Designation: E 1870 – 98

Standard Test Method for Odor and Taste Transfer from Polymeric Packaging Film[1]

This standard is issued under the fixed designation E 1870; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a recommended procedure for examining odor and taste properties of polymeric film intended for use as flexible packaging materials. This test method can be used for single (mono) layers, coextruded, and laminate materials. The focus of this test method is the evaluation of the film in terms of its perceived inherent odor and the transfer of package-related odors, or flavors, or both, to water and other model systems (bland food simulants).

1.2 This test method assumes testing of the films at a one-time point; shelf-life testing is not included. Please see Ref (**1**)[2] for discussion of shelf-life testing.

1.3 This test method can provide sample preparation procedures and two methods of evaluation. The Film Performance Score Method allows for the comparison of any film sample to another. The Ranking Method allows for comparison of samples within a set. The preparation of samples is consistent regardless of the method of evaluation used.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health precision and determine the applicability of regulatory limitations prior to use*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1292 Test Method for Odor in Water[3]

E 460 Practice for Determining Effect of Packaging on Food and Beverage Products During Storage[4]

E 619 Practice for Evaluating Foreign Odors in Paper Packaging[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *blown film, n*—a monolayer or coextruded film blown by air into a bubble, which is then flattened.

3.1.2 *coextruded film, n*—two or more layers of resin extruded simultaneously. These layers may be different resins or the same resin.

3.1.3 *direct contact, n*—packaging material in physical contact with test medium.

3.1.4 *extrusion coating, n*—the process of applying a molten polymer to a moving substrate.

3.1.5 *film performance score (FPS), n*—the FPS is a simple calculation that allows for the comparison of one film sample to another, as long as the same battery of tests is performed on each of the film samples. The FPS is calculated by summing the average score for each of the tests in the battery. The FPS can be used to rate acceptability by comparing it to that of known acceptable material.

3.1.6 *indirect contact, n*—packaging material not in physical contact with test medium but sharing the same confined airspace with the medium.

3.1.7 *laminated film, n*—the process of using a molten polymer to adhere two substrates to each other.

3.1.8 *monolayer film, n*—a film consisting of a single layer of one packaging material or resin.

4. Summary of Test Method

4.1 The inherent odor level of the film is estimated from the intensity of odors developed upon confinement. The potential for contamination of packaged products by transfer from the film is determined by its effect on the taste, or odor, or both, of several substrates. Model systems, such as mineral oil, water, butter, milk chocolate, or apple juice, or combination thereof, are possible media for transfer.

4.2 The complete procedure includes three categories of tests that use various media and temperatures:

4.2.1 *Confined Aroma (Inherent Odor at Ambient or Elevated Temperature).*

4.2.2 *Indirect Transfer (Vapor Transfer) Tests*:

4.2.2.1 Mineral oil for odor transfer;

4.2.2.2 Spring water for odor and flavor transfer; and

4.2.2.3 Other media, such as butter, milk chocolate, or apple juice.

4.2.3 *Direct Transfer Tests*:

4.2.3.1 Mineral oil for odor;

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[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[3] *Annual Book of ASTM Standards*, Vol 11.01.

[4] *Annual Book of ASTM Standards*, Vol 15.07.

4.2.3.2 Spring water for odor and flavor;

4.2.3.3 Other media, such as butter, milk chocolate, or apple juice; and

4.2.3.4 Ambient and elevated temperature testing.

4.2.4 Mineral oil and spring water serve as bland simulants for fatty and aqueous food products, respectively. The actual test media used should be selected to be most representative of the product(s) that will be packaged, that is, fatty, aqueous, acidic, dry, etc., or particularly sensitive to the effects of packaging materials.

4.2.5 Typically, tests are conducted at ambient temperature, but additional performance information can be gained by subjecting the direct transfer tests to an elevated temperature. Temperature selection should be based on intended use and storage conditions. See 13.2 for further discussion.

4.2.6 While the complete procedure of conducting all categories of tests is recommended, this may not always be practical due to limited resources, such as time, staff, or samples, or a combination thereof. At a minimum, testing of direct contact with a model system, that is, water, mineral oil, etc., representing final usage of product, as well as testing of inherent odor level should be conducted.

4.3 An experienced panel of at least five panelists evaluates the samples. Odor and taste intensities are either ranked or rated, depending upon the evaluation approach.

4.3.1 Ranking evaluations are conducted by comparing intensities within a sample set (see Appendix X3). Odor and flavor notes identified by panel members are reported as a qualitative description for each sample. These identified notes may be useful for diagnostic purposes (see Appendix X2 and Appendix X3).

4.3.2 For the rating approach, a sample is given an intensity rating for odor or flavor for each test. To obtain the sample film performance score (FPS), intensity ratings are averaged for each test, then summed across all tests (see Appendix X1 and Appendix X2).

NOTE 1—The calculation of the FPS may only be used to compare samples for which the same battery of tests has been performed.

4.4 Acceptance or rejection of a sample is determined by comparing its FPS or ranking score to that of representative films known to be acceptable for the relevant end uses. Permissible variation from such a standard is estimated from the variance of the ratings for the representative films.

4.5 This test method is consistent with the background information presented in Refs (**2-4**).

5. Significance and Use

5.1 This test method is designed for use by a trained sensory panel experienced in using an intensity scale or rank ordering and familiar with the descriptive terminology and references associated with the packaging materials. Data analysis and interpretation should be conducted by a trained and experienced sensory professional. See Refs (**4-5**) for discussions on panelist screening and training.

5.2 This test method should be considered as a screening technique for suppliers and end-users to use in assessing flavor impact of packaging films. The application of this test method will result in a FPS or rank data. The determination for suitability of a packaging film for a particular end-use should be based on a set of predetermined criteria including the FPS or rank score. Information obtained from the transfer tests can also be used to evaluate the origin of any transferred tastes or odors.

6. Testing Facilities and Personnel

6.1 All testing should be carried out in a location that is odor-free, quiet, temperature-controlled, and not used for chemical experimentation (Note 1). Folding tables, about 6 ft in length are convenient for sample preparation and testing. Unlaminated wood should be avoided as it may be very odorous and it is apt to absorb spills. Three such tables or their equivalent in bench space are needed. Freestanding, open metal shelves are useful for storing test equipment. Pegboards permit the storage of glassware so that air can circulate freely yet dust is kept to a minimum. Glasses should not be inverted on shelves as they can pick up and trap odor from shelving. For a general discourse on testing facilities, see Refs (**3, 6**).

6.2 All personnel, that is staff and panelists, should take precautions to minimize extraneous odors, that is personal-care products, smoke, food products, etc.

6.3 This test method is intended for use by trained panels under leadership of a sensory professional. For discussions on training panelists see Refs (**4-10**).

7. Apparatus

7.1 *Pyrex™ Glass Confinement Jars*, cylindrical, approximately 10 in (25 to 31 cm) in diameter, available from most laboratory glassware suppliers.

7.2 *Plate Glass Covers*, approximately 12 (by) 12 in. (31 (by) 31 cm), lightly beveled to remove sharp edges, obtainable from any glass shop; used to cover jars in 7.1.

7.3 *Petri Dishes*, glass, 4-in diameter, with tops.

7.4 *Plastic Spoons*, disposable, with no discernible taste or odor.

7.5 *Glass Bottles*, wide-mouthed, clean and odor-free, with screw-on tops, 4-oz size.

7.6 *Aluminum Foil*, wiped clean with toweling or cheesecloth.

7.7 *Glass Beakers*, 150-mL size, clean and odor-free.

7.8 *Watch Glasses*, of a size appropriate to fit over the top of the beaker described in 7.7.

8. Materials

8.1 *Mineral Oil*, odorless and high purity. Store in brown glass bottle away from light and heat.

8.2 *Water*, as odorless and tasteless as possible. If local water is of inadequate quality, bottled spring water may be used, or the water may be purified with activated carbon as described in Test Method D 1292. Do not use water stored in high density polyethylene (HDPE) containers.

8.3 *Butter*, (salted), with fresh flavor and aroma, either recently purchased or stored in foil or in an airtight container in a refrigerator or freezer.

8.4 *Milk Chocolate*, good quality chocolate in bar form.

8.5 Assurances should be made that any other product used as a substrate is free off-notes and is typical of that product.

9. Glassware Cleaning

9.1 The jars, bottles, lids, and petri dishes should be clean and odor-free. Wash carefully with an unscented detergent, and rinse well. Glassware should be rinsed finally with whatever water will be used for testing and then air-dried or dried in a drying oven at 250°F (120°C). Care should be taken to ensure that the drying oven is also odor-free. Glassware can develop a chalky character over time, which cannot be removed by cleaning. Such glassware should not be used for odor and flavor evaluations.

10. Sampling

10.1 The ideal sample should be a roll of film, ¼ in. (6.35 mm) or more in depth on the fiber core. Alternatively, a stack of sheets obtained by cutting across a large roll with a knife to a depth of ¼ in. or more (a slab) may be submitted, provided it has been promptly rolled up and tightly wrapped in clean aluminum foil. Remove at least a dozen layers from the outside of the roll or slab before removing sections of film for testing.

10.2 Fresh cut edges of monolayer samples should be used to maximize transfer of volatile compounds; however, fresh cut edges should be avoided when evaluating laminates or coextruded samples. This test method, therefore, utilizes pouches for evaluating laminates or coextruded samples.

11. Sampling Controls

11.1 Use fragrance-free soap to wash hands before preparing samples. This will prevent bacterial contamination of the samples, as well as minimize any odors that could be transferred to the samples.

11.2 All materials for contact, for example, glassware, water, etc., should be pretested for absence of odor and flavor.

11.3 Samples should be kept wrapped in uncoated, odorless aluminum foil prior to testing.

11.4 Avoid contact of samples with anything that could result in odors. This includes marking samples with magic markers, storing samples in plastic bags, and using adhesive tape or labels to seal samples.

11.5 It is critical to this test method that the same ratio of surface area to volume be maintained for each sample within a run and from run to run, otherwise test scores may not be compared to one another or to tests run at a previous time.

12. Preparation for Confined Film Odor and Odor/Taste Transfer by Indirect (Vapor) Contact

12.1 For each film, cut four pieces 1-yd^2 (0.9-m^2) in area from the sample roll (after discarding the outer layers). As each piece is cut, crumple it loosely, place it in a glass confinement jar, and cover it immediately with a square of plate glass. For printed films and laminates, fold the film so that the inner (contact) layer is facing outward, then seal the edges of the film (see 13.7.3). Place an identifying label on each jar. One of the jars will be used for the odor of confined film. Set up the remaining three for indirect transfer tests as described in 12.1-12.6.

12.2 Code a set of four covered petri dishes with randomly selected three-digit numbers. Place two of these dishes on top of the first jar and one on each of the others. Put 25 mL of mineral oil in one 25 mL of water in the other petri dish on the first jar. In the next, place two 1 × 1 × ¼ in. (2.5 × 2.5× 0.6 cm) pats of butter. In the remaining dish place about ½ oz (approximately 14-g) milk chocolate cut into approximately ½ in. (1.3-cm) cubes. Remove each jar lid momentarily and place the uncovered bottom section of the petri dishes in on the crumpled film (Note 2). Prepare a set of transfer media for each film sample. Record the code numbers of the sets.

NOTE 2—A single jar and portion of film can be used for testing transfer to both mineral oil and water because there is no cross transfer between these two media.

12.3 Prepare two additional sets of test media, that is, mineral oil, water, butter, and milk chocolate in petri dishes, for use as blank controls. Do not expose the test media to film. Code one set with randomly selected three-digit numbers, and label the other set as "known blank controls." Place the uncovered butter blank controls in one glass jar, the chocolate blank controls in a second, and the mineral oil and water blank controls in a third.

12.4 Allow the prepared samples and blank controls to stand at room temperature for at least 16 h but no longer than 24 h. Then, remove the petri dishes from the jars and replace the petri dish tops.

12.5 Line up in random order the coded portions of mineral oil exposed to the film samples and the coded (blind) blank control, with the known blank control at the head of the line. Similarly, arrange the water, butter, and chocolate samples.

12.6 Identify with three-digit codes for the jars containing film samples for the evaluation of confined odor intensity, and rearrange the jars in random order.

13. Preparation for Odor/Taste Transfer by Direct Contact

13.1 The following procedure will provide enough sample for evaluation by five panelists.

13.2 The usual ratio of surface area to test medium for direct contact testing is approximately 15 in.^{2}/3 oz (1 cm^2/mL). This provides a surface area to medium ratio similar to that of many packaged food products.

13.3 The temperature of the test medium at time of exposure to film sample can be varied to be consistent with the intended use of the film (for example, hot fill at 180°F (82°C) or cold fill at 72°F (22°C). Likewise, storage temperature of film exposed to test media can vary from 72 to 140°F (22 to 60°C) depending on intended product life cycle. It is important that exposure temperature be consistent within an experiment form sample to sample, as well as appropriate for the chosen substrate, for example, higher temperatures would not be appropriate for butter or chocolate as substrates.

13.4 For blown film, which is actually a flattened bubble, the film must be reopended in order to have the correct volume to surface ratio. For ease of separation of the film, stick a piece of tape on the corner of the creased edge and another on the cut edge of the film and pull them apart.

13.5 For extrusion coated films that can be separated from the substrate and that do not contain primers or adhesives, peel extrusion coating from substrate and discard the substrate. This process may have application primarily for resin suppliers and converters.

13.6 For monolayer films, that is, a single layer of material, reopened blow film, and extrusion coated films separated from their substrate, use the following procedure:

13.6.1 Cut eight pieces of each film 1 × 3 in. (2.5 × 7.5 cm) after discarding the outer layers of the sample roll, that is, approximately ¼ of the way into the sample. Place two film pieces in each of four 4-oz glass bottles coded with three-digit random numbers.

NOTE 3—Resin suppliers and converters should take film thickness into account when conducting evaluations. Be sure the thickness is consistent among the samples unless this is the variable being evaluated.

13.6.2 To two of the jars add 75 mL (2.5 oz) of mineral oil; to the other two, add 75 mL of water. Cover jars with a small piece of clean aluminum foil, shiny side down and of sufficient size to cover entire opening. Carefully, to avoid disruption foil, screw on cap over foil to close jar.

13.6.3 Prepare two similar jars without film containing water and two similar jars without film containing mineral oil as blank controls, or more if blind blank controls are to be included.

13.6.4 For each film and blank control, select one jar of mineral oil and one of water to be placed in an oven at 140°F (60°C) for 24 h. The other set will remain at ambient temperature for 24 h.

13.6.5 Remove jars from oven after 24 h and allow to cool to room temperature before proceeding (at least 1 h).

13.6.6 Remove caps and foil from all samples and blank controls. From each, pour off approximately 2 oz (60 ml) of test medium into a labeled 150 mL beaker, and cover with a watch glass.

13.7 For extrusion coated films where the coating cannot be separated from the substrate and for laminated film structures use the following procedure:

13.7.1 Pouches must be made from these types of materials in order to ensure that transfer occurs only from the contact layer of the film. The volume to surface ratio of the pouches should be representative of the final product or consistent with the ratios used in previous evaluations.

13.7.2 Cut eight 6.5 × 6.5 in. (16.25 × 16.25 cm) squares from each sample. This process should be consistent with a 1 cm^2/mL volume to surface ratio.

13.7.3 Using an impulse sealer, and seal two of the squares together (substrate to the outside) until an inseparable seal is made to make a pouch whose inner dimensions are 6 × 5 in (15 × 12.5 cm). Seal only three sides.

13.7.4 Repeat the procedure until four pouches have been made from each sample.

13.7.5 Pour approximately 10.5 oz (300 mL) mineral oil into each of two pouches and 10.5 oz (300 mL) of water into the outer two pouches. Remove air by pressing gently on bag and seal the top of each pouch to form a 5 × 5 $in.^2$ (12.5 × 12.5 $cm)^2$ pouch.

13.7.6 Lay pouches flat and store one set at room temperature and one set at 140°F (60°C) for at least 16 but no more than 24 h.

13.7.7 Cool pouches to room temperature and cut open. Pour (2 oz) (60 mL) of the test media into labeled 150 mL beaker, and cover with a watch glass. Allow the samples to equilibrate for at least 30 min before evaluating.

14. Evaluation Method Procedure

14.1 There are two recommended methods: obtaining a Film Performance Score (FPS) and ranking.

14.2 Up to four film samples may be evaluated in one panel session. Testing more than four samples at one time can cause fatigue and adversely affect the results.

14.3 To minimize bias due to order of presentation, carry over, and halo effects, present samples to the panelists according to a balanced block design if possible. Balanced incomplete block designs can also be used. For more information, see Refs (**3, 10-12**).

14.4 In addition to rating/ranking the samples, the panelists may also describe the off-odor or off-flavor detected. A glossary of descriptive terms (see Appendix X2), or selected reference standards, or both are helpful (**13**).

14.5 Alert panelists to the possible presence of coded controls.

14.6 Provide a scoresheet for each test with spaces for recording sample codes, numerical ratings/rankings, and qualitative descriptions.

14.7 Within each test, evaluate the samples in the order in which they are aligned on the table. In order to minimize carry-over effects, perform the tests in the following sequence: mineral oil odor, water odor, water flavor, butter odor, butter flavor, and chocolate flavor. The confined film odor may be done at any convenient time.

14.8 *FPS Method (Rating)*:

14.8.1 Use an experienced panel of at least five panelists.

14.8.2 Use any suitable intensity scale for film performance score ratings; however, the panelists should be trained in use of the scale. Training should include references to illustrate the intensity of the scale anchors.

14.8.3 For each test in the battery except confined film odor, the panelists rate the intensity of the odor or flavor perceived in the known blank control and then rate each unknown as compared to this known blank control. Ratings are conducted on an absolute basis assuming room air as the control. For the confined film odor tests, a known blank control is not used.

14.9 *Ranking Method*:

14.9.1 Panelists should be familiar with the rank order method.

14.9.2 For each test in the battery, samples are ranked from least intense to most intense. A known blank control may be used as a reference.

14.9.3 The panelists rank the intensity of the odor or flavor perceived in each unknown as compared to the other unknown samples. Ranking is conducted based upon the relative intensities of the samples.

14.10 *Techniques of Examination*:

14.10.1 For all odor transfer tests, first evaluate the blank control if provided by moving the watch glass back slightly and

sniffing the sample. Rest for 10 to 15 s, then evaluate the unknowns using the same procedure, resting 10 to 15 s between each sample. Repeat if necessary to decide on the descriptors, but the intensity rating or ranking should be decided on the first sniff. Record results and proceed to the other samples. The blank control may be resampled as needed.

14.10.2 For the taste transfer tests, try the known blank control at the outset, then taste and rate each of the unknown samples in turn. Panelists may taste the known blank control again any time they feel it is necessary, but tasting it immediately before each unknown is not required and may cause fatigue. Evaluating two samples of the blank control, the first being used as a warm-up, may also be desirable. Repeat tasting of the samples if necessary to decide on the descriptors, but the intensity rating or ranking should be decided on the first taste.

14.10.3 Wait at least 15 s after tasting each sample before trying the next. If a sample has a strong flavor intensity, rinse mouth with spring water and wait at least 1 min before proceeding to the next sample.

14.10.4 Use a separate plastic spoon each time the water and butter samples are tasted. Take butter samples from the top surface layer in so far as possible.

14.11 For the confined film odor test, slide the glass plate about 1 in. to one side, and sniff the air in the jar once or twice. Replace the cover immediately, and record the intensity and descriptors.

15. Data Analysis

15.1 Obtain the average of the rating or ranking reported in each test.

15.2 *Rating Scores*:

15.2.1 Calculate the FPS for each film sample. The FPS can be calculated as the sum of the averages or the average of the averages for the separate tests in the battery (see 4.2 for a list of tests). As a caution, if you are using only a portion of the tests in the battery, compare just the results of those tests (see Appendix X2).

15.2.2 Compare the FPS for each sample with its appropriate reference score to determine whether the sample FPS falls within the permissible limits that have been established as described in Section 16.

15.3 For ranking scores, analyze the data using a nonparametric analysis of variance test, such as the Friedman test, followed by a multiple comparison test.

15.4 Summarize the qualitative descriptions into relevant categories.

16. Reference FPS Scores and Limits

16.1 The maximum acceptable FPS or rank score depends to a large extent on the packaging application intended and will also vary with the type of film. This means that a single approach to the problem would be inappropriate. Confidence in the FPS or rank score depends upon the number of times the product is tested and the number of types of media used. A minimum of three replications is recommended in order to determine the range of the FPS or rank scores per media type.

16.2 A useful general basis is the FPS level obtained by testing samples of film already known to be acceptable. Including an acceptable film in the ranking test allows for a direct overall comparison to the test sample.

16.3 *Reference Scores*:

16.3.1 Determine the average FPS or rank score for each type of film by testing a number of samples (at least three) known to be acceptable, using experienced panelists and if possible the same panelists that will do the control testing (in the case of the FPS).

16.3.2 This reference score should be continuously revised and updated by including data obtained in the routine testing of production samples that prove to be acceptable.

16.4 *Judgmental Limits*:

16.4.1 This category is included in recognition of the fact that some films may be acceptable for some applications even though their FPS or rank scores may be outside the statistically determined limits as described above.

16.4.2 Setting such relaxed limits must be on the basis of experience and negotiation between manufacturer and purchaser. No guidance can be provided here.

17. Interpretation

17.1 The decision is usually based upon the overall FPS; however, in certain applications the separate scores obtained in one or more subtests may be more critical. This will depend upon the intended end use of the film and the objectives of the study.

17.2 When using judgmental criteria, acceptance or rejection is based upon comparison of the obtained FPS with the negotiated limit. No statistical testing is involved.

17.3 The statistical analysis of ranking data will indicate whether there are significant differences among the samples and versus the blank control. The decision to use the packages is based upon the test objectives.

18. Special Considerations

18.1 The ratings for the unidentified (blind) blank controls, are nominally zero and should always be very low. The ranking for the unidentified (blind) blank controls should typically be least intense. They are used internally to evaluate individual panelist performance and quality of test materials. Panelists who consistently rate these samples significantly above zero or rank them high should be dropped or retrained. Several panelists rating these samples above zero may be an indication of contamination and the test should be repeated.

18.2 It may be useful to include a summary of the qualitative descriptions in any test report. Providing a summary particularly is helpful when a sample has been rejected, for it may suggest possible reasons for the high FPS or rank score.

18.3 Rejects may also be reported in categories, such as good, borderline acceptable, and rejected.

19. Precision and Bias

19.1 Variance of FPS ratings of acceptable samples are calculated and are used to determine any subsequent sample's acceptability. The same panelists must be used for all evaluations. Judgmental options, as described in Section 18, are such that a statement of statistical precision and bias is not applicable.

20. Keywords

20.1 film; odor; packaging; taste

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE NO. 1—FILM PERFORMANCE SCORE (FPS)

X1.1 *Design*—A blank control and five samples were evaluated by five experienced panelists, using a rating technique. The entire battery of tests was performed on all samples to obtain a total FPS on each sample.

X1.2 *Criteria*—The blind control must score less than 2.0 for an acceptable evaluation. Based upon historical data with this panel, any total FPS greater than 8.0 would indicate a failure for the package for this example. A total FPS below 8.0 would indicate an acceptable package.

X1.3 *Results*—See Table X1.1. The blank control and the blind control, sample 813, both received a total FPS of 0.4, indicating an acceptable run. Sample 658 received a total FPS of 11.4, and thus failed. Samples 274, 572, and 401 all received total FPS scores below 8.0, and thus passed. Samples 274 and 572 received total FPS scores of 0.9 and 4, respectively, and were rated as GOOD, where sample 401 received a total FPS score or 6.2 and was rated as ACCEPTABLE.

X2. EXAMPLE NO. 2—FILM PERFORMANCE SCORE (FPS)

X2.1 *Design*—A blank control and five samples were evaluated by five experienced panelists, using a rating technique. Samples 356 and 443 were not tested using butter or milk chocolate, and thus, could only be evaluated using a modified FPS. The entire battery of tests was performed on all other samples.

X2.2 *Criteria*—The blind control must score less than 2.0 for an acceptable evaluation. Based upon historical data with this panel, any total FPS greater than 8.0 or a modified score of 7.0 would indicate a failure for the package for this example. A total FPS below 8.0 or a modified score of 7.0 would indicate an acceptable package. Samples 356 and 443 can be compared by modified FPS scores only, due to incomplete testing. The modified FPS is calculated on all samples by summing the scores for all tests except butter and chocolate. Since the sum of 7 tests versus 9 tests may be a lower score, historical data must be considered when evaluating these scores for pass/fail criteria. In this case, 7.0 has been determined as the acceptable limit.

X2.3 *Results*—See Table X2.1. The blank control received a total FPS of 0.4. The blind control, sample 443, received modified FPS of 0.4 and an average FPS of 0.057. This indicates an acceptable run. Sample 356 received modified FPS score of 8.6 and an average FPS score of 1.229, which would indicate a failure of the package. Samples 274, 572, and 401 all received total FPS scores below 8.0 and thus passed. Samples 274 and 572 received total FPS scores of 0.9 and 4, respectively, and were rated as GOOD, where sample 401 received a total FPS score or 6.2 and was related as ACCEPTABLE.

X3. EXAMPLE NO. 3—RANKING EVALUATION

X3.1 *Design*—Four samples of LLDPE blown film were compared by 24 panelists using a ranking technique.

X3.2 *Results*—Sample C contributed a more intense taste to water. No significant odor differences were detected among the samples.

Sample	Intensity Ranking	
	Taste	Odor
A	2.14	2.04
B	2.16	2.40
D	2.31	2.50
C	3.37	2.93

where:

Intensity Ranking Scale: 1 = least intense 4 = most intense.

Significance Levels Taste			
Sample	to	Sample	Significance Level
C	>	A	1.0 %
C	>	B	1.0 %
C	>	D	2.5 %

X3.2.1 *Odor*—No significant differences were found at confidence levels of 90 % or higher.

Sample Preparation:
Taste:
Test medium: Ozarka brand drinking water.
Sample: blown film.
Contact time: 20 h at room temperature.