 Equipment and Materials

- a. American Instrument Electronic Hydrometer (Model No. 30-87 or equivalent) manufactured by Newport Scientific, Inc., 8246E Sandy Court, Jessup, MD 20794.
- b. Sensors, Color Code-Gray, (Cat-No. 4822W) for the above instrument, available from the same manufacturer. The Company makes different types of sensors for different ranges of humidities. This sensor is the one most commonly used in meat and poultry product analyses. They have an a_w range of about 0.81 to 0.99. Each sensor is unique and comes with its own factory calibration curve. When purchasing gray sensors specify that the a_w readings between 0.90 - 0.94 be inside the linear portion of the calibration curve. Also request that the correction factor of each sensor at 30°C (86°F) be incorporated into each calibration curve.
- c. Sensor lids and 8-gang switch box. These socket type lids normally fit into the rims of standard pint size canning jars. The 8-gang switch box allows measurement of eight samples at a time. The sensor connectors should be labeled 1 to 8 to correspond to the switch position.
- d. A forced-air incubator should be used to hold the samples at $30 \pm 0.5^\circ\text{C}$. If necessary, cut a 1.5" diameter hole in the incubator to introduce the electrical leads for the eight sensors into the incubator. Be sure to fill the hole with sealant.
- e. Clean and dry standard pint-size glass canning jars, without chips or cracks on the rims, for the samples.
- f. Pipettes
- g. Preparation of a saturated ammonium phosphate, monobasic, $[(\text{NH}_4)\text{H}_2\text{PO}_4]$ slush

(NH ₄)H ₂ PO ₄ , reagent grade	200 g
Merthiolate	25 mg
Glass distilled water	

Place the ammonium phosphate and merthiolate in a new or clean pint-size jar, slowly add glass-distilled water (approximately 2-3 ml at a time), and stir vigorously with a spoon until approximately one half of the crystals are dissolved. Care must be taken to avoid splashing the salts onto the sides and rims of the jar.

Incubate the salt slushes at 30°C for 2-3 days to establish equilibrium.

- h. Preparation of saturated potassium dichromate (K₂CrO₄) slush

Use the same procedure as above. Omit the merthiolate.

- i. Store the salt slushes indefinitely in a 30°C incubator at all times except to install or remove sensors.
- j. The a_w of the salt slushes should be (measured with a calibrated gray sensor):

(NH ₄)H ₂ PO ₄ slush	0.929 at 30°C
K ₂ CrO ₄ slush	0.865 at 30°C

2.46 Procedure

- a. Follow the manufacturer's directions very carefully when using this method.
- b. Test each sensor first in (NH₄)H₂PO₄ and then in K₂CrO₄ salt slush and record the results on the analysis sheet. The sample test results will be recorded on the same sheet. Do not use sensors that differ from the expected value of the salt slush by more than a_w 0.01 unit.
- c. If the a_w is going to be measured in other than the range specified for the grey sensor, be sure to use the appropriate sensor and prepare salt slushes appropriate for the expected range. A table of other salt slushes can be found in Chapter 8, "Measurement of water activity (a_w) and acidity", in the Compendium of Methods for the Microbiological Examination of Foods.

2.5 Selected References

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