# Review of the validation status of regulated matrices for the VIDAS™ *Salmonella* (SLM) AOAC Official Method 2004.03: 2018 Matrix Extension Data

Warren Shnaekel and R. Derike Smiley

Arkansas Laboratory, Office of Regulatory Science, Office of Regulatory Affairs, U.S. Food and Drug Administration, 3900 NCTR Road, Building 26, Jefferson, AR 72079

**Abstract**

Adherence to ISO 17025 standards requires that all microbiological analytical methods be validated against a reference method for each type of product for which the method is used. In order to comply with this requirement, the United States Food and Drug Administration routinely performs spiked-sample analysis concurrently with any test samples for matrices that have not been fully validated. The spike detection results are collected in the Field Accomplishments and Compliance Tracking System (FACTS) until a determination of the validation status can be made. The *Salmonella enterica* spiked-matrix results for the VIDAS™ SLM method (AOAC Official Method 2004.03), collected in 2018, were reviewed and added to the cumulative data set which now covers the period from May 01, 2007 through December 31, 2018. The list of matrices which can be considered validated currently consists of 73 product categories. The number of matrices that fail to meet matrix-extension validation is currently 51. The purpose of monitoring matrix-extension validation results is to ensure that the method and matrix are compatible and thus ensuring that the analytical results meet the standard necessary for enforcing regulatory compliance. Continued monitoring and periodic evaluation of the spiked-matrix data is needed to ensure that the FDA is adhering to ISO 17025 standards of using validated analytical methods when testing for the presence of *S. enterica*.

## 1. Introduction

Microbiological analysis is frequently performed by the U.S. Food and Drug Administration (FDA) to ensure the safety of foods that are available to consumers within the United States. The use of rapid microbiological diagnostic methods during routine surveillance and targeted inspection activities is favored over that of the FDA Bacteriological Analytical Manual (BAM) reference method particularly when analyzing perishable products, because it shortens the analysis time. The VIDAS™ *Salmonella* (SLM) enzyme-linked immuno-fluorescence assay (AOAC Official Method 2004.03) is a rapid detection method which is favored with the FDA testing laboratories since it has undergone rigorous evaluation including multi-laboratory validation (McMahon *et al*. 2004).

Despite having achieved “Official Method of Analysis” status from the AOAC, the FDA must still demonstrate that the VIDAS™ SLM method is compatible with each matrix tested. The use of validated methods is not only a necessary component of good regulatory science practices but is a requirement of ISO 17025 accreditation. Because of the wide range of products that fall under the regulatory jurisdiction of the FDA, performing a full multi-laboratory validation for each is impractical. Therefore, to establish the fitness of this method for each type of product encountered by the FDA, a spiked-matrix control is analyzed in parallel with the test sample; if *S. enterica* is successfully detected in the spiked control then the results for the test sample are deemed valid. Spiked-matrix results are continually recorded for each matrix until a requisite number of observations are obtained at which time a decision is made regarding the validation status of the matrix. Currently, the validation determination criteria are based on recommendation from the FDA Foods Program Science and Research Steering Committee (SRSC). For a matrix to be considered validated it must have between seven and 19 spike results with no observance of *S. enterica* detection failure. Alternatively, if more than 19 spike results are available the *S. enterica* detection success rate must be ≥95% (http://sharepoint.fda.gov/orgs/OFVM-Science/SRSC/Forms/AllItems.aspx?RootFolder=%2Forgs%2FOFVM%2DScience%2FSRSC%2FMethods%20Development%20Validation%20and%20Implementation%20Pr

ogram%2FMDVIP%20SOP%20and%20Validation%20Guidelines) (last accessed 12/16/2018).

The validation status for the VIDAS™-SLM method is periodically assessed and reported to; 1) ensure that this test method meets the standard necessary for enforcing regulatory compliance, 2) alert FDA testing laboratories about any problematic matrices which might result in high false negative results, and 3) help FDA testing laboratories meet the ISO 17025 requirement of using validated analytical methods. This study is a summary of the spiked-matrix results collected by the Office of Regulatory Affairs' (ORA) field laboratories and recorded in the Field Accomplishments and Compliance Tracking System (FACTS) from May 2007 through December 2018.

## 2. Methods

### *2.1 Data retrieval*

The cumulative dataset used in this review included spiked matrix results from all accomplishing laboratories for the timeframe May 01, 2007 through December 31, 2018. Spike detection result data were obtained from ORA's FACTS using the ORA Reporting, Analysis and Decision Support System (ORADSS SAP Business Objects Business Intelligence Suite 4.0 Feature Pack 3). The retrieved data included: Sample Number, Accomplishing Laboratory, Sampling District, PAC code, PAF code, Completion Date, Laboratory Class, Product Code, Product Description, Method Source Code, Method Code, SUB, Rapid Method Results, Conventional Method Results, Spike Results, Genus/ Species used for spiking, Selective Agar Results, Selective Agar Used, Kit Compare Remarks, Description Text and Product Label.

### *2.2 Data selection*

The FACTS entries included in the final analysis were selected based on the completeness of the product description and a reported spiking level between 1-30 CFU/25 g. If a sample had multiple spike entries with the same result, then only one was included. If a sample had multiple spike entries with differing results, then all entries were omitted. If the sample subsequently tested positive for the presence of *S. enterica*

then the spiked-matrix results were also omitted from the analysis since an accurate determination of the initial levels of *Salmonella* was not possible.

*2.3 Data analysis*

All products were objectively grouped by the narrowest classification (*i.e*. product groups) deemed reasonable. All product groups were evaluated based on the following criteria derived from the SRSC's guidance; 1) seven to 19 spiked-matrix results with no false negative results or 2) 20 or more spiked-matrix results with <5% false negative results. Product groups meeting the matrix extension acceptance criteria were considered validated matrices.

## 3. Results and Discussion

*3.1 VIDAS-SLM Spiking Data Summary*

Approximately 9300 spiked-matrix results were available in FACTS as of December 31, 2018. Of these, approximately 1600 entries could not be used in assessing the matrix validation status for this method for several reasons including; 1) incomplete information concerning the spiking level, 2) spiking levels outside of the acceptable limits, 3) duplicate spiking entries for the same samples, and 4) presence of naturally occurring *Salmonella*. Additionally, approximately 1400 spiked-matrix entries were excluded due to ambiguous product descriptions or too few results to warrant classification. From the remaining approximately 6300 spiked-matrix results 296 product categories were established with the validation status of 151 products determined using the SRSC's guidance as described above.

*3.2 Matrices meeting matrix extension acceptance criteria*

Currently, 33 matrices meet the SRSC's matrix-extension validation criterion of having a minimum of 20 spiked-matrix results with a *Salmonella* detection rate of ≥95% (Table 1). Previously, the number of matrices that met the same validation criterion was 21 (Shnaekel et al., 2019). New product categories included Brussel sprouts, cabbage/choy, coconut candies, Kratom dietary supplement, smoked fish, guacamole,

cephalopodic mollusks, paprika spice, peas/pea protein, jerky-style pet treats, potato chips, squash, and fresh tomatoes. Squid, which was previously validated (Shnaekel et al., 2019), is no longer listed individually but has been combined with octopus and cuttlefish in the category Cephalopodic mollusks (Table 1). The individual results for squid, cuttlefish, and octopus can be found in the supplementary table S5. Similarly, chili peppers, tree nuts, edible seeds, crustaceans, and bivalve mollusks were all established as classification groups for validation purposes; these groups encompass more than one highly similar matrices. The spike-detection rate for individual matrices within these groups are reported in supplemental tables S1, S2, S3, S4, and S5, respectively.

Forty food matrices meet the SRSC's matrix-extension validation criterion of having 7-19 spiked-matrix results with no reported failures (Table 2). Seventeen new matrices (Multigrain bakery products, dried banana, gummy candies, lollipops, marzipan candy, nougat candies, chayote, dried ginger, halva/halwa, limes, milk/dairy powder, peanuts, seasoned peanuts, peanut butter, rice, dried shrimp, and tahini) were added to the list based on spike detection results captured in FACTS during the 2018 calendar year. Chocolate, energy/nutrient bars, and mushrooms/fungi underwent a validation status change. In the previous report (Shnaekel et al., 2019) these three matrices were considered validated, but each now have one spike detection failure (Table 4) so their validation status is now unresolved until addition spike detection data is collected. Additionally, the accrual of spike detection results resulted in Brussels sprouts, guacamole, peas/pea protein, potato chips, and jerky-style pet treats being validated based on the SRSC's criterion of a minimum of 20 spiked-matrix results with ≥95% *Salmonella* detection rate; these matrices are now listed in Table 1; these matrices had previous been considered validated based on the criterion of having 7-19 spiked-matrix results with no reported failures (Shnaekel et al., 2019).

### *3.3 Matrices which fail matrix extension criteria*

Fifty-one matrices failed to meet the SRSC's matrix-extension validation criteria based on spike detection failure rate (Table 3). Eight matrices (mango pulp with chile

candy, tamarind candy, coconut, corn snacks, gelatin, scallions, and radish) were added to the list of failed matrices based on further spike detection data collected in 2018. The other 43 matrices failing validation were previously reported (Shnaekel et al., 2019). In previous reports, the category onion had included both bulb onions and scallions (green onions). In this report, the category onion has been refined; scallions remain on the list of failed matrices while bulb onions have been placed on the list of matrices requiring additional testing (Table 4).

*3.4 Matrices requiring further evaluation*

There were 33 matrices having between seven and 19 spike detection results with one detection failure (Table 4). Additional collection and monitoring of the spike detection results is needed to resolve the validation status of these products. Three food products (Chocolate, energy/nutrient bars, and mushrooms) were previously deemed validated based on a minimum of seven spike-detection entries with zero failures (Shnaekel et al., 2019). Additional spiking data collected in 2018 resulted in a validation status change for these three products and now additional data is needed to determine if the VIDAS™-SLM is method is appropriate for analyzing these matrices for the presence of *Salmonella*.

*3.5 Study summary*

The FDA's field laboratories continue to collect spiked-recovery data for matrices that have not yet been validated for the VIDAS™-SLM assay, but which are encountered during routine and target food safety inspections. Although this method has been rigorously tested via multi-laboratory validation (McMahon et al., 2004), its performance was not assessed for every potential food matrix encountered by the FDA. Since the VIDAS™-SLM assay is a popular test method within the FDA, continual assessment of the spiked-matrix recovery results is needed to establish the validation status of regulated food products as this is a requirement of ISO 17025. Continual assessment of the matrix extension data from FACTS also results in refinements in the classification of matrices. The FDA analyzes many highly similar but distinct food

products. The ability to view validation data in both broad and narrow classifications is important when laboratories analyze infrequent matrices. For instance, a laboratory may receive a specific variety of fresh chile pepper, such as the Cubanelle, for which there is little validation data available. Since there is only one spike matrix result available, the validation status cannot be determined. However, fresh chili peppers, as a broad category, tend to perform well with this method. More specifically, Cubanelle peppers belong to the species *Capsicum annuum* and this species also tends to perform well with this method. So, despite not being able to resolve the validation status of this specific variety of pepper, there is some level of confidence that it should perform well with the VIDAS™-SLM method based on the results of similar peppers. As a regulatory agency, the FDA is tasked with protecting the nation's food supply. It is important that the microbiological methods used meet the highest analytical standards. Using validated methods helps ensure this.

**4. References and Additional Information**

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Table 1. Product groups meeting matrix extension acceptance criteria based on a minimum of 20 results and a detection rate of 95% for VIDAS™ *Salmonella* screening by AOAC method 2004.03 using spiked-matrix data recorded in FACTS.

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Asparagus (fresh) | 27 | 27 | 0 | 100 | Passed |
| Avocado (fresh, frozen) | 134 | 130 | 4 | 97 | Passed |
| Brussels Sprouts | 22 | 22 | 0 | 100 | Passed |
| Cabbage/Choy | 21 | 20 | 1 | 95 | Passed |
| Candy, Coconut | 25 | 24 | 1 | 96 | Passed |
| Crustaceans | 92 | 90 | 2 | 98 | Passed |
| Cucumbers (fresh) | 490 | 483 | 7 | 99 | Passed |
| Cereal/Pseudo-cereal Grain Flour | 48 | 46 | 2 | 96 | Passed |
| Dietary Supplement, Kratom | 39 | 37 | 2 | 95 | Passed |
| Fish, Smoked | 27 | 26 | 1 | 96 | Passed |
| Flour, Cereal/Pseudo-cereal Grain | 48 | 46 | 2 | 96 | Passed |
| Guacamole | 20 | 20 | 0 | 100 | Passed |
| Kale | 80 | 79 | 1 | 99 | Passed |
| Mango (fresh, puree/pulp, frozen) | 134 | 131 | 3 | 98 | Passed |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Mole sauce | 30 | 30 | 0 | 100 | Passed |
| Mollusks, Bivalve | 49 | 48 | 1 | 98 | Passed |
| Mollusks, Cephalopods | 57 | 55 | 2 | 96 | Passed |
| Mung Beans | 33 | 33 | 0 | 100 | Passed |
| Papayas (fresh) | 52 | 50 | 2 | 96 | Passed |
| Peppers, Chili[1] | 1118 | 1076 | 42 | 96 | Passed |
| Paprika Spice | 21 | 20 | 1 | 95 | Passed |
| Peas/Pea Protein | 21 | 21 | 0 | 100 | Passed |
| Pet food, dry (kibble, pellet, biscuit) | 146 | 141 | 5 | 97 | Passed |
| Pet food, jerky | 32 | 31 | 1 | 97 | Passed |
| Potato Chips | 20 | 19 | 1 | 95 | Passed |
| Poultry feed | 21 | 21 | 0 | 100 | Passed |
| Seeds, edible | 188 | 183 | 5 | 97 | Passed |
| Squash | 58 | 55 | 3 | 95 | Passed |
| Spinach (frozen, fresh) | 21 | 21 | 0 | 100 | Passed |
| Tomato, fresh | 45 | 43 | 2 | 96 | Passed |
| Tree Nuts | 105 | 102 | 3 | 97 | Passed |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Wheat grain bakery products | 178 | 175 | 3 | 98 | Passed |
| White pepper | 21 | 21 | 0 | 100 | Passed |

[1]See FDA ORA LIB #4622 (Melvin and Smiley, 2017) for additional information on the *Salmonella* spike detection in chili peppers using the VIDAS™ SLM method. Cultivars of *C. annuum* include, but are not limited to, jalapeño, bell, poblano, and serrano. Cultivars of *C. chinense* include, but are not limited to, habanero and Scotch Bonnet.

Table 2. Product groups meeting the matrix extension acceptance criteria based on a minimum of seven results, but fewer than 20, with no reported spiked detection failures for the VIDAS™ *Salmonella* screening method.

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Bakery Products, multigrain | 9 | 9 | 0 | 100 | Passed |
| Banana, dried | 9 | 9 | 0 | 100 | Passed |
| Blueberries (fresh, frozen) | 15 | 15 | 0 | 100 | Passed |
| Candy, gummies | 10 | 10 | 0 | 100 | Passed |
| Candy, lollipops | 10 | 10 | 0 | 100 | Passed |
| Candy, marzipan | 7 | 7 | 0 | 100 | Passed |
| Candy, nougat | 6 | 6 | 0 | 100 | Passed |
| Canola meal (pellets, granular) | 7 | 7 | 0 | 100 | Passed |
| Carrots (fresh) | 8 | 8 | 0 | 100 | Passed |
| Celery | 17 | 17 | 0 | 100 | Passed |
| Chayote | 9 | 9 | 0 | 100 | Passed |
| Cheese-stuffed chile peppers | 11 | 11 | 0 | 100 | Passed |
| Chick peas (raw, dried) | 16 | 16 | 0 | 100 | Passed |
| Coriander (dried) | 11 | 11 | 0 | 100 | Passed |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Cloves | 9 | 9 | 0 | 100 | Passed |
| Coffee | 13 | 13 | 0 | 100 | Passed |
| Cooking oil | 12 | 12 | 0 | 100 | Passed |
| Fennel (whole, seeds, powder) | 11 | 11 | 0 | 100 | Passed |
| Fenugreek (dried, whole) | 16 | 16 | 0 | 100 | Passed |
| Fish (Ntrl/Artfcl Dried) | 16 | 16 | 0 | 100 | Passed |
| Ginger, dried | 7 | 7 | 0 | 100 | Passed |
| Granola bar | 13 | 13 | 0 | 100 | Passed |
| Guava nectar | 10 | 10 | 0 | 100 | Passed |
| Halva/Halwa | 10 | 10 | 0 | 100 | Passed |
| Infant formula | 9 | 9 | 0 | 100 | Passed |
| Limes | 8 | 8 | 0 | 100 | Passed |
| Melons (honeydew, watermelon, koreon, canteloupe, chameleon, pepino) | 17 | 17 | 0 | 100 | Passed |
| Milk/Dairy Powder | 8 | 8 | 0 | 100 | Passed |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Oatmeal | 14 | 14 | 0 | 100 | Passed |
| Peanuts | 7 | 7 | 0 | 100 | Passed |
| Peanuts, seasoned | 10 | 10 | 0 | 100 | Passed |
| Peanut Butter | 7 | 7 | 0 | 100 | Passed |
| Pet Treats, bones | 18 | 18 | 0 | 100 | Passed |
| Rice | 10 | 10 | 0 | 100 | Passed |
| Salsa | 7 | 7 | 0 | 100 | Passed |
| Shrimp, dried | 9 | 9 | 0 | 100 | Passed |
| Starch | 10 | 10 | 0 | 100 | Passed |
| Tahini | 11 | 11 | 0 | 100 | Passed |
| Water (flavored, non-flavored) | 10 | 10 | 0 | 100 | Passed |
| Whey protein | 13 | 13 | 0 | 100 | Passed |

Table 3. Product groups failing to meet matrix extension acceptance criteria for VIDAS™ *Salmonella* screening by AOAC method 2004.03 using spiked-matrix data recorded in FACTS.

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Animal feed, pelleted | 64 | 55 | 9 | 86 | Failed |
| Aniseed (dried, whole or ground) | 18 | 14 | 4 | 78 | Failed |
| Annatto | 7 | 5 | 2 | 71 | Failed |
| Apples | 6 | 4 | 2 | 67 | Failed |
| Beans, Green Beans | 40 | 37 | 3 | 93 | Failed |
| Broccoli (fresh, frozen, heat treated) | 25 | 22 | 3 | 88 | Failed |
| Cactus (dried) | 10 | 8 | 2 | 80 | Failed |
| Cactus (fresh) | 26 | 24 | 2 | 92 | Failed |
| Candy, Mango Pulp w/ Chile | 9 | 6 | 3 | 67 | Failed |
| Candy, Tamarind | 20 | 17 | 3 | 85 | Failed |
| Cheese | 46 | 34 | 12 | 74 | Failed |
| Cherries (dried, fresh, frozen, cultured/cured) | 7 | 4 | 3 | 57 | Failed |
| Chili pepper spice dried (whole, powder, flakes) | 106 | 94 | 12 | 89 | Failed |
| Cinnamon | 24 | 22 | 2 | 92 | Failed |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Coconut | 45 | 42 | 3 | 93 | Failed |
| Corn (fresh, dried, heat treated) | 39 | 30 | 9 | 77 | Failed |
| Corn chips | 25 | 23 | 2 | 92 | Failed |
| Corn Snacks | 24 | 22 | 2 | 92 | Failed |
| Dietary Fiber Supplements | 12 | 10 | 2 | 83 | Failed |
| Fish, fresh/frozen | 55 | 50 | 5 | 91 | Failed |
| Garlic (dried) | 28 | 20 | 8 | 71 | Failed |
| Gelatin | 5 | 3 | 2 | 60 | Failed |
| Gooseberry powder | 5 | 2 | 3 | 40 | Failed |
| Green tea | 6 | 3 | 3 | 50 | Failed |
| Hibiscus (dried) | 6 | 2 | 4 | 33 | Failed |
| Khatta meetha | 14 | 11 | 3 | 79 | Failed |
| Lemon pepper | 4 | 1 | 3 | 25 | Failed |
| Masala/Curry/Spice Blends | 345 | 273 | 72 | 79 | Failed |
| Microgreens[1] (all varieties) | 116 | 108 | 8 | 93 | Failed |
| Milk Replacer (animal, medicated) | 13 | 10 | 3 | 77 | Failed |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Milk Replacer (animal, non-medicated) | 35 | 31 | 4 | 89 | Failed |
| Onion, Scallions | 12 | 9 | 3 | 75 | Failed |
| Pasta | 71 | 66 | 5 | 93 | Failed |
| Pet food, freeze-dried | 14 | 12 | 2 | 86 | Failed |
| Pet food, moist | 33 | 31 | 2 | 94 | Failed |
| Pet food, raw | 11 | 9 | 2 | 82 | Failed |
| Pet Treats, Rawhide | 30 | 25 | 5 | 83 | Failed |
| Plums, flavored | 5 | 3 | 2 | 60 | Failed |
| Radish | 18 | 16 | 2 | 89 | Failed |
| Raspberries (freeze dried, frozen, fresh) | 7 | 5 | 2 | 71 | Failed |
| Salt | 7 | 5 | 2 | 71 | Failed |
| Soybeans (paste, fresh, frozen, heat treated) | 33 | 31 | 2 | 94 | Failed |
| Sprouts[2], (all varieties) | 169 | 136 | 33 | 80 | Failed |
| Sprout Irrigation Water | 50 | 41 | 9 | 82 | Failed |
| Squash | 42 | 39 | 3 | 93 | Failed |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Strawberries (fresh/ frozen) | 28 | 26 | 2 | 93 | Failed |
| Sumac | 9 | 5 | 4 | 56 | Failed |
| Taro (frozen, dried) | 10 | 8 | 2 | 80 | Failed |
| Tea, herbal | 115 | 93 | 22 | 81 | Failed |
| Tomato dried | 3 | 1 | 2 | 33 | Failed |
| Turmeric | 22 | 19 | 3 | 86 | Failed |
| Yogurt | 9 | 7 | 2 | 76 | Failed |

[1]For results of individual varieties of microgreens see supplemental table S6.
[2]For results of individual varieties of sprouts see supplemental table S7.

Table 4. Product groups where the matrix extension acceptance criteria cannot yet be determined for the VIDAS™ *Salmonella* screening method.

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Animal Feed, Oats | 16 | 15 | 1 | 94 | Pending |
| Basil, raw/fresh | 10 | 9 | 1 | 90 | Pending |
| Beets | 7 | 6 | 1 | 86 | Pending |
| Bird Food | 14 | 13 | 1 | 93 | Pending |
| Black Pepper | 9 | 8 | 1 | 89 | Pending |
| Blackberries | 11 | 10 | 1 | 91 | Pending |
| Cabbage/choy | 12 | 11 | 1 | 92 | Pending |
| Candy, Chocolate | 15 | 14 | 1 | 93 | Pending |
| Candy, Milk Candy | 16 | 15 | 1 | 94 | Pending |
| Chocolate (Syrup, bars, chips) | 19 | 18 | 1 | 95 | Pending |
| Cilantro (fresh) | 18 | 17 | 1 | 94 | Pending |
| Corn Gluten | 7 | 6 | 1 | 86 | Pending |
| Corn, Processed (Flour, Milled) | 9 | 8 | 1 | 89 | Pending |
| Cumin | 11 | 10 | 1 | 89 | Pending |
| Dates | 15 | 14 | 1 | 93 | Pending |

| Product | Total # Samples | VIDAS™ Positive | VIDAS™ Negative | Sensitivity Rate (%) | Status |
|---|---|---|---|---|---|
| Distillars grain | 15 | 14 | 1 | 93 | Pending |
| Energy/Nutrient Bars | 12 | 11 | 1 | 92 | Pending |
| Fish, Anchovies | 11 | 10 | 1 | 91 | Pending |
| Hing | 7 | 6 | 1 | 86 | Pending |
| Mamey pulp | 9 | 8 | 1 | 89 | Pending |
| Mushrooms/ Fungus | 13 | 12 | 1 | 92 | Pending |
| Onion | 11 | 10 | 1 | 91 | Pending |
| Onion, Dry/ Powder | 11 | 10 | 1 | 91 | Pending |
| Oregano | 18 | 17 | 1 | 94 | Pending |
| Radish (fresh, salted, pickled) | 15 | 14 | 1 | 93 | Pending |
| Parsley | 12 | 11 | 1 | 92 | Pending |
| Pineapple | 7 | 6 | 1 | 86 | Pending |
| Plantain Chips | 8 | 7 | 1 | 88 | Pending |
| Seaweed | 14 | 13 | 1 | 93 | Pending |
| Soy protein | 10 | 9 | 1 | 90 | Pending |
| Spring rolls | 11 | 10 | 1 | 91 | Pending |
| Sugar | 7 | 6 | 1 | 86 | Pending |
| Tofu | 11 | 10 | 1 | 91 | Pending |

Table S1. Summary of VIDAS™ SLM spike detection success for all cultivars of fresh chili peppers.

| Cultivar | Species | Total Samples | VIDAS™ Pos | VIDAS™ Neg | Spike Detection % |
|---|---|---|---|---|---|
| Anaheim | *C. annuum* | 64 | 63 | 1 | 98 |
| Arbol | *C. annuum* | 2 | 2 | 0 | 100 |
| Banana | *C. annuum* | 8 | 8 | 0 | 100 |
| Bell | *C. annuum* | 276 | 255 | 21 | 92 |
| Caribe | *C. annuum* | 12 | 11 | 1 | 92 |
| Cayenne | *C. annuum* | 6 | 5 | 1 | 83 |
| Cubanelle | *C. annuum* | 1 | 1 | 0 | 100 |
| Fresno | *C. annuum* | 5 | 4 | 1 | 80 |
| Habanero | *C. chinense* | 37 | 37 | 0 | 100 |
| Hungaro | *C. annuum* | 11 | 11 | 0 | 100 |
| Jalapeño | *C. annuum* | 311 | 303 | 8 | 97 |
| Korean | *C. annuum* | 4 | 4 | 0 | 100 |
| Manzano | *C. pubescens* | 6 | 6 | 0 | 100 |
| Non-specified | NA | 90 | 86 | 4 | 96 |
| Pasilla | *C. annuum* | 50 | 49 | 1 | 98 |
| Pequin | *C. annuum* | 1 | 1 | 0 | 100 |
| Pimiento | *C. annuum* | 2 | 2 | 0 | 100 |
| Poblano | *C. annuum* | 55 | 53 | 2 | 96 |
| Pueblo | *C. annuum* | 1 | 1 | 0 | 100 |
| Puya | *C. annuum* | 1 | 1 | 0 | 100 |
| Scotch Bonnet | *C. chinense* | 3 | 3 | 0 | 100 |
| Serrano | *C. annuum* | 160 | 158 | 2 | 99 |
| Shishito | *C. annuum* | 6 | 6 | 0 | 100 |
| Thai | *C. annuum* | 6 | 6 | 0 | 100 |

Table S2. Summary of VIDAS™ SLM spike detection success for tree nuts.

| Variety | Total Samples | VIDAS™ Pos | VIDAS™ Neg | Spike Detection % |
|---|---|---|---|---|
| Almond | 19 | 18 | 1 | 95 |
| Brazil | 10 | 10 | 0 | 100 |
| Cashew | 26 | 25 | 1 | 96 |
| Macadamia | 13 | 13 | 0 | 100 |
| Pecan | 23 | 22 | 1 | 96 |
| Pine | 7 | 7 | 0 | 100 |
| Pistachio | 7 | 7 | 0 | 100 |

Table S3. Summary of VIDAS™ SLM spike detection success for edible seeds.

| Variety | Total Samples | VIDAS™ Pos | VIDAS™ Neg | Spike Detection % |
|---|---|---|---|---|
| Adzuki | 2 | 2 | 0 | 100 |
| Alfalfa | 19 | 19 | 0 | 100 |
| Amaranth | 5 | 5 | 0 | 100 |
| Basil | 6 | 6 | 0 | 100 |
| Broccoli | 7 | 5 | 2 | 71 |
| Cardamon | 6 | 6 | 0 | 100 |
| Chia | 29 | 29 | 0 | 100 |
| Clover | 18 | 18 | 0 | 100 |
| Flaxseed | 13 | 13 | 0 | 100 |
| Kalonji | 3 | 3 | 0 | 100 |
| Melon | 7 | 6 | 1 | 100 |
| Poppy | 4 | 4 | 0 | 100 |
| Pumpkin | 36 | 36 | 0 | 100 |
| Quinoa | 3 | 2 | 1 | 67 |
| Sesame | 18 | 17 | 1 | 94 |
| Sunflower | 12 | 12 | 0 | 100 |

Table S4. Summary of *S. enterica* detection in spiked fresh/frozen crustaceans with the VIDAS™ SLM method.

| Matrix | Total Samples | VIDAS™ Pos | VIDAS™ Neg | Spike Detection % |
|---|---|---|---|---|
| Lobster | 9 | 9 | 0 | 100 |
| Crayfish | 6 | 6 | 0 | 100 |
| Crab | 22 | 22 | 0 | 100 |
| Shrimp | 35 | 35 | 0 | 100 |

Table S5. Summary of *S. enterica* detection in spiked bivalve and cephalopodic mollusks with the VIDAS™ SLM method.

| Matrix | Total Samples | VIDAS™ Pos | VIDAS™ Neg | Spike Detection % |
|---|---|---|---|---|
| Clams | 15 | 15 | 0 | 100 |
| Mussels | 11 | 10 | 1 | 91 |
| Oysters | 2 | 2 | 0 | 100 |
| Scallops | 18 | 18 | 0 | 100 |
| Whelks[a] | 2 | 2 | 0 | 100 |
| Cuttlefish | 1 | 1 | 0 | 100 |
| Octopus | 7 | 6 | 1 | 86 |
| Squid | 49 | 48 | 1 | 98 |

[a]Although included with the bivalve mollusks, Whelks (sea snails) are actually members of the class Gastropoda.

Table S6. Summary of *S. enterica* detection in spiked microgreens with the VIDAS™ SLM method.

| Variety | # Samples (Total) | VIDAS™ Positive | VIDAS™ Negative | Spike Detection % |
|---|---|---|---|---|
| Alfalfa | 1 | 1 | 0 | 100 |
| Amaranth (red) | 1 | 1 | 0 | 100 |
| Arugala | 4 | 3 | 1 | 75 |
| Basil | 4 | 3 | 1 | 75 |
| Beet | 3 | 3 | 0 | 100 |
| Broccoli | 3 | 3 | 0 | 100 |
| Cabbage (red) | 1 | 1 | 0 | 100 |
| Chrysanthemum (Shungiko) | 1 | 0 | 1 | 0 |
| Cilantro | 5 | 5 | 0 | 100 |
| Kale | 4 | 4 | 0 | 100 |
| Mustard | 1 | 1 | 0 | 100 |
| Pea | 4 | 4 | 0 | 100 |
| Peppercress | 1 | 1 | 0 | 100 |
| Radish | 7 | 7 | 0 | 100 |
| Shungiku | 1 | 0 | 1 | 0 |
| Sunflower | 4 | 4 | 0 | 100 |
| Wasabi | 1 | 1 | 0 | 100 |
| Wheat grass | 1 | 1 | 0 | 100 |
| Non-specified single variety | 14 | 13 | 1 | 93 |
| Asian Mix | 4 | 4 | 0 | 100 |
| Garden Mix | 1 | 1 | 0 | 100 |
| Intensity Mix | 4 | 4 | 0 | 100 |
| Italian Mix | 3 | 3 | 0 | 100 |

| Variety | # Samples (Total) | VIDAS™ Positive | VIDAS™ Negative | Spike Detection % |
|---|---|---|---|---|
| Mediterranean Mix | 1 | 1 | 0 | 100 |
| Petite Mix | 2 | 2 | 0 | 100 |
| Rainbow Mix | 12 | 9 | 3 | 75 |
| Spectrum Mix | 6 | 6 | 0 | 100 |
| Spicy Mix | 4 | 4 | 0 | 100 |
| Tiny Greens Mix | 2 | 2 | 0 | 100 |
| Non-specified Mix | 17 | 16 | 1 | 94 |

Table S7. Summary of *S. enterica* detection in spiked sprouts with the VIDAS™ SLM method.

| Variety | # Samples (Total) | VIDAS™ Positive | VIDAS™ Negative | Spike Detection % |
|---|---|---|---|---|
| Alfalfa | 34 | 30 | 4 | 88 |
| Broccoli | 11 | 10 | 1 | 91 |
| Clover | 15 | 13 | 2 | 86 |
| Mixed | 10 | 10 | 0 | 100 |
| Mung Bean | 63 | 45 | 18 | 71 |
| Radish | 11 | 9 | 2 | 82 |
| Soybean | 20 | 14 | 6 | 70 |
| Sunflower | 5 | 5 | 0 | 100 |