ASTA
CLEANLINESS SPECIFICATIONS
FOR
SPICES, SEEDS, AND HERBS

(FOREIGN and DOMESTICALLY PRODUCED)

REVISED 2014

American Spice Trade Association
www.astaspice.org

PREFACE

ASTA adopted the original Cleanliness Specifications for spices in 1969 and while they have been revised numerous times, the goal of the specifications has remained unchanged over the years. ASTA seeks to ensure that the spices traded by its members meet federal regulatory requirements for safety and cleanliness before being further processed into acceptable finished products for consumption at the consumer, food service and industrial level.

The ASTA Cleanliness Specifications were designed to meet or exceed the U. S. Food and Drug Administration (FDA) Defect Action Levels (DALs). ASTA's Cleanliness Specifications establish limits for macroscopic extraneous matter for spices coming into the U. S. The Cleanliness Specifications also include microscopic filth limits (e.g. insect fragments, rodent hairs) for specific processed products that are also addressed by the FDA DALs.

The ASTA Cleanliness Specifications are widely recognized within the spice industry and members are encouraged to apply them in transactions between buyers and sellers of spices, including instances when an ASTA contract is utilized.

The ASTA Cleanliness Specifications are provided as a service to ASTA members on issues related to clean, safe spices. ASTA provides the Cleanliness Specifications without providing any warranties of any kind, either express or implied, including but not limited to warranties of merchantability, fitness for a particular purpose, accuracy, design, usage, quality, performance, compatibility, or title. ASTA is not responsible for the use or nonuse of any information presented or discussed in the Cleanliness Specifications. It is the responsibility of each ASTA member to verify information presented in the Cleanliness Specifications before acting on it, and to comply with all relevant federal, state, and local laws.

CLEANLINESS SPECIFICATIONS

For purposes of these Specifications, extraneous matter is defined as everything foreign to the product itself and includes, but is not restricted to: stones, dirt, wire, string, stems, sticks, nontoxic foreign seeds, excreta, manure and animal contamination.

The level of contaminants permitted under these Specifications must fall below those shown on the following table, except for the column ∆ "Whole Insects, Dead" which cannot exceed the limits shown. The list below does not have every item on the ASTA spice list. Please check current FDA DAL'S (link below)

CLEANLINESS SPECIFICATIONS	**∆ WHOLE INSECTS, DEAD**	**EXCRETA, MAMMALIAN**	**EXCRETA, OTHER**	**MOLD**	**INSECT DEFILED/ INFESTED**	**EXTRANEOUS/ FOREIGN MATTER**
Name of Spice, Seed or Herb	**By Count**	**By Mg./Lb.**	**By Mg./Lb.**	**% By Wgt.**	**% By Wgt.**	**% By Wgt.**
Allspice	2	5	5.0	2.00	1.00	0.50
Anise	4	3	5.0	1.00	1.00	1.00
Sweet Basil	2	1	2.0	1.00	1.00	0.50 ■
Caraway	4	3	10.0	1.00	1.00	0.50
Cardamom	4	3	1.0	1.00	1.00	0.50
Cassia	2	1	1.0	5.00	2.50	0.50
Cinnamon	2	1	2.0	1.00	1.00	0.50
Celery Seed	4	3	3.0	1.00	1.00	0.50
Chillies*	4	1	8.0	3.00	2.50	0.50
Cloves**	4	5	8.0	1.00	1.00	1.00 *
Coriander	4	3	10.0	1.00	1.00	0.50
Cumin Seed	4	3	5.0	1.00	1.00	0.50
Dill Seed	4	3	2.0	1.00	1.00	0.50
Fennel Seed	SF(2)	SF(2)	SF(2)	1.00	1.00	0.50
Ginger	4	3	3.0	SF(3)	SF(3)	1.00
Laurel Leaves***	2	1	10.0	2.00	2.50	0.50
Mace	4	3	1.0	2.00	1.00	0.50
Marjoram	3	1	10.0	1.00	1.00	1.00 ■
Nutmeg (Broken)	4	5	1.0	SF(4)	SF(4)	0.50
Nutmeg (Whole)	4	0	0.0	SF(5)	SF(5)	0.00
Oregano	3	1	10.0	1.00	1.00	1.00 ■
Black Pepper	2	1	5.0	SF(6)	SF(6)	1.00
White Pepper*****	2	1	1.0	SF(7)	SF(7)	0.50
Poppy Seed	2	3	3.0	1.00	1.00	0.50
Rosemary Leaves	2	1	4.0	1.00	1.00	0.50 ■
Sage***	2	1	4.0	1.00	1.00	0.50
Savory	2	1	10.0	1.00	1.00	0.50 ■
Sesame Seed	4	5	10.0	1.00	1.00	0.50
Sesame Seed, Hulled	4	5	1.0	1.00	1.00	0.50
Tarragon	2	1	1.0	1.00	1.00	0.50 ■
Thyme	4	1	5.0	1.00	1.00	0.50 ■
Turmeric	3	5	5.0	3.00	2.50	0.50

Cleanliness Specifications - Footnotes:

* **Chillies** 3% moldy and/or insect infested by weight.

** **Clove Stems:** Less than (<) 5% allowance by weight for unattached clove stems over and above the tolerance for Other Extraneous Matter is permitted.

*** **Laurel Leaves:** **Sage:** "Stems" will be reported separately for economic purposes and will not represent a pass/fail criteria.

*****	**White Pepper:**	"Percent Black Pepper" will be reported separately for economic purposes and will not represent a pass/fail criteria.
(2)	**Fennel Seed:**	In the case of Fennel Seed, if 20% or more of the subsamples contain any rodent, other excreta or whole insects, or an average of 3 mg/lb or more of mammalian excreta, the lot must be reconditioned.
(3)	**Ginger:**	More than 3% moldy pieces and/or insect infested pieces by weight.
(4)	**Broken Nutmeg:**	More than 5% mold/insect defiled combined by weight.
(5)	**Whole Nutmeg:**	More than 10% insect infested and/or moldy pieces, with a maximum of 5% insect defiled pieces by count.
(6)	**Black Pepper:**	1% moldy and/or infested pieces by weight.
(7)	**White Pepper:**	1% moldy and/or infested pieces by weight.
Δ	**Whole Insects, Dead:**	Cannot exceed the limits shown**.** This includes equivalent whole insects (see C. below)
■	**Extraneous Matter:**	Includes other plant material, e. g. Foreign leaves (see ASTA method 26.0)

GROUND PROCESSED SPICE *

(Cannot exceed limit shown)

Spices	Whole Equivalent Insects	Insect Fragments	Mites	Other Insects	Rats/ Mouse Hairs	Animal Hairs
Ground Paprika		Average of more than 75 fragments /25g			Average of more than 11 rodent hairs/25g	

*** Microanalytical Methods for Paprika and Ground Capsicums can be found in the "Analytical Procedures" section of this book.**

The FDA Defect Action Level Handbook is available on the FDA Web site at www.fda.gov

Insect fragments must have one of the following characteristics:†

- Readily recognizable shape of a whole or a portion of a specific appendage or body part.
- An articulation or joint.
- One or more setae arising from a pit (**Note**: Setae must not have a cellular structure.)
- One or more setal pits.
- Surface sculpture characteristic of a specific insect or part thereof.
- One or more sutures.

† "Light and Heavy Filth," AOAC Official Method 970.66, Section B.(h), *Official Methods of Analysis*, 19th Edition (2012), AOAC International: Gaithersburg, MD.

IN ADDITION TO THE PRECEDING SPECIFICATIONS, A LOT MUST ALSO BE RECONDITIONED:

A. MAMMALIAN EXCRETA -

if the average of the total number of subsamples exceeds the listed milligram per pound Specification.

Exception: In the case of fennel seed, see footnote (2).

B. OTHER EXCRETA -

if the average weight expressed as milligrams per pound for all subdivisions of the sample exceeds the specified values shown in the table.

Exception: In the case of fennel, see footnote (2).

NOTE: The Food and Drug Administration specifies only mammalian excreta, ASTA will count all types of non-mammalian excreta as Other Excreta. FDA does retain the right to detain merchandise containing excessive amounts of excreta which is of non-mammalian origin on the basis that the merchandise was exposed to Insanitary Conditions.

C. INSECTS –

WHOLE OR EQUIVALENT INSECT

A whole insect, separate head, or body portions with head attached. ("Light and Heavy Filth," AOAC Official Method 970.66, Section B.(i), *Official Methods of Analysis*, 19th Edition (2012), AOAC International: Gaithersburg, MD.)

If the total number of whole dead insects found in the total number of the subsamples exceeds the specified value shown in the table.

if live insects are found in the original sample reconditioning is to include fumigating. If the number of live and dead insects exceed the cleanliness specification for whole dead insects for that spice, then reconditioning must also include sifting and blowing, requiring samples to be drawn and analyzed.

Exceptions:

a. In the case of fennel seed, if 20% or more of the subsamples contain any whole insects, the lot must be reconditioned. (For example, if two or more subsamples of a ten-unit sample each contains one whole insect, the lot must be reconditioned.)

b. If the number of live insects found in the total number of subsamples are less than the cleanliness specifications for whole insects for that spice, the lot must be fumigated and then resampled.

c. If it appears to the unaided eye that 50 or more mites and psocids are present, the lot must be fumigated, sifted and blown. Mites and/or psocids are not to be counted as insects.

D. MOLD -

if mold is present, as expressed by percent by weight of the total quantity of spice in all subsamples, in excess of the specified values shown in the table. A product is classified as moldy if it contains mold, visible to the naked eye, exceeding 1/4 of its surface area or in the case of capsicum pods, has an aggregate area > 1 cm^2 (MPM v.8). and confirmed by the presence of mycelial filaments and spores when examined with the aid of a microscope (40 X magnification or less).

E. INSECT DEFILED/INFESTED -

if the total sample quantity exceeds the specified values shown in the table expressed as percent by weight of insect infested, bored, or otherwise defiled seeds, leaves or roots. Before reconditioning a lot is considered defiled whenever a sample shows visible evidence of webbing or definite insect feeding.

F. RECONDITIONING AND RECONDITIONED ITEMS -

Reconditioning may include, but shall not be limited to, techniques such as fumigating, washing, cutting, sifting, aspirating and blowing.

Insect channels or insect-bored holes in reconditioned spices will not be counted as insect defiled, as they would in the examination of non-reconditioned spices, provided there are no insects, webbing or excreta in those channels or holes.

G. LIGHT BERRIES - Black Pepper -

if the light berries, though not considered extraneous matter, exceed 4% by weight.

SAMPLING AND ANALYTICAL PROCEDURES

A. SAMPLING -

i. Each lot distinguished by specific chop marks/markings and/or numbers must be sampled/analyzed separately. A lot shall be defined as not to exceed one container load, where applicable. No commingling is permitted.

ii. In sampling merchandise for analysis under these specifications, the number of samples drawn must be equal to the square root of the packages, bags or containers in the lot with a maximum of ten samples drawn. In the event that this is for ground/crushed processed spices the number of samples drawn must be six.

iii. The sample size shall be 3/4 to 1 pound for the high density items. These include: Black and White Pepper, Cassia, Cinnamon (Seychelle), Nutmeg (Whole and Broken), Ginger, Cloves, Allspice/Pimento, Turmeric, Celery Seed, Poppy Seed, Sesame Seed, Caraway Seed, Cardamom Seed, Anise Seed, Coriander Seed, Cumin Seed, Dill Seed, and Fennel Seed.

The sample size shall be 1/2 to 3/4 of a pound for the low density items. These include: Chillies, Capsicums, Mace, Sage, Oregano Leaves, Basil Leaves, Laurel Leaves, Thyme Leaves, Rosemary Leaves, Tarragon Leaves, Marjoram Leaves and Savory Leaves.

iv. The sampling size shall be 4-6 ounces (113-170 grams) for ground/crushed processed spices.

v. In all cases, each subsample must be analyzed. In the case of high and low density items the entire sample must be analyzed, in the samples of ground and crushed processed spices the amount to be analyzed is determined by the method used.

B. PROCEDURES -

Utilize the appropriate methods as given under the “Analytical Procedures” section of this manual.

C. RESAMPLING/REANALYSIS -

i. No resampling or reanalysis is permitted except in those instances where fumigation and/or reconditioning has taken place.

ANALYTICAL PROCEDURES

14.0 Mold and Extraneous Matter in Black and White Pepper
14.1 Extraneous Matter in Spices (Excluding Black and White Pepper)
14.2 Light Berries in Black and White Pepper
22.1 Microanalytical Analysis of Paprika
22.2 Microanalytical Analysis of Ground Capsicums (Excluding Paprika)
26.0 Foreign Leaves in Oregano

Method 14.0 Mold and Extraneous Matter in Black and White Pepper

Purpose: To determine the amount of mold and extraneous matter in black or white pepper.

Principle: Peppercorns are sampled, sifted by sieve and by hand for extraneous matter, and inspected visually for mold. Percent extraneous matter is calculated by mass ratio.

A. Apparatus:

1. A standard pepper sieve, (No. 9 1/2 round screen with a frame 18 to 22 inches in diameter and 2 3/4 inches in height. The bottom is a metal sheet perforated with round holes of 7/64 inch in diameter, with an average of 5 1/2 holes per linear inch. Screen only with standard pepper sieve obtainable from: McNichols Company, 5501 Gray Street, Tampa, Florida 33609 (813) 876-4100 or (800) 237-3820. U.S. Standard No. 8 sieve (0.0937 in. or 2.38 square mm opening) provide equivalent sieve opening.

2. Balances -- one with sensitivity to ± 0.01 g and one with sensitivity to ± 0.1 mg.

3. Beaker, 400 ml.

4. Tweezers.

5. Stereoscopic, Binocular, wide-field microscope (40-50x).

B. Reagents:

1. Petroleum ether (Note 1)

C. Preparation of Sample:

1. The number of samples drawn must be equal to the square root of the packages, bags, or containers in the lot, with maximum of 10 samples drawn.

2. The sample size shall be 3/4 to 1 pound (340 g to 454 g).

3. Each entire subsample must be analyzed.

D. Procedure:

1. To Determine Excreta, Insects, Mites, Psocids, Mold, and Percent Black Pepper in White Pepper:
   a. Weigh each sub-sample to the nearest gram. Sprinkle and examine a small portion at a time, with a good light and against a white background into a standard pepper sieve. Pick out any bird, rodent, or other animal excreta. Separate mammalian from non-mammalian excreta. Weigh to the nearest 0.1 mg and record. Do not remove other extraneous/foreign material at this time.

b. Shake pepper sieve moderately back and forth, examine siftings collected on white background for live and dead insects and for excreta.
c. Accumulate the siftings.
d. Mix sub-sample of pepper on sieve and weight 50 g of aliquot into a pan. Hand-pick moldy peppercorns and weigh (Note 1). In case of white pepper, additionally hand pick for black peppercorns (with skin coat attached) and record. Each sub-sample is examined in sequence in a similar manner and the results are averaged.

2. Extraneous/Foreign Matter by Sifting:
   a. Weigh to nearest 0.1 g the cumulated siftings and calculate the percentage by weight. Percent siftings must be determined after the removal of small berries that pass through the pepper sieve. (See Calculations)

3. Extraneous/Foreign Matter by Hand Picking
   a. Combine sufficient material from each sub-sample to give a composite sample of approximately 5 lbs. Mix composite well.
   b. Form the composite into a pile shaped like a cone. Quarter the cone designating each quarter as A, B, C, or D in a clockwise sequence.
   c. From two opposite quarters such as A & C, weigh 100 grams from each and hand pick for any sticks, stones, stems, foreign seeds, other extraneous matter, and make note of its nature. Set the hand-picked berries aside for determination of light berries by ASTA method 14.2.
   d. Weigh the pickings and calculate. (See Calculations)

E. Calculations:

$$\% \text{ Extraneous/Foreign Matter by Sifting} = \frac{\text{Wt. of combined sifting (g)}}{\text{Combined wt. of sub-samples (g)}} \times 100$$

$$\% \text{ Extraneous/Foreign Matter by Hand Picking} = \frac{\text{A (in grams) + C (in grams)}}{2}$$

F. Statistics:

TBD

G. Notes:

1. Coating of peppercorns with exogenous oils has been used to mask visual detection and hide the presence of mold. If this practice is suspected, one should remove the oil from the sample before inspection. To remove the oil, soak 50 g of peppercorns briefly in 100 ml petroleum ether, pour off the solvent and allow the peppercorns to dry. Continue with the visual inspection.

H. References:

Macroanalytical Procedures Manual 1984, Chapter 5.

I. Revision History

10/02/12 Moved instructions for light berries determination to a separate method. Specified use of hand-cleaned subsamples (end of step D.3.) for use in light berries determination to be in conformance with ISO standard 959-1 (Annex A). Added Note 1 and petroleum ether to reagent list for treatment to remove any added oil coatings from black pepper and facilitate visual detection of mold. Added Principle section.

Method 14.1 Extraneous Matter in Spices (Excluding Black and White Pepper)

Purpose: To determine the amount of extraneous matter in spices (excluding black and white pepper).

Principle: Spices are sampled, sorted, examined visually and analyzed by mass or number count for level of extraneous matter and moldy/defiled/infested product.

A. Apparatus

1. A standard pepper sieve, (No. 9 1/2 round screen with a frame 18 to 22 inches in diameter and 2 3/4 inches in height. The bottom is a metal sheet perforated with round holes of 7/64 inch in diameter, with an average of 5 1/2 holes per linear inch. Screen only with standard pepper sieve obtainable from: McNichols Company, 5501 Gray Street, Tampa, Florida 33609 (813) 876-4100 or (800) 237-3820. U.S. Standard No. 8 sieve (0.0937 in. or 2.38 square mm opening) provide equivalent sieve opening.

2. Balances with sensitivity of ± 0.01 g for sample and ± 0.1 mg for excreta.

3. Tweezers.

4. Binocular, wide-field microscope (40-50x).

B. Reagents

None required.

C. Preparation of Sample

1. The number of samples drawn must be equal to the square root of the package, bags or containers in the lot with a maximum of ten samples drawn.

2. The sample size shall be 3/4 to 1 pound for high density items. These include: Cassia, Cinnamon (Seychelle), Nutmeg (Whole and Broken), Ginger, Cloves, Allspice/Pimento, Turmeric, Celery Seed, Poppy Seed, Sesame Seed, Caraway Seed, Cardamom Seed, Anise Seed, Coriander Seed, Cumin Seed, Dill Seed, and Fennel Seed.

3. The sample size shall be 1/2 to 3/4 of a pound for low density items. These include: Chillies, Capsicums, Mace, Sage, Oregano Leaves, Basil Leaves, Laurel Leaves, Thyme Leaves, Rosemary Leaves, Tarragon Leaves, Marjoram Leaves and Savory Leaves.

4. Regardless of sample size, the entire subsample must be analyzed.

D. Procedure

1. Whole and Broken Nutmegs:

   Whole Nutmegs:

   a. Weigh and shake each subsample on the sieve. Examine siftings for live and dead insects, extraneous matter and mammalian or other excreta.

   b. Select at random 100 Nutmegs from each subsample. Cut the Nutmegs in half longitudinally. Examine the cut surfaces of each Nutmeg for evidence of insects or insect damage and presence of mold filaments. Report as rejects Nutmegs containing insects or insect parts, insect excreta, insect channeling, and those showing mold filaments on 25% or more of the cut surface of each. (Note 3) Check borderline or doubtful specimens using magnification. Report results for Insect Defiled/Infested and for Mold separately for each subsample in % by count and average.

   Broken Nutmegs:

   a. Weigh and shake each subsample on the sieve. Examine siftings for live and dead insects, extraneous matter. (Note 1)

   b. Mix thoroughly, weigh out 50 grams of each subsample and examine the surfaces of the Nutmegs for evidence of insects or insect damage and presence of mold filaments. Report as rejects Nutmegs containing insects or insect parts, excreta, insect channeling, and those showing mold filaments on 25% or more of the cut surface of each. (Note 3) Check borderline or doubtful specimens using magnification. Report results of each subsample in % by weight and average. Results of Insect Defiled/Infested and Mold can be combined in the case of Broken Nutmegs. (Note 1)

2. Chillies:

   a. The individual subsample is weighed, shaken from the bag, a small portion at a time, with a good light, on the sieve with white paper beneath. As the chillies are discharged on the sieve, they are examined for extraneous/foreign matter, mammalian, or other excreta. (Note 1)

   b. When the entire sample is on the sieve, it is shaken back and forth a few times. The siftings on the white paper are also examined for live and dead insects, mammalian, or other excreta.

   c. The sample is mixed and a 25 gram portion for chillies up to 2 1/2 inches in length or 100 gram portion for chillies over 2 1/2 inches in length is taken at random for examination of mold or insect defiled/infested chillies. (Note 3) The chillies are broken and examined inside. Moldy chillies (mold exceeding 1/4 of its area or with aggregate area > 1 cm^2) or insect defiled/infested pods are weighed and % by weight determined.

   d. Each sample representing the lot is done in sequence in this manner.

3. Basil, Marjoram, Oregano (Note 2), Rosemary Leaves, Savory, Tarragon, and Thyme:
    a. The individual subsamples are weighed. Each subsample is shaken from the bag, a small portion at a time on white paper, with good light.

    b. As the sample is discharged and spread out on the paper, examine and pick out live and dead insects, mammalian and other excreta, mold and insect defiled/infested pieces. (Note 1 and Note 3)
    c.
    d. Report by count (Whole Insects) or by weight (Mammalian Excreta. Other Excreta, Mold and Insect Defiled/Infested Pieces) on the Certificates of Analysis/

    e. Extraneous/Foreign Matter is defined as everything foreign to the product itself and includes, but is not restricted to: stones, dirt, wire, string, stems, sticks, nontoxic foreign seeds and hair and other plant materials, e.g. foreign leaves. (Note 5)

    f. From a composite of the subsamples weigh out and hand pick 100 grams of sample for extraneous/foreign matter.

    g. Record results in percent by weight.

4. Anise Seed, Caraway Seed, Celery Seed, Cloves, Coriander, Cumin Seed, Dill Seed, Fennel Seed, Mace (siftings), Poppy Seed, Sesame Seed, Hulled Sesame Seed:
    a. The individual subsamples are weighed. Each subsample is shaken from the bag, a small portion at a time on white paper, with good light.

    b. As the sample is discharged and spread out on the paper, examine and pick out live and dead insects, mammalian or other excreta, mold and insect defiled/infested pieces. (Note 1, Note 3)

    c. Report by count (Whole Insects) or by weight (Mammalian Excreta. Other Excreta, Mold and Insect Defiled/Infested Pieces).

    d. Extraneous/Foreign Matter is defined as everything foreign to the product itself and includes, but is not restricted to: stones, dirt, wire, string, stems, sticks, nontoxic foreign seeds and hair.

    e. From a composite of the subsamples weigh out and hand pick 50 grams of sample for extraneous/foreign matter.

    f. Record results in percent by weight.

5. Allspice/Pimento, Whole Cardamom, Broken Cassia, Madagascar and Seychelle Cinnamon, Ginger, Laurel Leaves, Mace (whole), Sage, Turmeric (Note 4, Note 5):
    a. The individual subsample is weighed, shaken from the bag, a small portion at a time, with a good light, on the sieve with white paper beneath. As the sample is discharged on the sieve, examine for extraneous/foreign matter, mammalian, or other excreta.

b. When the entire sample is on the sieve, it is shaken back and forth a few times. The siftings on the white paper are also examined for live and dead insects, mammalian, or other excreta. (Note 1)

c. Examine entire sample for mold or insect defiled/infested pieces. (Note 3)

d. Report by count (Whole Insects) or by weight in milligrams (Mammalian Excreta, Other Excreta).

e. Each sample representing the lot is done in sequence in this manner.

6. Cassia Sticks or Vera AA Cassia:
   a. Break each stick separately from the entire subsample into pieces with a hammer or weight.
   b. Examine the pieces for mold or insect defiled/infested pieces. (Note 3)
   c. The entire stick is considered in the calculations where evidence of contamination is found.
   d. Report results of each subsample in % by weight in milligrams.

E. Calculations

1. $$\text{Excreta mg/lb} = \frac{\text{Weight Excreta (mg)} \times 454\text{g}}{\text{Weight of Product (g)} \quad 1\text{ lb.}}$$

2. $$\text{\% Moldy/Insect Defiled/Infested Product} = \frac{\text{Weight Reject Product (g)}}{\text{Weight Product (g)}} \times 100$$

3. $$\text{\% Siftings} = \frac{\text{Weight Siftings (g)}}{\text{Weight Product (g)}} \times 100$$

4. $$\text{\% Extraneous Matter} = \frac{\text{Weight Extraneous Matter (g)}}{\text{Weight Product (g)}} \times 100$$

F. Statistics

TBD

G. Notes

1. Calculate the average milligrams of mammalian excreta and the average milligrams of other excreta across all of the subsamples analyzed and report each value separately, and as mg/lb (see Calculations).

2. In the case of Oregano, analysis for the presence of Sumac must be performed (See Method 26.0). However, if the samples are marked "Product of Mexico", analysis for the presence of Sumac shall not be mandatory.

3. Classification of Mold and Insect Defiled - Insect Defiled -- Any product material exhibiting definite evidence of insect feeding or webbing.

   Mold -- any material bearing mold, visible to the naked eye, exceeding 1/4 of its area and confirmed by the presence of mycelial filaments and spores when examined with the aid of a microscope (40X magnification or less).

4. In the case of Sage and Bay leaves only, a separate column will be used on the Certificate of Analysis to report "Stems." This information will be for economic purposes only and will not represent a pass/fail criteria.

5. The definitions of extraneous plant material/stem:

   SAGE - If any pithy plant material exceeds one (1) millimeter in diameter at any point on its contiguous body, the attached leaves are stripped and if the length exceeds twelve and a half (12.5) millimeters, the remaining material is defined as a stem. In addition, if any pithy plant material exceeds two (2) millimeters in diameter at any point, it is considered to be a stem regardless of its length. That material is to be weighed and the total weight of stems reported as a percentage.

   BAY (LAUREL) LEAVES - If any pithy plant material, excluding the "bud," exceeds one (1) millimeter in diameter at any point on its contiguous body, the attached leaves are stripped and if the length exceeds twelve and a half (12.5) millimeters, the remaining material is defined as a stem. In addition, if any pithy plant material exceeds two (2) millimeters in diameter at any point, it is considered to be a stem regardless of its length. That material is to be weighed and the total weight of stems reported as a percentage.

   ROSEMARY and SAVORY - The analyst establishes an average size of the leaves in a particular lot. Any pithy plant material other than the leaves exceeding that size/dimension is defined as extraneous matter.

   THYME - If any pithy plant material exceeds the suggested length of twelve and a half (12.5) millimeters (1/2"), it is defined as extraneous matter.

   CLOVES - If a stem attached to a clove is greater in length than the clove itself, it shall be broken off and counted as a clove stem.

OREGANO - If any pithy plant material exceeds one (1) millimeter in diameter at any point on its contiguous body, the attached leaves are stripped and if the length exceeds twelve and a half (12.5) millimeters (1/2"), the remaining material is defined as extraneous matter. In addition, if any pithy plant material exceeds two (2) millimeters in diameter at any point, it is considered to be extraneous matter regardless of its length.

SWEET BASIL - If any pithy plant material exceeds one (1) millimeter in diameter at any point on its contiguous body, the attached leaves are stripped and if the length exceeds twelve and a half (12.5) millimeters (1/2"), the remaining material is defined as extraneous matter. In addition, if any pithy plant material exceeds two (2) millimeters in diameter at any point, it is considered to be extraneous matter regardless of its length.

H. References

Macroanalytical Procedures Manual (MPM) 1984, Chapter V.

I. Revision History

4/26/14 Added aggregate area limit to mold on chillies to be consistent with directions in ASTA Cleanliness Specifications. Specified balance precision for measurement of excreta. Added Principle section and updated formatting to comply with current ASTA method layout.

Method 14.2 Light Berries in Black and White Pepper

Purpose: *To determine the amount of light berries in black or white pepper. Do not confuse this measurement with analysis for bulk density by ASTA Methods 25.0 or 25.1. (Note 4)*

Principle: *The weight percent of "light" or low density pepper berries is determined by collection and mass measurement of berries that float in an alcohol/water solution with relative density of 0.80-0.82.*

A. Apparatus:

1. Balance -- sensitivity 0.01 g.

2. Beaker, 600 ml. Griffin, Low form, pyrex approximately 85 mm. in diameter and 120mm. in height is recommended. (Note 1).

3. Blotting paper or other similar absorbent material.

B. Reagents:

1. Alcohol-water solution with relative density of 0.80 - 0.82 at 20ºC (Note 2). The alcohol may be ethanol, denatured ethanol or isopropanol.

C. Preparation of Sample:

1. Sample shall be cleaned of extraneous matter as in ASTA method 14.0.

D. Procedure:

1. Perform the following steps in duplicate with two separate 50.0 g samples. Place each sample into the 600 mL Griffin, low-form pyrex beaker and add 300 mL of the alcohol-water solution.
2. Stir the material in the beaker with a spoon and allow to settle two minutes; then spoon off the berries which float.
3. Repeat the stirring, settling and removal of the floating berries until two successive additional stirrings raise no more berries to the surface. Remove only the berries that actually float (Note 3).
4. Blot the removed berries to free them from excess liquid and spread them out to dry on a piece of paper towel or other absorbent material.
5. Air dry for one hour and weigh the air dried light berries to the nearest 0.01 g and calculate and report the percent of light berries to the nearest 0.1%. (See Calculations.)
6. If the range of two determinations is not over 0.8%, the two determinations shall be averaged and reported as percent light berries. If the difference is greater than 0.8%, determine the light berries in a third sample. Average all three values and report as percent light berries.

E. Calculations:

$$\% \text{ Light Berries} = \frac{\text{weight of light berries (g)}}{\text{weight of samples (50 g)}} \text{ X } 100$$

F. Statistics:

TBD

G. Notes:

1. Other transparent beakers may be used, but they should be between 75 and 100 mm. in diameter and between 100 and 140 mm in height.

2. Specially denatured alcohols no. 3A, 23A, or 30 are recommended.
   a. SDA no. 3A: 5 gallons of methyl alcohol plus 100 gallons 95% ethyl alcohol.
   b. SDA no. 23A: 10 gallons USP acetone plus 100 gallons 95% ethyl alcohol.
   c. SDA no. 30: 10 gallons methyl alcohol plus 100 gallons 95% ethyl alcohol.

   For use of denatured alcohol or alcohols of unknown purity, the density of the solvent should be verified between 0.80-0.82 by measurement. The following tables may be used as a guide for preparation and for testing performed at temperatures higher than 20ºC. The shaded values fall within the specified test range.

Specific gravity of ethanol-water solutions at 20ºC and 25ºC.

Percent ethanol by weight (g/100 g soln)	Percent ethanol by volume (mL/100 mL soln)	density (20ºC)	density (25ºC)
100	100.0	0.79074	0.78736
98	98.8	0.79688	0.79349
96	97.5	0.80280	0.79939
94	96.1	0.80848	0.80507
92	94.7	0.81401	0.81060
90	93.3	0.81942	0.81600
88	91.8	0.82469	0.82128

From *Lange's Handbook of Chemistry*, 10th ed., McGraw-Hill: New York, 1967.

Specific gravity of isopropanol-water solutions at 20ºC.

Percent isopropanol by weight (g/100 g soln)	Percent isopropanol by volume (mL/100 mL soln)	density (20ºC)
100	100.0	0.78620
96	97.2	0.79630
92	94.3	0.80610
88	91.3	0.81600
84	88.2	0.82580

From *Handbook of Chemistry and Physics*, 56th ed., CRC Press: Boca Raton, FL, 1975.

3. Some berries may remain suspended some distance below the surface of the liquid. These are not considered as floaters.

4. Bulk index/bulk density is a measurement of weight to volume (density) in a loose or tapped sample. It should not be confused with or used as an indication of percent light berries, which is a measure of the weight percentage of "low density" peppercorns in a sample.

H. References:

ISO Standard 959-1 ("Pepper (Piper nigrum L.), whole or ground — Specification —Part 1: Black pepper"), 2nd ed. (1998-05-15).

I. Revision History

10/02/12 This method was excerpted from ASTA method 14.0 ("Extraneous Matter in Black and White Pepper") and reissued as method 14.2. Two changes were introduced for conformance to ISO Standard 959-1: (1) berries must be cleaned of extraneous matter before testing and (2) the relative density of the test solution is specified at 20 ºC instead of 25 ºC. Added Principle section. Added Note 4 to clarify difference between bulk density and percent light berries.

Method 22.1 Microanalytical Analysis of Paprika

Purpose: To isolate extraneous material of insect, rodent, other animal and bird origin from ground paprika for microscopic detection and enumeration.

A. Apparatus:

1. Stereoscopic binocular microscope - wide field with following minimum specifications: 3 parfocal objectives - 1X, 3X and 6X or 7.5X; paired 10X wide field oculars, mounted on a base and capable of illumination by reflected light. Ordinarily 30X magnification is used for routine examination of filter papers. Confirmation of suspect material at higher magnification may be required.

2. Microscope illuminator - preferably with a transformer or rheostat to vary light intensity, a focusing adjustment to give uniformly lighted field of view, and blue-white color from a cool low-voltage source.

3. Wildman trap flask - consists of a 2L Erlenmeyer flask into which is inserted a close-fitting rubber stopper supported on a stiff metal rod, 3/16" diam., and about 4" longer than height of flask. Rod is threaded at lower end and furnished with nuts and washers to hold it in place on the stopper. Countersink lower nut and washer in the rubber stopper to prevent striking flask.

4. Filter paper:
   a) 32 cm folded rapid flow (S & S 588, or equivalent).
   b) 9 cm high wet strength, ruled, 5mm apart (S&S #8 or equivalent).

5. Hirsch funnel , porcelain, 56 mm plate diameter.

6. Büchner funnel, porcelain, 114 mm diameter.

7. Suction flask to provide suction by means of an H_2O aspirator or electric vacuum pump.

8. Sieve U.S. Standard No. 230, 8" or 12" diameter **(**plain-<u>not</u> twill weave)."

9. Magnetic stirrer **-** hot plate.

10. Teflon coated magnetic stirring bar, 1 3/4" - 2" x 3/8" (44.4 mm - 50.8 mm x 9.5 mm)**.**

11. Beakers, glass - 1 liter, funnels, glass or metal, 6" diameter or greater.

B. Reagents

1. Isopropanol and 40% isopropanol in water.

2. Premix Tween 80-40% isopropanol-Tetrasodium EDTA: mix 250mL of (a) and 250mL of (b):
   a) Mix and filter 40mL Tween 80 and 210mL 40% isopropanol.

b) Dissolve 5g Na_4 EDTA in 150mL H_2O add 100mL isopropanol, mix and filter. Mixed reagent is stable several weeks. Store in non-metal containers.

3. Mineral Oil - paraffin oil, white, light 125/135, saybolt viscosity (38°), specific gravity 0.84-0.86 (24°). Fisher Scientific Co. No. 0-119 or equivalent.

C. Preparation of Sample

1. The number of samples drawn should be six.

2. The sample size shall be 4 - 6 ounces (113 to 170 grams).

D. Procedure

1. Weigh 25.0g of paprika and place in a filter paper cup formed by fitting a 32cm filter paper around a 400mL beaker. Place cup with ground paprika in a 1L beaker.

2. Pour 400mL 99% isopropanol into the paper cup in the beaker. Place on a pre-heated hot plate, bring to a boil, then boil gently exactly 10 minutes (a "cold finger" should be used to condense vapors).

3. Remove cup from beaker without delay and place in a Büchner funnel and aspirate to slow drip. Discard liquid.

4. Replace cup in 1 liter beaker and repeat Step 2 and 3 twice using 400mL 99% isopropanol each time to remove oil and pigment.

5. Using a gentle stream of water, quantitatively transfer the sample to a prewashed No. 230 sieve. Avoid splashing and loss of sample.

6. Wash the sample with a forceful stream of warm **(**55-70°C**)** water using a Fisher aerator until foam is gone and drainings are clear. Higher flow rates may cause breakage of fragments.

7. Add 400mL 40% isopropanol to wash bottle. Place 6" diameter funnel in trap flask. Wash sample to the edge of the sieve and quantitatively transfer to the trap flask with 40% isopropanol. Wash walls of flask and pour remainder of 400mL into flask.

8. Place on hot plate, bring to a boil, then boil gently 10 minutes, using gentle magnetic stirring to avoid splashing. Wash sides of flask every 2 minutes to prevent material from accumulating and drying on flask wall.

9. Remove from hot plate and immediately add 100mL premixed Tween 80-40% isopropanol - Na_4 EDTA solution down stirring rod.

10. Stir mag., gently, about 1 minute. Let stand 10 minutes.

11. Dilute to 800mL with 40% isopropanol added *slowly* down stirring rod, positioned with stopper just above liquid level.

12. Add 50mL mineral oil down stirring rod and stir mag. 3 minutes with stopper located above liquid level.

13. Add 40% isopropanol slowly down stirring rod to bring oil into neck of flask. Let stand about 10 minutes.

14. Raise stopper to middle of flask and swirl gently to hasten rising of oil droplets.

15. Rinse rod with 40% isopropanol and clamp so that stopper is at mid point of flask.

16. Add 40% isopropanol down rod to bring bottom of oil layer to level 1cm above raised stopper.

17. Let stand 10 minutes and swirl very gently again.

18. Let stand 10 minutes undisturbed and trap off into beaker, or onto ruled filter paper in Hirsch funnel.

19. Add 35mL mineral oil and hand stir 1 minute at speed to sufficiently keep oil moving through trap flask. Add about 20mL 40% isopropanol, stir gently at about 5 minute intervals for 20 - 25 minutes, then let stand undisturbed 5 - 10 minutes**.**

20. Trap off into second beaker or onto ruled filter paper in Hirsch funnel and rinse neck of flask with alcohol or undiluted isopropanol.

21. Filter onto ruled paper, rinsing beaker with isopropanol, and examine at 30X.

E. Calculation:

Report separately numbers of insect, rodent hair, animal hair and feather barbule fragments.

F. Statistics:

	Repeatability	Reproducibility
Rodent hairs	6.41%	8.59%
Elytra squares	5.89%	6.24%

G. Notes

1. Periodically check the 32cm filter paper used under microscope at 30X for completeness of transfer of fragments.

2. When 230 sieve draining slows, wash with detergent**,** then 50% sodium hydroxide (heated, if necessary).

3. Complete analysis without overnight interruption.

H. References

AOAC Official Methods of Analysis - 16.14.22 (977.25).
JAOAC 60 114 (1977).

Method 22.2 Microanalytical Analysis of Ground Capsicums (Excluding Paprika)

Purpose: To isolate extraneous material of insect, rodent, other animal and bird origin from ground capsicums, excluding paprika, for microscopic detection and enumeration.

A. Apparatus:

1. Stereoscopic binocular microscope - wide field with following minimum specifications: 3 parfocal objectives - 1X, 3X and 6X or 7.5X; paired 10X wide field oculars, mounted on a base and capable of illumination by reflected light. Ordinarily 30X magnification is used for routine examination of filter papers. Confirmation of suspect material at higher magnification may be required.

2. Microscope illuminator - preferably with a transformer or rheostat to vary light intensity, a focusing adjustment to give uniformly lighted field of view, and blue-white color from a cool low-voltage source.

3. Wildman trap flask - consists of a 2L Erlenmeyer flask into which is inserted a close-fitting rubber stopper supported on a stiff metal rod, 3/16" diam., and about 4" longer than height of flask. Rod is threaded at lower end and furnished with nuts and washers to hold it in place on the stopper. Countersink lower nut and washer in the rubber stopper to prevent striking flask.

4. Filter paper:
   a) 32cm folded rapid flow (S & S 588, or equivalent).
   b) 9 cm high wet strength, ruled, 5mm apart (S&S #8 or equivalent).

5. Hirsch funnel - porcelain, 56 mm plate diameter.

6. Büchner funnel, porcelain, 114 mm diameter.

7. Suction flask to provide suction by means of an H_2O aspirator or electric vacuum pump.

8. Sieve U.S. Standard No. 230, 8" or 12" diameter **(“**plain-<u>not</u> twill." weave).

9. Magnetic stirrer - hot plate.

10. Teflon covered stirring bars about 47mm x 9mm (egg-shaped, round or octagonal).

11. Beakers, glass - 1 liter, funnels, glass or metal, 6" diameter or greater.

B. Reagents:

1. Isopropanol (IPA) - 99% and 40% by volume.

2. Ethanol 95% and 60% by volume.

3. Tween 80-ethanol-tetrasodium EDTA Premix: pour 420mL 60% ethanol in 1L graduate. Add 80mL Tween 80 to 250mL glass stoppered graduate. Invert 250mL graduate over 3L beaker and drain briefly. Rinse 250mL graduate with several portions of the 420mL 60% ethanol, pouring each into beaker. Add rest of 60% ethanol to beaker and start mag. stirring. Add 10g Tetrasodium EDTA to beaker while stirring rapidly. Add 500mL 60% ethanol and stir until uniform. Store in non-metal containers. Mixed reagent is stable several weeks.

4. Mineral Oil - Paraffin oil, white, light 125/135, saybolt viscosity (38°), specific gravity 0.84-0.86 (24°). Fisher Scientific Co. No. 0-119 **(**or equivalent**)**.

5. Heptane - commercial heptane containing less than 8% toluene.

6. Flotation liquid - mineral oil and heptane (85+15).

C. Preparation of Sample

1. The number of samples drawn should be six.

2. The sample size shall be 4 - 6 ounces (113 to 170 grams).

D. Procedure:

1. Weigh 25 g of capsicum and place in a filter paper cup formed by fitting a 32cm filter paper around a 400mL beaker. Place cup with ground capsicums in a 1L beaker.

2. Pour 400mL 99% isopropanol into the paper cup in the beaker. Place on a pre-heated hot plate, bring to a boil, then boil gently 10 min.

3. Remove cup from beaker without delay and place in a Büchner funnel and aspirate to slow drip. Discard liquid.

4. Replace cup in 1 liter beaker and repeat Step 2 and 3 twice using 400mL 99% isopropanol each time to remove oil and pigment.

5. Using a gentle stream of water, quantitatively transfer the sample to a prewashed No. 230 sieve. Avoid splashing and loss of sample.

6. Wash the sample with a forceful stream of warm **(**55-70°C**)** water using a Fisher aerator until foam is gone and drainings are clear. Higher flow rates may cause breakage of fragments. (Note: Longer washing time than for paprika is needed.)

7. Add 600mL 60% ethanol to wash bottle. Place 6" diameter funnel in trap flask. Wash sample to the edge of the sieve and quantitatively transfer to the trap flask with 60% ethanol. Wash walls of flask and pour remainder of 600mL into flask.

8. Place on hot plate, bring to a boil, then boil gently 10 minutes, using gentle magnetic stirring to avoid splashing. Wash sides of flask every 2 minutes to prevent material from accumulating and drying on flask wall.

9. Remove from hot plate and cool to between 20 and 25° with cold water. Add 40mL flotation liquid down stirring rod.

10. Dilute to 800mL with 60% ethanol and stir mag. 5 minutes.

11. Set aside, add 100mL Tween 80-ethanol-tetrasodium EDTA premix, down stirring rod, and mix through liquid by gently swirling (to prevent foaming) stopper about 1 minute. Let stand 3 minutes. Wash sides of flask with 60% ethanol to keep solids down.

12. Slowly add 60% ethanol down trap rod, maintaining stopper above oil layer, until oil just reaches neck of flask.

13. Gently swirl stopper through lower portion of flask to suspend settling.

14. Add 60% ethanol down rod to bring bottom of oil layer to a level 1cm above raised stopper.

15. Clamp rod with stopper at mid point of flask. Let stand 15 minutes. Then gently swirl stopper through upper half of liquid to hasten rising of oil droplets.

16. Let stand 15 minutes undisturbed and trap into beaker, rinsing neck of flask with 60% ethanol. Filter onto ruled paper.

17. Add 30mL flotation liquid and stir manually 1 minute, with an up and down motion.

18. Clamp rod at mid point and let stand 10 minutes. Swirl stopper gently through upper half of liquid and adjust oil level.

19. Let stand 15 minutes undisturbed and trap off.

20. Rinse neck of flask with 95% ethanol.

21. Filter onto ruled paper, rinsing beaker with 95% ethanol, and examine at 30X.

E. Calculation:

Report numbers of insect, rodent hair, animal hair and feather barbule fragments.

F. Statistics:

	Repeatability	Reproducibility
Rodent hairs	13.43%	14.66%
Elytra squares	8.10%	9.18%

G. Notes:

1. Periodically check the 32cm filter paper used under microscope for completeness of transfer of fragments.

2. When 230 sieve draining slows, wash with detergent, then 50% sodium hydroxide (heated if necessary).

3. Complete analysis without overnight interruption.

4. Do not use any plastic equipment because fragments or hairs might adhere.

H. Reference:

AOAC Official Methods of Analysis 16.14.10 (978.22).
JAOAC 61 900 (1978).

Method 26.0 Foreign Leaves in Oregano

Purpose: To determine the presence of foreign leaves in oregano.

A. Apparatus

1. Stereoscopic binocular microscope--widefield with the following minimum specifications: 3 parfocal objectives--1X, 3X and 6X or 7.5X; paired 10X widefield oculars, mounted on a base and capable of illumination by transmitted or reflected light. Ordinarily 30X magnification is used for routine examination of filter papers. Confirmation of suspect material at higher magnification may be required.

2. Compound polarizing microscope - microscope with the following minimum specifications: 4 parfocal achromatic objectives of ca 4, 10, 20, and 40X; revolving 4-place nosepiece; Abbe condenser with N.A. of 1.25; 10X Huygenian or widefield eyepieces; fine adjustment; mechanical stage; fitted with polarizing prisms below and above the mechanical stage.

3. 100 mm Petri plates.

4. 7 cm (or 9 cm) ruled filter papers.

5. Microscope slides and cover slips.

6. Eye dropper.

7. Dissecting needle and forceps.

B. Reagents

1. Xylene - reagent grade.

C. Preparation of Sample:

1. Utilize sample procedures for original sampling (see Method 14.1). From each sub-sample, take a representative 10 g (approximately 75 mL) sample of oregano leaf. These samples will be composited and gently blended.

2. Prepare a 5 to 10 g analytical sample from above using a sampling splitter or a quartering procedure.

3. Maintain leaf integrity; do not break up leaves.

D. Procedure

1. Gently shake enough oregano into one Petri plate lined with standard 7 cm (or 9 cm) ruled filter paper to cover the filter paper in a single layer (approximately 500 leaf fragments per plate; in no case is less than 400 mg of oregano fragments to be viewed).

2. Examine the plate of material under the 30X to 60X magnification of the stereoscopic binocular microscope looking for any leaf fragment other than oregano. (See notes 1 and 2).

3. If no sumac is found in the plate it can be reported as “Sumac Negative”.

4. If foreign leaf fragments are observed place oregano leaf fragments and representatives of any foreign leaf fragments on a glass microscope slide and place a cover slip over the material. Using an eye dropper, introduce enough xylene to fill the cover slip.

5. Examine the slide using the compound polarizing microscope using both crossed and uncrossed polars.

6. If sumac is detected and confirmed, report as “Sumac Positive”.

7. If any other foreign leaf is detected estimate the total percentage and add to extraneous matter total.

E. Calculation

N/A

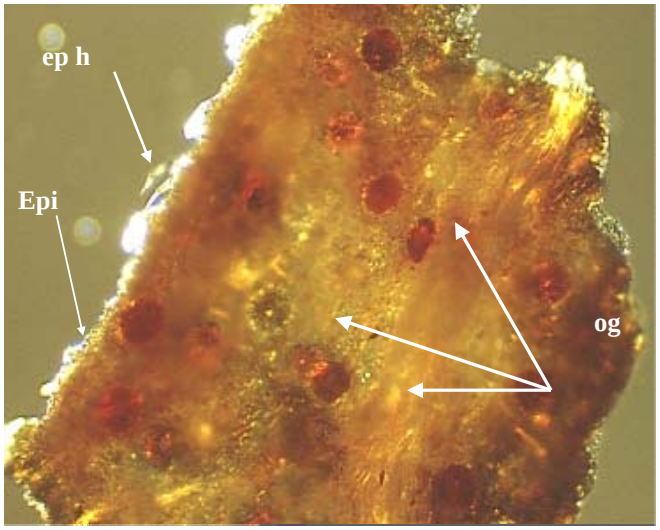
F. Statistics

N/A

G. Notes

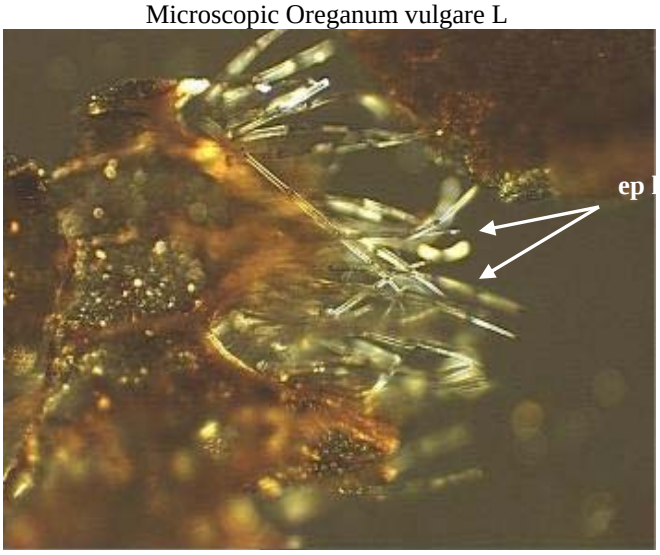
Upon removing the polarization, the oxalate crystals in the sumac disappear.

1. Oregano leaves contain numerous large red to red/orange oil glands evenly distributed over leaf surface. The leaf surface is rough, waxy and scale-like. Numerous jointed, curved, pointed, multicellular hairs are present. No oxalate crystals are present.



Microscopic Oreganum vulgare L

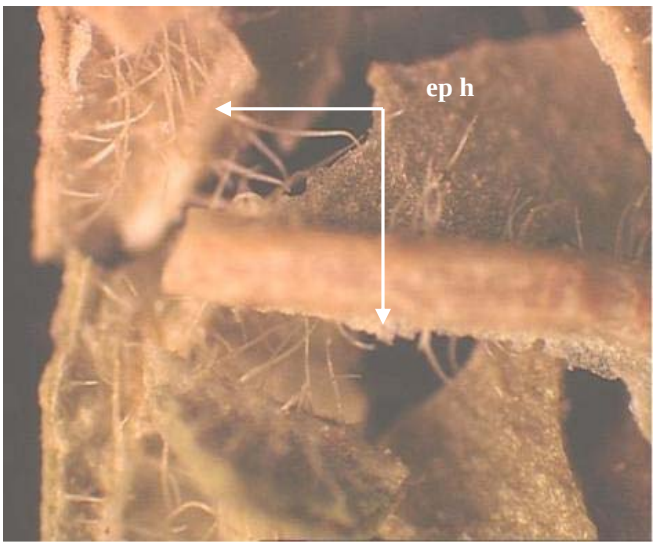

Origanum vulgare



Microscopic Origanum onites


Origanum onites

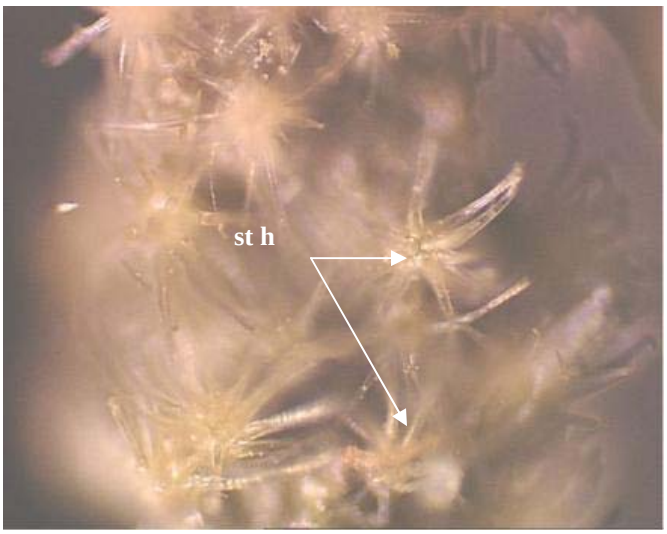
2. The following foreign leaves have been found in oregano:
   - **Sumac:** The leaf surfaces are smooth and hairy with no heavy waxy coating. Epidermal hairs are long, sharply pointed, slightly curved and have a conspicuous central hollow canal. The hairs show birefringence when viewed under crossed polars. No oil glands are visible on the leaf surface. When viewed under crossed polars, the leaf shows numerous clusters of calcium oxalate crystals which are interspersed throughout the leaf and are heavily clustered along leaf veins.



Microscopic Sumac


Sumac

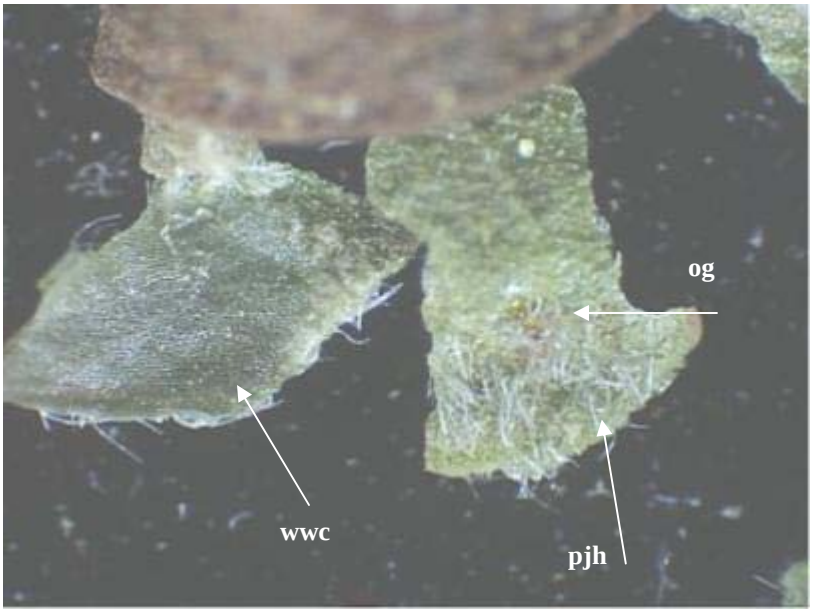
   - **<u>Cistus</u> spp.:** The undersides of the leaves contain many multi-branched epidermal hairs. No oxalate crystals present.



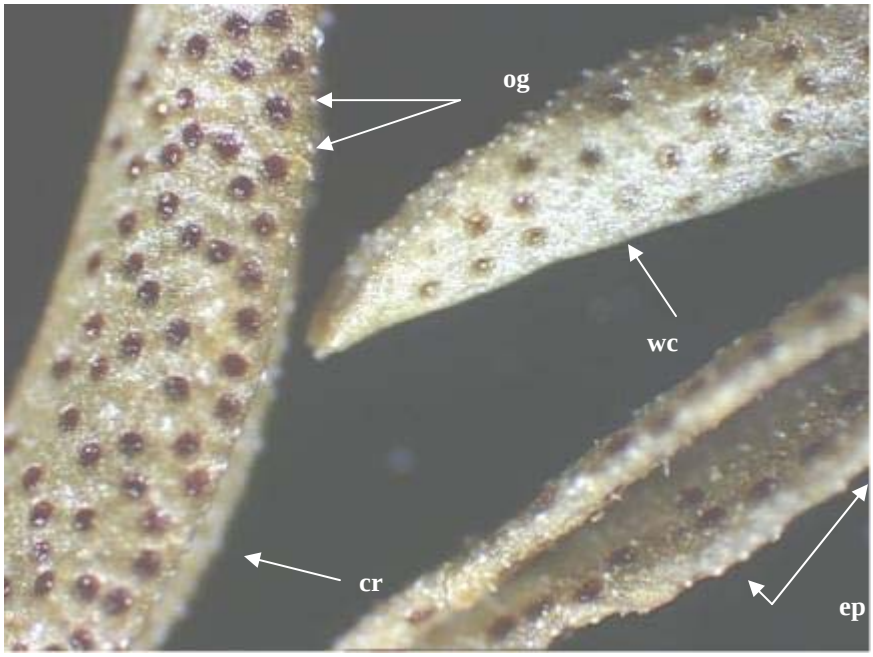
Microscopic Cistus


Cistus

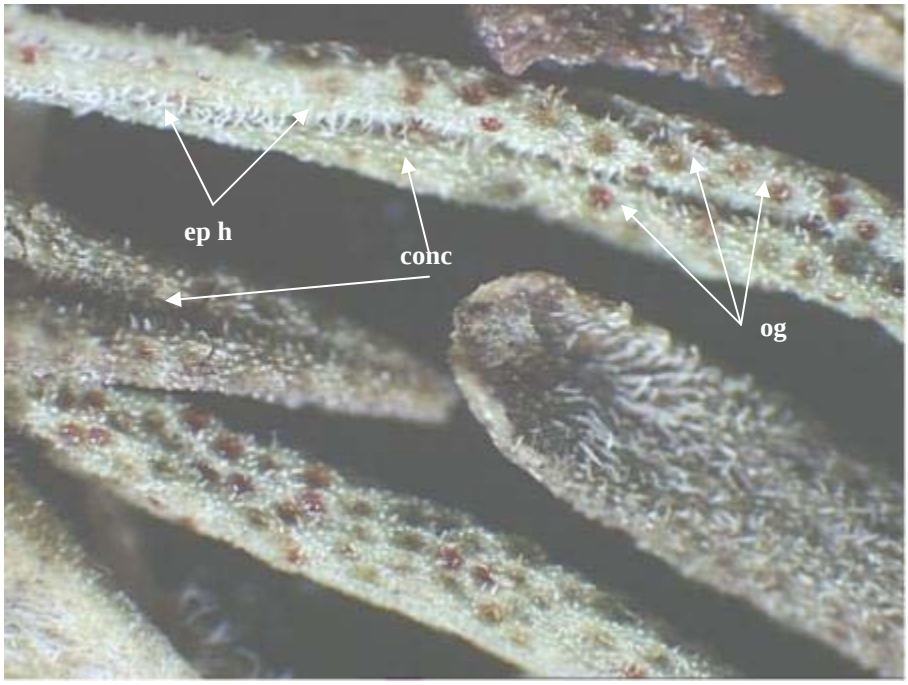
- **Marjoram**: Oil glands are widely scattered and are a bright yellow-gold colored. The glands are usually smaller and more irregularly placed across the leaf surfaces than oil glands on the oregano leaf. Surface hairs are long, pointed, multi-celled and often in dense clusters.



- **Savory**: Can be distinguished by the extreme inward to upward folding of the leaf along the midrib. The cuticle is characterized by a tough, waxy material and short, stubby, capitate epidermal projections. The oil glands are almost as large as those on oregano leaves except that there are many more of them. They are very evenly placed on the leaf, are orange to slightly brown in color, and may even be collapsed.



- **Thyme:** the leaves are oval to lance-shaped or needle-like in overall appearance. The leaf surface is waxy and many small greenish to orange-red oil glands are visible. These are more numerous but not nearly as large or as red as those seen on oregano leaves. There is a concavity or fold which traverses centrally the entire length of each leaf. Surface hairs are numerous, short curved and not as obviously jointed as those on oregano leaves.



KEY

ep h – epidermal hairs	pjh – pointed, jointed hairs
epi – epidermis	wwc – wavy-walled cells
og – oil glands	cr – crease (along midrib)
st h – stellate epidermal hairs	wc – waxy coating
conc - concavity	cu - cuticle

- **Hemlock:** The epidermis bears stomata on both its surfaces, but much more abundant on the under than on the upper. The cells of the upper epidermis have wavy walls, while those on the under epidermis, which are smaller, are sinuate and slightly striated. There are no oxalate crystals.

- **Olive:** The epidermis has a rough wax layer and abundant stomata. A few stellar trichomes cover the upper epidermis. The bottom leaf surface has a silvery color. The leaf appears thicker than others. There is a dimple-like appearance of the upper epidermis.

- **Other:** hazelnut, myrtle, strawberry tree

Hazelnut

myrtle

wild strawberry tree leaves

ASTA Manual: Microscopic Identification of Spices (2003)

I. Revision History

10/03/10 Added instructions for detection of the following foreign leaves: cistus, marjoram, savory, thyme, hemlock, olive. Added reference to ASTA manual on Microscopic Identification of Spices.