

Laboratory Proficiency Testing for Shear Force Measurements

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BACKGROUND

The Department of Agriculture (USDA), Agricultural Marketing Service (AMS), Livestock, Poultry and Seed (LPS) Program will certify carcasses and meat cuts for tenderness-marketing claims based on the American Society for Testing and Materials (ASTM) International tenderness standards. The basis for assessing tenderness that meets the performance requirements outlined in this document was established after consultation with an industry-working group convened by the LPS Program. The Industry Working Group was comprised of representatives of USDA, industry associations, processing companies, producers, technology providers, and academia.

PURPOSE AND SCOPE

The LPS Program *Operational Requirements for the USDA Certification of ASTM International Tenderness Marketing Claims* specifies that slice shear force (SSF) or Warner-Bratzler shear force (WBSF) will be the methods of assessing tenderness. AMS approved third parties may conduct the SSF/WBSF testing required to validate that the requirements of an ASTM International tenderness standard have been met. Third party laboratories are approved to conduct SSF and/or WBSF through proficiency testing conducted in conjunction with an AMS designated SSF/WBSF reference laboratory. This document outlines the procedures and requirements of proficiency testing.

REFERENCE DOCUMENTS

1. Operational Requirements for the USDA Certification of ASTM Tenderness Marketing Claims. USDA LPS Program, October 2012.
2. Quality Systems Verification Programs General Policies and Procedures. Grading and Verification Division (GVD) 1000 Procedure.
3. Research Guidelines for Cookery, Sensory Evaluation and Instrumental Tenderness Measurements of Fresh Meat. American Meat Science Association (AMSA), 1995.
4. Slice Shear Force Protocol for Large Volume. USDA, Agricultural Research Service (ARS) <http://www.ars.usda.gov/SP2UserFiles/Place/54380530/protocols/SSFProtocolforlargevolume.pdf>
5. Standard Practice for Force Verification of Testing Machines. ASTM International Standard E 4.
6. Standard Practice for User Requirements for Livestock, Meat, and Poultry Evaluation Devices or Systems. ASTM International Standard F 2341.
7. Standard Test Method for Livestock, Meat, and Poultry Evaluation Devices. ASTM International Standard F 2343.

8. USDA Quality Systems Assessment (QSA) Program. GVD 1002 Procedure.
9. Warner-Bratzler Shear Force Protocol. USDA, ARS
<http://www.ars.usda.gov/SP2UserFiles/Place/54380530/protocols/Warner-BratzlerShearForceProtocol.pdf>
10. Wheeler, T.L., Shackelford, S.D., and Koohmaraie, M. Beef longissimus slice shear force measurement among steak locations and institutions. *Journal Animal Science* 2007, 85:2283–2289

REQUIREMENTS

In addition to the required information as outlined in GVD 1000 Section 6, an individual or firm seeking to serve as an AMS approved party that conducts either SSF and/or WBSF testing must: (1) provide documentation that describes the quality management system as outlined in GVD 1002 Section 7; and, (2) demonstrate conformance with the elements below.

A quality management system must, at a minimum, specifically address the following:

- The organizational structure necessary to carry out these requirements;
- Requirements for the production of quality data;
- Control of documents, records and changes; and,
- Control and calibration of measuring and test equipment.

Operational Requirements

Testing SSF and/or WBSF instrument systems shall be used, operated, inspected, and maintained as described in ASTM International Standard F 2341. The areas addressed in this standard include instrument installation, operation, verification, inspection and maintenance, and operator training.

Test Samples

All testing will be conducted on 2.54-centimeter (one-inch) thick beef strip loin steaks from thirty strip loins. The strip loins shall include the following distribution of SSF as determined by the reference lab: for SSF, not more than 75% < 17 kg and at least 10% > 25 kg; and for WBSF, not more than 75% < 4.1 kg and at least 10% > 5.0 kg. Tenderness variation will be accomplished by varying or minimizing postmortem aging and may include other means to ensure that a sufficient distribution exists.

The strip loins shall be obtained by the third party lab and shipped to the reference lab as soon as possible after harvest such that the reference lab can freeze 15 of the strip loins no later than 3 days postmortem and another 15 strip loins no later than 14 days postmortem. If the 3 day postmortem requirement cannot be met, then all 30 strip loins should be frozen no later than 7 days postmortem.

Four steaks from the thirty strip loins ($n = 120$) will be tested by both the reference and third party labs. The reference lab will cut the frozen strip loins into 2.54-centimeter (one inch) thick steaks. The reference lab will assign two sets of two adjacent steaks to the third party lab and two sets for the reference lab in a manner that accounts for the potential location variation in shear force: reference lab steaks 1 & 2, third party lab steaks 3 & 4, reference lab steaks 5 & 6, third party lab steaks 7 & 8, with this order alternating among strip loins.

Randomly numbered frozen steaks will be labeled and shipped overnight by the reference laboratory to third party laboratories participating in the proficiency testing.

Equipment

Cooking. Accurate shear force can be accomplished using a variety of cooking methods using constant time or constant temperature endpoints (Wheeler et al., 2007). Cooking should be conducted in a manner and with a method known to provide consistent results. The cooking endpoint target is 71°C (160°F) (AMSA *Research Guidelines for Cookery, Sensory Evaluation and Instrumental Tenderness Measurements of Fresh Meat*). Internal steak temperature must be measured with a calibrated thermometer. Steak weights must be obtained with a calibrated scale with appropriate weighing capacity.

Shearing. Several testing machines are available that can be equipped with SSF or WBSF attachments (see *Slice Shear Force Protocol for Large Volume*, and, *Warner-Bratzler Shear Force Protocol*, USDA, Agricultural Research Service). Instruments should be equipped with a load cell appropriate for the normal operating range for SSF or for WBSF. Instruments must be properly calibrated and operated in accordance with the manufacturer's instructions.

Method/Procedure

Shear force measurements should be conducted as described in protocols by USDA, ARS U.S. Meat Animal Research Center (see *Slice Shear Force Protocol for Large Volume*, and, *Warner-Bratzler Shear Force Protocol*, USDA, ARS).

Data Collection

Data should be recorded in the spreadsheet provided by the reference laboratory. Data recorded for each individual steak will include: frozen weight, refrigerator temperature, internal thawed temperature, cooking instrument (make and model), cooking time and temperature, internal cooked temperature, cooked weight, total thaw/cook loss, SSF or WBSF.

Performance Assessment

The reference lab and the third party lab(s) will send completed data spreadsheets to USDA-LPS for performance assessment. Despite measures taken to ensure an adequate level of variation in shear force measurements, the amount of variation in a given dataset will impact all statistics associated with shear force. To account for this fact, performance criteria will be normalized to the reference lab. Proficiency will be determined by conformance to the following key performance elements.

REQUIRED KEY PERFORMANCE ELEMENTS

- Repeatability of duplicate samples must be at least 90% of the repeatability of the reference lab.
 - Repeatability will be measured as: $R = \sigma^2_{\text{sample}} / (\sigma^2_{\text{sample}} + \sigma^2_{\text{error}})$
- Accuracy measured by difference from the reference lab. The mean SSF or WBSF of the third party lab cannot be less than ($P < 0.05$) the corresponding mean SSF or mean WBSF for the reference lab. It is permissible for the third party lab to have a higher mean than the reference lab because this will result in a more conservative approval for tenderness labeling.

- Precision measured by the standard deviation of the differences (rSD). The ratio of the third party lab rSD to the reference lab rSD must be ≤ 1.40 .

APPROVAL PROCESS

Interested parties must submit their quality management plan and supporting data for review through a desk audit to the Standards and Technology Division (STD). Once the desk audit is satisfactorily completed, the quality management system is verified through an onsite audit conducted by the STD. In addition, the SSF and/or WBSF instruments will be verified over each third of the normal operating range that encompasses the tenderness standards (adapted from ASTM International Standard E 4 and F 2343). Once the onsite audit is satisfactorily completed, approval will be granted.

ADDITIONAL INFORMATION

You may find more information about a documented quality management program in GVD 1000 Procedure - Quality Systems Verification Programs General Policies and Procedures and GVD 1002 USDA Quality Systems Assessment (QSA) Program.

Questions or comments pertaining to these performance requirements and/or quality management program plan and performance assessment data spreadsheets should be submitted to:

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