



United States
Department
of
Agriculture

Agricultural
Marketing
Service

Fruit and
Vegetable
Division

Processed
Products
Branch

Grading Manual for Tomato Sauce

November 1994

This manual is designed for Processed Products Branch Personnel of the U.S. Department of Agriculture. Its purpose is to give background information and guidelines to assist in the uniform application and interpretation of U.S. grade standards, other similar specifications and special procedures.

The citation of any data, criteria, techniques, illustrations, copyrighted material, or pictorial representation accredited to private authorship is used with the permission of the individuals or sources cited. Unless a specific reference is cited, the information in this manual has been compiled or developed from sources available to the public as well as from technical knowledge of personnel in the Department.

Following the suggested guidelines in this manual does not excuse failure to comply with the Federal Food, Drug, and Cosmetic Act or any other applicable Federal or State laws or regulations.

Except for official USDA inspection aids or devices and color guides (or standards) produced under license of the Department, the mention of any supplier, patented device, product, brand name or equipment does not imply endorsement by the Department over any other similar, or equally effective material.

Address inquires to:

Chief, Processed Products Branch
Fruit and Vegetable Division, AMS
U.S. Department of Agriculture
P.O. Box 96456, Rm. 0709, South Building
Washington, DC 20090-6456

TOMATO SAUCE GRADING MANUAL

TABLE OF CONTENTS

Page No.

I.	DESCRIPTION OF PRODUCT.	1
A.	Refractive Index Versus Salt-Free Tomato Solids.	1
B.	History and Development of the Product.	1
II.	INGREDIENTS.	2
A.	Tomato Pulp.	2
B.	Other Ingredients.	2
III.	PROCESSOR CONTROL.	3
A.	Color Control.	3
B.	Consistency Control.	3
C.	Flavor Control.	3
IV.	GRADING THE PRODUCT.	4
A.	Equipment Needed.	4
B.	Suggested Order of Grading.	4
V.	EXAMINATION FOR FILTH AND EXTRANEIOUS MATTER.	11
VI.	CERTIFICATION.	12
	SCORING TOMATO SAUCE COLOR OBJECTIVELY	13

I. DESCRIPTION OF PRODUCT.

While there are many condiment sauces which contain tomato pulp as one ingredient, the tomato sauce standards cover only those sauces that are composed primarily of spiced concentrated tomato pulp which have a refractive index of 1.3455 or more.

Tomato sauce is a concentrated tomato product that has a refractive index value of not less than 1.3455.

A. Refractive Index Versus Salt-Free Tomato Solids.

Because of the practical impossibility of determining the percentage of salt-free tomato solids in a product which may contain added salt, sugar, vinegar, and other vegetable flavoring ingredients, the concentration requirement of the product is given in terms of the refractive index of the filtrate. The refractive index while easily and accurately measured, however, is not accurately convertible to total solids, specific gravity, salt-free tomato solids or sucrose in a product of this type. It is believed, however, that if the refractive index falls at 1.3455 or above and the color, flavor, and consistency of the sauce falls in the Grade A or Grade B range, there will be no question about proper concentration of the tomato ingredient.

B. History and Development of the Product.

Tomato sauce was probably developed by the first packers as a by-product of canned tomatoes; that is, a product to utilize surplus pulp made from tomato peelings and trimmings. Today in many plants it is still a by-product line--a place for the excess pulp from canning or, more importantly, a product to utilize residual tomato material after the first and often better flavored pulp has been extracted for use as tomato juice. At other plants the production of tomato sauce is a "main line" operation and the tomato ingredient consists principally of whole, pulped tomatoes. A more recent trend is the increased use tomato concentrates in the manufacture of tomato sauce.

Sauces made from residual material are often highly spiced and may contain Cayenne pepper. Such sauces are often called "hot sauce" by the manufacturers. In the United States grade standards, no distinction is made between sauces on the basis of the source of the tomato ingredient or the spices used. In fact it is not always possible to be certain of the source. Consistency may be better in product made from residual material for the same percent soluble solids.

In recent years, tomato sauce has been used quite extensively in cooking wherever tomato paste or tomato puree is used, or, as a condiment. It has, to a large extent, replaced retail size cans of tomato puree on many grocery shelves. The added spices are a convenience which appeals to home cooks.

II. INGREDIENTS.

The ingredients used in tomato sauce may be similar to those used in tomato catsup or may vary considerably. Company formulas can vary, depending on ethnic and consumer preferences. Sugar is usually added only in very small amounts, if at all, in tomato sauce while in tomato catsup approximately 50 percent of the total solids is due to added sugar. The tomato ingredient may be previously manufactured tomato paste or puree if such ingredient is declared on the label.

A. Tomato Pulp.

Tomato pulp supplies most of the important characteristics of the product. In order to obtain the desired consistency at the refractive index specified for tomato sauce, the tomato pulp from which the sauce is prepared, must be of high consistency. The pulp must have been produced in a manner so that its consistency is relatively high at refractive indexes as low as 1.3455.

Among practices which tend to increase the consistency of tomato pulp are:

1. Hot break process to preserve the action of pectic substance;
2. Recooked peelings, seed and other residue from juice
extraction;
3. Extracted high-fiber pulp from tomato juice for canning;
4. Hard-meated tomatoes, particularly pear-shaped varieties; and
5. Milled pulp (stacked fiber).

B. Other Ingredients.

There are no standardized formulas between manufacturers with respect to the amounts of sugar or vinegar or of the amount, type, or quality of the spices, onion, garlic, or other flavoring ingredients. Any vegetable flavoring such as peppers, onion, or garlic is usually added in finely ground form prior to concentrating the pulp. Just before finishing, the other spices in the form of spice oils or extracts, sugar, and salt are added. The product is usually slightly salted.

The processor usually determines the finishing point by using the refractometer.

III. PROCESSOR CONTROL.

Prior to the manufacture of the product, certain specifications of quality will have been established covering such factors as color, consistency, absence of defects, flavor, acidity and refractive index. Formulas will have been devised and methods of processing developed to meet the requirements. Quality control consists of making such adjustments as are necessary to meet the specifications. Samples are examined during and after the process in order to determine what adjustments are to be made.

A. Color Control.

Color of the pulp and also of the product is evaluated based on comparing the product color with the spinning discs as prescribed in the United States grade standards, color plates, colorimeter readings, and standard reference samples of product. Failure of the product to meet the color requirement may necessitate an adjustment in the packing practice, such as, more pulp or better pulp in the product, or a change in the manufacture of the product, depending on the cause of the loss of color.

B. Consistency Control.

The amount of pulp needed to produce the desired consistency depends to a large extent on the quality of the pulp with respect to the size and character of the insoluble material, the amount and effectiveness of the pectins and gums present. To maintain good quality control of tomato sauce the quality of the pulp should be as uniform as possible. Consistency is adjusted during processing by measuring certain characteristics of the hot sauce or of the cooled product and making adjustments by increasing or decreasing the concentration to meet the desired quality.

C. Flavor Control.

Flavor control is usually accomplished by tasting samples and comparing them with standard reference samples, making adjustments to the formula, as necessary.

IV. GRADING THE PRODUCT.

A. Equipment Needed.

1. Scale and pan.
2. Vacuum gauge.
3. Headspace gauge.
4. Large flat white trays and 12"x18" (outside dimension) shallow white trays .
5. Graph paper.
6. Equipment for determining tomato products color.
7. Refractometer.
8. Bostwick consistometer.
9. White plastic sheet and clear plexiglass sheet, 18"x18"x3/16".
10. Mold counting equipment.
11. Equipment for making filth determination.
12. Inspection instructions for tomato products, grades, and definitions.
13. Score sheets and other inspection forms.
14. U.S. Standard No. 12 sieve screen (optional)

B. Suggested Order of Grading.

1. After the nonquality factors (codes, net weights, vacuum, etc.) have been recorded, **evaluate and grade** the sample units on a container-by-container basis.

The consistency of tomato sauce is partly due to the pectin in the product. If the jell is broken by hard stirring and beating, the consistency will change. Refractometer readings, however, may not be accurate if taken only from the most liquid portion at the top of the container. For these reasons the sample unit should be prepared by **stirring gently**, just enough to fold in excessive liquid portions, before taking the refractometer reading.

Solids content in tomato sauce is expressed in terms of the refractive index (Methods of Analyses for Tomato Products, Solids Content Determinations).

2. **Stir** each container gently, **determine** and **record** the refractive index. This may be read from a direct smear or if there is difficulty in obtaining a clear line, it may be necessary to take the reading on the filtrate.

3. **Refer** to the color score guide found under the section for color of the U.S. grade standards for tomato sauce to evaluate color. Accuracy depends on approved lighting, reliable equipment, and good technique. If using USDA-approved colorimeters to determine tomato sauce color, **refer** to the APPENDIX in this manual. Otherwise:

Determine the color score using the Macbeth-Munsell Disks Colorimeter--Type 1.

Grade A Color (Good color). **Record** a score of 21 to 25 points if the color of the tomato sauce is as red or more red than the prescribed combinations of the spinning Munsell disks described in the U.S. grade standards.

Grade B Color (Reasonably good color). **Record** a score of 17 to 20 points if the tomato sauce **meets or exceeds the requirements for U.S. Grade B Color** in the U.S. grade standards **but fails to meet the requirements for good color**.

Substandard Color. Any color that is less red than Grade B or not typical of tomato sauce would receive a score of 16 points or less.

4. **Determine** the consistency by using the Bostwick Consistometer or other equipment which gives equivalent results. **Refer** to "Methods of Analyses for Tomato Products, Determination of Consistency." Consistency is determined from the product as it comes from the container. It may be mixed by stirring gently, taking care to minimize incorporating air into the product. The consistometer must be clean and dry for each determination.

Place on a steady support and level by means of the leveling screws. **Mix** sample by gently stirring and pour immediately into reservoir chamber of the consistometer. The temperature of the product in the consistometer should be as close as practicable to 20 degrees Celsius (68° F). Slightly overfill the reservoir, avoiding incorporation of air bubbles. Pass a straight-edge across the filled chamber to remove excess product, starting at the gate and working toward the back of the reservoir. Release the gate using gradual pressure on the release lever. Hold the instrument steady as the gate is released. Note the time interval, and, after 30 seconds, measure the maximum distance of product flow. Read flow distance to the nearest 0.1 cm.

Record the Bostwick consistometer reading in centimeters on the score sheet.

Place a tablespoon of tomato sauce on a flat dry tray or on a flat transparent plastic plate located over a sheet of graph paper (1/16 inch graduations) and determine the amount of "weeping" after two minutes. This test for serum separation is a supplement to the test for consistency to help determine a score point value. **Record** the amount of separation on the scoresheet. If there is very little separation of free liquid at the end of two minutes, the score may be in the Grade A range with respect to free liquid. A narrow ring of free liquid averaging 5 mm (3/16 inch) around the mass is allowed in U.S. Grade A. A ring of free liquid averaging 10 mm (3/8 in) is permitted in U.S. Grade B.

Use the score point guide in this section for consistency and assign the score for consistency and separation of free liquid. When several characteristics of a factor of quality must be considered you are expected to exercise sound judgment in weighing the effect of such characteristics in assigning score points. The following table is provided as a guide for scoring consistency. Note that a consistometer reading of less than 3 cm is considered "excessively stiff."

SCORE POINT GUIDE -- CONSISTENCY

Points	Consistometer Readings (cm)	Free Liquid (inch)
U.S. Grade A		Not More than 5 mm (3/16 in)
25	4.0 - 7.0	
24	7.1 - 9.0	1/16
23	9.1 - 11.0	2/16
22	11.1 - 12.0	3/16
U.S. Grade B		Not more than 10 mm (3/8 in)
21	3.8 - 3.9 or 12.1 - 13.0	
20	3.6 - 3.7 or 13.1 - 13.7	4/16
19	3.4 - 3.5 or 13.8 - 14.4	5/16
18	3.0 - 3.3 or 14.5 - 15.0	6/16
Substandard	More than 15.0 less than 3.0	More than 3/8 inch

Record the score points for consistency on the score sheet.

5. **Determine** the score points for defects.

The scoring of defects is based on the degree of freedom from such defects as dark brown or black specks, whole seeds, peel, core material, other similar material that affect the overall appearance of the product. Next, take a 100 gram sub-sample, with an adjusted Tomato Soluble Solids (TSS) of 8.0 to 9.0, and spread it over a smooth white

surface of at least 968 square centimeters (150 sq in). One way to accomplish this is with the use of a 12"x18" shallow white tray:

Transfer 100 grams of tomato sauce, prepared as indicated above, into the shallow tray. **Tap** the edges of the tray to distribute the product evenly at least 968 square centimeters (150 sq in) towards the edges of the tray.

Another more efficient method is to use a:

White plastic sheet, 18"x18"x3/16"; and
Clear plexiglass sheet, 18"x18"x3/16"

Transfer 100 grams of tomato sauce, prepared as indicated above, to the center of the white sheet of plastic. Then place the clear plexiglass sheet over the white plastic sheet and press gently. This will force the sauce out towards the edges. Once you have spread the sauce an average diameter of 14 to 15 inches, leaving the clear plexiglass sheet in place, you will be able to count the dark brown and black specks, whole seeds, peel, and core material, using Table I in the U.S. grade standards for tomato sauce. Other methods may be used to spread the sauce as long as the 100 grams of sauce are spread over at least a 150 square inch area.

Next, **examine** the entire contents of the container for whole seeds. Count the number of whole seeds in the sample unit.

Checking for whole seeds may be done when:

- a. The presence of seeds may be indicated from a routine (100 g) check for other defects; or
- b. There is a history of finding whole seeds.

Checking for whole seeds may be accomplished by:

- a. Examining the entire contents of the container by pouring smaller subsamples of the product onto a tray and spreading the material thin enough to detect any seeds that may be present; or
- b. Washing the entire contents of the container through a U.S. Standard No. 12 screen (if available) and count the seeds remaining on the screen.

- 6. **Record** the score points for defects on the score sheet using the following table which corresponds with the criteria for Defects in Table I of the U.S. grade standards:

DEFECTS COLOR, TYPE, OR SIZE	CLASSIFICATION		
	Minor	Major	Severe
Dark brown or black specks:			
Larger than 1.0 mm (1/32 inch), up to and including 3.2 mm (1/8 inch)	X		
Larger than 3.2 mm (1/8 inch), up to and including 6.5 mm (1/4 inch)		X	
Larger than 6.5 mm (1/4 inch)			X
Pieces of peel exceeding 5 mm (3/16 inch)	X		

The following is a guide in regulating score points with relation to the number and type of defects found.

Severe	Major	Minor/Total	Score Points	Grade
0	0	0 - 3	25	A
0	0	4 - 6	24	
0	0	7 - 9	23	
0	0	10 - 12	22	
0	0	13 - 15	21	
0	1	16 - 22	20	B
0	--	23 - 29	19	
0	2	30 - 36	18	

The most severe defect(s) limits the score. Examples:

1 major and 10 minor = 20 points

2 major and 12 minor = 18 points

Rejection numbers for various defect classifications:

Grade	Defect Classification						
	Severe		Major		Minor/Total		Seeds
A	AC	RE	AC	RE	AC	RE	Not more than 1 seed/100 oz
	N/A		0	1	15	16	
B	0	1	2	3	36	37	Not more than 5 seeds/100 oz

Remember to use the above chart as a guide. In the U.S. grade standards, any combination of defects present that does not materially affect the appearance or eating quality is Grade A. Any defects present that materially affect but does not seriously affect the appearance or eating quality is U.S. Grade B.

7. **Determine** the score points for flavor and odor. Tomato sauce is a formulated product and the flavor can be adjusted considerably by the use of different spices, amounts of sugar and acid, as well as by differing amounts of tomato pulp or different qualities of tomato pulp. Flavor is an important characteristic of tomato sauce and every effort should be made to accurately evaluate this factor to minimize personal preferences. The following may be helpful:

Tomato sauce that has a good bright color and a strong, pleasing odor will usually have a good, acceptable flavor. Therefore, in line with the wording of the standards if the tomato sauce has a flavor that indicates that good quality ingredients were used in suitable proportions and that the process was proper, a score of 21 to 25 points may be given. The proportions of the various ingredients must be considered because these strongly affect the acceptability of the flavor; that is, if the sauce is extremely acidic or very bland or too sweet, it probably would not be Grade A. No salt, excessive salt, or an excess of any condiment (except Cayenne pepper in a product declared to be a hot sauce) would lower the score. Lack of a clean, distinct tomato flavor or bitterness due to crushed seeds would tend to also lower the score.

Good flavor and odor mean a distinct tomato flavor and odor. Such flavor and odor is free from scorching or any other objectionable flavor and odor.

Reasonably good flavor and odor mean a flavor and odor in which there may be slight traces of undesirable flavor, such as scorched, bitter, or astringent flavor, but is free from objectionable off-flavors and odors.

Substandard flavor and odor mean the flavor and odor are off-flavor and do not meet the requirements for reasonably good flavor.

The flavor of tomato sauce and hot sauce must be evaluated quickly. The first impression is the best impression. **Taste** a small portion of the product and **assign** the score points for flavor and odor.

8. Determine the finish of the tomato sauce.

Good finish means the product is evenly comminuted, has uniform, smooth texture, and is free from noticeable lumps.

Poor finish means the product fails to meet the definition of "good finish".

Indicate the quality of the finish as either "good" or "poor".

9. Total the score points for defects, consistency, color, and flavor for each sample unit. If any whole seeds were found, before assigning the "lot as a whole U.S. grade," remember to go back and compare the total number of whole seeds found with the total amount of product in all the sample units. Whole seeds allowances are based on each 100 ounces of product. To determine the number of whole seeds per 100 ounces, divide the number of seeds found into total net weight of all sample units. Example: 2 whole seeds are found in 620 oz of product.

$$620/2 = 1 \text{ seed per 310 oz.}$$

One whole seed per 100 oz is allowed in Grade A, so 1 seed per 310 oz is allowed in Grade A.

V. EXAMINATION FOR FILTH AND EXTRANEIOUS MATTER.

Before assigning the "lot as a whole U.S. grade" to any processed food product, the following analyses are to be made:

Mold counts. Refer to "Methods of Analyses for Tomato Products Mold Count"

Fly egg and maggot determination.

Insect fragment and other light filth analyses.

(These to be made only if specifically directed or requested or if there is any question about sanitary manufacture or suitable raw materials.)

VI. CERTIFICATION.

In addition to applying File Code 165-A-1, Certification, the following information is also applicable to the certification of tomato sauce. The following procedure may be used for certification of the refractive index values.

Any individual sample unit may be as low as 1.3447 (corrected to 20.0 degrees Celsius) provided that the average of all sample units in the lot is equal to or greater than 1.3455.

If a product offered for inspection as tomato sauce does not meet this tolerance, the grade statement should be similar to:

"NO APPLICABLE STANDARDS FOR GRADES OF THIS PRODUCT -- refractive index less than requirement for tomato sauce."

If the tomato sauce contains an **excess** amount of Cayenne pepper, certify the grade but indicate in the body of the certificate:

Flavor -- highly spiced.

SCORING TOMATO SAUCE COLOR OBJECTIVELY

In addition to the use of the Macbeth-Munsell colorimeter other selective electronic color meters may be used as an alternate means of determining color in tomato sauce. Such meters shall be calibrated to indicate that the color of the product is as red or more red than that produced by spinning the Munsell color disks in the combination as described in the U.S. grade standards.

Methods

Tomato Sauce. Color of tomato sauce is measured as the product comes from the container. No dilution is necessary. The sample should be stirred prior to measurement. During stirring, care should be taken to avoid incorporation of air bubbles into the product. Transfer the sample to the appropriate colorimeter sample cup for measurement.

Colorimeters - Operation, Standardization and Color Score Calculation

Hunter Colorimeters:

Instrument. Use Hunterlab **D25-D2** series with type A optical head.

Selection and Use of Sample Cups. On request, U. C. Davis will supply several six-ounce cans of the calibration standard (see page 12 for address).

Color Score Point Conversions - Hunter Colorimeter

The following equation is used for calculation of tomato sauce color score:

$$\text{Score} = -154.39 + 1.1142(a_L) + 22.596(b_L) - 0.86736(b_L)^2$$

Agtron Colorimeters:

Agtron M400 and M500. Use black and red discs to set zero on scale.

Selection and Use of Sample Cups. (Agtron M400 and M500 Models). Use only pre-selected cups. On request, U. C. Davis will supply several six-ounce cans of the standard (see page 12 for address).

Color Score Point Conversions - Agtron Colorimeters

The following equation is used for calculation of tomato sauce color score:

Agtron M400 and M500 Colorimeters

$$\text{Score} = -25.002 + 1.5234(R) - 0.0092174(R^2) - 0.25817(G)$$

Gardner Colorimeters:

Instrument. Use Gardner models XL20 or XL23 series, XL-805 or Colorgard 2000/05 models.

Selection and Use of Sample Cups. Use only pre-selected cups. On request, U. C. Davis will supply several six-ounce cans of the calibration standard (see below for address).

Color Score Point Conversions - Gardner Colorimeters

The following equation is used for calculation of tomato sauce color score:

$$\text{Score} = -193.20 + 1.0211(a_L) + 27.649 (b_L) - 1.0175(b_L)^2$$

Information and Assistance

Assistance in colorimeter standardization and operation may be obtained by contacting your supervisor at the local area field office.

For further information about obtaining cans of tomato color calibration standards to use to calibrate these colorimeters, please contact:

Teri Wolcott
Department of Food Science and Technology
Cruess Hall
University of California
Davis, California 95616
(916) 752-8079