2017 update of the matrix extension data for the VIDAS™ *Salmonella* (SLM) AOAC Official Method 2004.03 captured in the Field Accomplishment Computerized Tracking System (FACTS).

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Abstract

The *Salmonella enterica* spiked-matrix results for the VIDAS™ SLM method, collected in 2017, were reviewed and added to the cumulative data set which now covers the period from May 01, 2007 through December 31, 2017. The list of matrices which can be considered validated currently consists of 52 product categories; some of these categories contain multiple distinct, but highly similar, matrices such as the cereal/pseudo-cereal grain flour category. The list of matrices that fail to meet matrix-extension validation now contains 46 product categories; some of these categories contain multiple distinct, but highly similar, matrices such as the sprout category. 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 make certain that the FDA is using validated methods when testing for the presence of *S. enterica*.

1. Introduction

The United States Food and Drug Administration (FDA) perform routine surveillance and targeted inspections of a wide assortment of food matrices. To process samples in a timely manner the FDA frequently uses the VIDAS™ *Salmonella* (SLM) enzyme-linked immuno-fluorescence assay (AOAC Official Method 2004.03) since it shortens the analysis time relative to the standard Bacteriological Analytic Manual (BAM) reference method. The original AOAC study included 24 matrices that were

validated by a single laboratory of which 10 of those matrices were included in the final multi-laboratory validation (McMahon *et al*. 2004). Performing a full validation of the VIDAS™ SLM method on all matrices that fall under the FDA regulatory authority is impractical; however, the FDA must still demonstrate that all methods are fit for their intended use. To comply with this burden, 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 as to if the matrix should be considered validated. If so, spiking for that matrix ceases. If the matrix fails to meet the requirements, then an alternate testing method should be considered. Currently, the validation determination criteria are based on recommendation of 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%20Program%2FMDVIP%20SOP%20and%20Validation%20Guidelines) (last accessed 12/16/2018).

The purpose of matrix-extension validation 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. It is therefore essential that the spike-matrix data be periodically assessed. The spiked-matrix results for the VIDAS™ SLM method that are captured in the Field Accomplishment Computerized Tracking System (FACTS) between May 01, 2007 and December 31, 2014 were used to create an initial list of validated food matrices (Welch *et al*., 2016a). Subsequent evaluations of the data were performed to include spiked-matrix data collected during 2015 (Welch *et al*., 2016b) and 2016 (Melvin and Smiley, 2017a). During these previous assessments several issues were noted that complicate the construction of a resolute list of validated

matrices which can be used by the FDA's regulatory testing laboratories to assess the appropriateness of the VIDAS™ SLM method for a matrix that they might encounter. One such complication is achieving a meaningful and consistent categorization of matrices; for example, should two otherwise highly similar products be grouped separately simply because one is frozen and the other is fresh (*e.g*. raw fresh broccoli florets versus raw frozen broccoli florets)? Another previously mentioned example (Melvin and Smiley, 2017b) is the grouping of chili peppers; do all varieties need to be evaluated individually or can all varieties be considered equivalent? The primary consideration when formulating matrix groupings has been factors that might affect microbial recovery and detection (*e.g*. differences in pH, salinity, presence of preservatives). Despite guidance (Anon., 2006), matrix classification continues to be an issue when attempting to extrapolate the validation status of the VIDAS™ SLM method to foods/matrices not included in the original study.

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, 2017. Spike detection result data were obtained from 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 Matrices meeting matrix extension acceptance criteria

Approximately 940 spiked-matrix results records were retrieved from FACTS for 2017 of which approximately 850 were included in the final analysis. The current cumulative data set consists of 7845 total spike-matrix results. Approximately 6400 results were deemed suitable for use; the remainder were removed for incomplete information, duplication, incorrect spiking levels, or naturally occurring *S. enterica* contamination of the sample. The data were sorted into 262 product categories.

Twenty-one matrices meet the matrix-extension validation criterion of having at least 20 recorded results and a *S. enterica* detection rate of ≥95% (Table 1). Wheat grain bakery products is a new matrix category which consists of bread, cookies, cake, biscuits, doughnuts, tortillas (wheat based), and various other pastries. This is a broad category and was created to capture much of the unused data for bakery products that had not been considered in earlier reports due to infrequent observation within each sub-category. Cereal/pseudo-cereal grain flour was another new category that was created to capture much of the unused data for flours from various cereal and pseudo-

cereal grains (*e.g*. barley, quinoa, millet, and amaranth). A suitable number of spiked-matrix results were available for wheat flour but there were not enough observations for the other grains. Also included in this category is biscuit, cake, and pancake mixes despite the inclusion of other ingredients as these are generally chemical leavening agents and typically present at low levels. Although a cereal grain, ground corn was included with the corn products category as it is similar to cracked corn. A category for poultry feed was also created and includes products composed of individual but non-specified cereal grains, mixed cereal grains, and spent cakes from the processing of oilseed products (*e.g*. soybean and canola). Chili peppers are grouped into a single classification irrespective of variety (see Table S1 for chili pepper spiked-matrix results by variety). Tree nuts were also grouped into a single classification (see Table S2 for individual tree nut spiked-matrix results); similarly, so were edible seeds (see Table S3 for individual edible seed spiked-matrix results). The category for crustaceans is comprised of lobster, crayfish, crab, and shrimp (Table S4) and bivalve mollusks include scallops, oysters, clams, whelks, and mussels (Table S5). The remaining product categories in Table 1 are less ambiguous.

Thirty-one food types meet the matrix-extension validation criterion of having 7-19 spiked-matrix results with no reported failures (Table 2). Ten new matrices (Brussel sprouts, celery, cheese-stuffed chili peppers, chocolate, cooking oil, energy/nutrient bars, lobster meat, peas, potato chips, and starch) were added to this list based on spiked detection results captured in FACTS during the 2017 calendar year. Several matrices are no longer individually listed resulting from reclassification efforts. These include various nuts (now combined under Tree Nuts), scallops (now included under Bivalve mollusks), various seeds (now combined under Edible Seeds), and fresh strawberries (now combined with frozen strawberries).

3.2 Matrices which fail matrix extension criteria

Forty-six matrices fail to meet the matrix-extension validation criteria based on spike-detection failure rate (Table 3). Two matrices (flour and broccoli seeds), which were originally classified as failed matrices, were removed through reclassification.

Spiked-matrix entries corresponding to cereal or pseudo-cereal grain flours were used to form their own grouping leaving behind several orphan matrices with insufficient entries to regroup. Broccoli seeds were removed and combined with other seeds to form the edible seed group. Additionally, chamomile and damiana teas were combined with other teas under the general category of herbal teas; herbal teas remain on the list of matrices that fail to meet matrix-extension validation. Thirteen matrices were added to the list of failed matrices. Only one matrix, pasta, experienced a change in the validation status from passed to fail. The remaining 12 matrices were new and have not previously been included in earlier spiked-matrix results reports.

3.4 Matrices requiring further evaluation

There are 17 matrices for which the validation status cannot be fully resolved; these matrices have between seven and 19 spiked-matrix entries and a single spike-detection failure (Table 3). Continued monitoring of the spiking results is needed to resolve the validation status of these products.

3.5 Study summary

The FDA monitors for the presence of bacterial pathogens in a wide variety of foods. Performing a full multi-laboratory or even a single laboratory validation for every method-matrix combination is not practical. Matrix extension is an abbreviated validation process whereby a matrix that is similar to a fully validated matrix can be assessed with minimum spike-detection testing. Matrix extension validation is an unorthodox concept and the categorization of foods into distinct matrices is complicated; despite some recommendations, there are no rules firmly establishing product similarity and so categorizing foods for this purpose remains highly subjective. When establishing the matrix categories several factors were taken into consideration: 1) product description similarity entered into FACTS; 2) processes (*e.g*. raw, frozen, or cooked) represented within the category being considered; and 3) addition of other ingredients or components. Each of these will be described with further detail. When organizing the spike-results captured in FACTS, the task is to make an objective classification based

on descriptions that are often subjective. For instance, should “cornmeal”, the rough flour made by grinding dried corn, be placed in the same category as a matrix described as “ground corn”? Often, the product description entered into FACTS was heavily influenced by perceived end usage of the product; “cornmeal” is typically used for human consumption whereas “ground corn” describes an animal feed component. Any processing that was applied to the product was also considered as this would affect the levels of background microorganisms which could ultimately affect the ability to detect the target organism. Frozen raw shrimp and frozen cooked shrimp are expected to have greatly differing levels of background microorganisms. Extending the validation status to frozen cooked shrimp based on spiked-matrix results using frozen raw shrimp is logical since the primary source of target detection inhibition (*i.e*. high microbial background) has been eliminated by cooking. The reverse situation would be more problematic as spiked-matrix results collected using cooked products would not accurately reflect the impact of background microflora found on raw product. In this study, raw and cooked matrices were combined when it could be shown that the raw product would individually pass matrix extension validation. Many products that the FDA tests have multiple components which complicate placing them in a specific matrix category; cheese-filled chili peppers are one such product. This product does not conveniently fit into either “chili peppers” or “cheese” categories. The placement of cheese-filled chili peppers is further confounded since chili peppers pass the matrix extension criteria, but cheese does not. Currently this product has its own category and passes the matrix extension criterion of having a minimum of seven spike detection results with no failures; however, since cheese fails matrix-extension validation additional scrutiny may be warranted.

The FDA’s field laboratories have been collecting spiked-matrix results since 2004 for the VIDAS™ SLM method to expand the validation status to other foods that were not included in the original validation study, but which fall under their regulatory authority. The spiked-matrix results collected between 2004 and 2014 were initially reviewed (Welch *et al*., 2016a) with updates for spiked-matrix data collected in 2015 (Welch *et al*., 2016b) and 2016 (Melvin and Smiley, 2017a). Continued monitoring and

periodic evaluation of the spiked-matrix data is needed to ensure that the FDA is using appropriate methods when testing for the presence of *S. enterica*.

4. References

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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)	24	24	0	100	Passed
Avocado (fresh, frozen)	134	130	4	97	Passed
Crustaceans	69	67	2	97	Passed
Cucumbers (fresh)	486	479	7	99	Passed
Cereal/Pseudo-cereal Grain Flour	40	38	2	95	Passed
Kale	84	83	1	99	Passed
Mango (fresh, puree/pulp, frozen)	124	121	3	98	Passed
Mole sauce	22	22	0	100	Passed
Mollusks, Bivalve	37	36	1	97	Passed
Mung Beans	32	32	0	100	Passed
Papayas (fresh)	48	46	2	96	Passed
Peppers, Chili[1]	1027	989	38	96	Passed
Pet food, dry (kibble, pellet, biscuit)	134	129	5	96	Passed
Pet food, jerky	32	31	1	97	Passed
Poultry feed	21	21	0	100	Passed

Seeds, edible	139	135	4	97	Passed
Spinach (frozen, fresh)	21	21	0	100	Passed
Squid	41	40	1	98	Passed
Tree Nuts	83	81	2	98	Passed
Wheat grain bakery products	125	122	3	98	Passed
White pepper	19	19	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 with no reported spiked detection failures for the VIDAS™ *Salmonella* screening method.

Product	Total # Samples	VIDAS™ Positive	VIDAS™ Negative	Sensitivity Rate (%)	Status
Blueberries (fresh, frozen)	14	14	0	100	Passed
Brussel Sprouts	7	7	0	100	Passed
Canola meal (pellets, granular)	7	7	0	100	Passed
Carrots (fresh)	8	8	0	100	Passed
Celery	8	8	0	100	Passed
Cheese-stuffed chile peppers	9	9	0	100	Passed
Chick peas (raw, dried)	14	14	0	100	Passed
Chocolate (syrup, bars, chips)	8	8	0	100	Passed
Coriander (dried)	10	10	0	100	Passed
Cloves	8	8	0	100	Passed
Coffee	13	13	0	100	Passed
Cooking oil	12	12	0	100	Passed
Energy/Nutrient Bars	9	9	0	100	Passed

Fennel (whole, seeds, powder)	10	10	0	100	Passed
Fenugreek (dried, whole)	15	15	0	100	Passed
Fish (Ntrl/Artfcl Dried)	13	13	0	100	Passed
Granola bar	11	11	0	100	Passed
Guacamole (fresh, frozen, dried)	13	13	0	100	Passed
Guava nectar	10	10	0	100	Passed
Infant formula	9	9	0	100	Passed
Melons (honeydew, watermelon, koreon, canteloupe, chameleon, pepino)	13	13	0	100	Passed
Mushrooms/Fungus (fresh, dried)	8	8	0	100	Passed
Oatmeal	13	13	0	100	Passed
Peas/pea protein	13	13	0	100	Passed
Potato chips	11	11	0	100	Passed
Salsa	7	7	0	100	Passed
Starch	7	7	0	100	Passed
Treats, bones	18	18	0	100	Passed
Treats, jerky	7	7		100	Passed

(chicken)					
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	57	50	7	88	Failed
Aniseed (dried, whole or ground)	14	10	4	71	Failed
Annatto	6	4	2	67	Failed
Apples	6	4	2	67	Failed
Beans, Green Beans	13	10	3	77	Failed
Broccoli (fresh, frozen, heat treated)	22	19	3	86	Failed
Cactus (dried)	9	7	2	78	Failed
Cactus (fresh)	18	16	2	89	Failed
Cheese	35	24	11	69	Failed
Cherries (dried, fresh, frozen, cultured/cured)	7	4	3	57	Failed
Chili peppers dried (whole, powder, flakes)	83	74	9	89	Failed
Cinnamon	17	15	2	88	Failed
Corn (fresh, dried, heat treated)	38	29	9	76	Failed
Corn chips	20	18	2	90	Failed

Dietary Fiber Supplements	12	10	2	83	Failed
Fish, fresh/frozen	44	39	5	89	Failed
Garlic (dried)	22	15	7	68	Failed
Gooseberry powder	4	1	3	25	Failed
Green tea	6	3	3	50	Failed
Hibiscus (dried)	6	2	4	33	Failed
Khatta meetha	11	8	3	73	Failed
Lemon pepper	3	0	0	0	Failed
Masala/Curry/Spice Blends	260	206	54	79	Failed
Microgreens (all varieties)	116	108	8	93	Failed
Milk Replacer (animal, medicated)	12	10	2	83	Failed
Milk Replacer (animal, non-medicated)	35	31	4	89	Failed
Onion (fresh)	15	11	4	73	Failed
Pasta	43	40	3	93	Failed
Pet food, freeze-dried	14	12	2	86	Failed
Pet food, moist	23	21	2	91	Failed
Pet food, raw	11	9	2	82	Failed

Plums, flavored	5	3	2	60	Failed
Raspberries (freeze dried, frozen, fresh)	7	5	2	71	Failed
Salt	7	5	2	71	Failed
Soybeans (paste, fresh, frozen, heat treated)	28	26	2	93	Failed
Sprouts, (all varieties)	168	135	33	80	Failed
Sprout Irrigation Water	45	36	9	80	Failed
Squash	42	39	3	93	Failed
Strawberries (fresh or frozen)	20	18	2	90	Failed
Sumac	6	3	3	50	Failed
Taro (frozen, dried)	9	7	2	75	Failed
Tea, herbal	96	75	21	78	Failed
Tomato dried	3	1	2	33	Failed
Tomato fresh	33	31	2	94	Failed
Treats, Pet (rawhide)	29	24	5	83	Failed
Tumeric	17	14	3	82	Failed

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
Blackberries	11	10	1	91	Pending
Cabbage/choy	12	11	1	92	Pending
Cilantro (fresh)	12	11	1	92	Pending
Coconut	13	12	1	92	Pending
Curry powder	13	12	1	92	Pending
Dates	13	12	1	92	Pending
Distillars grain	11	10	1	91	Pending
Anchovies	7	6	1	86	Pending
Hing	7	6	1	86	Pending
Mamey pulp	9	8	1	89	Pending
Oregano	9	8	1	89	Pending
Radish (fresh, salted, pickled)	15	14	1	93	Pending
Paprika	18	17	1	94	Pending
Seaweed	13	12	1	92	Pending
Soy protein	10	9	1	90	Pending
Spring rolls	9	8	1	89	Pending
Tofu	10	9	1	90	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*	61	60	1	98
Arbol	*C. annuum*	2	2	0	100
Banana	*C. annuum*	7	7	0	100
Bell	*C. annuum*	254	236	18	93
Caribe	*C. annuum*	12	11	1	92
Cayenne	*C. annuum*	2	1	1	50
Cubanelle	*C. annuum*	1	1	0	100
Fresno	*C. annuum*	5	4	1	80
Habanero	*C. chinense*	36	36	0	100
Hungaro	*C. annuum*	11	11	0	100
Jalapeño	*C. annuum*	281	273	8	97
Korean	*C. annuum*	4	4	0	100
Manzano	*C. pubescens*	6	6	0	100
Non-specified	NA	89	85	4	96
Pasilla	*C. annuum*	44	43	1	98
Pimiento	*C. annuum*	2	2	0	100
Poblano	*C. annuum*	46	44	2	96
Pueblo	*C. annuum*	1	1	0	100
Scotch Bonnet	*C. chinense*	2	2	0	100
Serrano	*C. annuum*	148	147	1	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	11	10	1	91
Brazil	10	10	0	100
Cashew	24	23	1	96
Macadamia	13	13	0	100
Pecan	17	17	0	100
Pine	7	7	0	100
Pistachio	1	1	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	16	16	0	100
Amaranth	5	5	0	100
Basil	5	5	0	100
Broccoli	7	5	2	71
Cardamon	3	3	0	100
Chia	26	26	0	100
Clover	10	10	0	100
Flaxseed	9	9	0	100
Kalonji	3	3	0	100
Melon	3	3	0	100
Poppy	4	4	0	100
Pumpkin	22	22	0	100
Sesame	15	14	1	93
Sunflower	9	9	0	100

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

Matrix	Total Samples	VIDAS™ Pos	VIDAS™ Neg	Spike Detection %
Lobster	8	8	0	100
Crayfish	4	4	0	100
Crab	16	16	0	100
Shrimp	41	39	2	95

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

Matrix	Total Samples	VIDAS™ Pos	VIDAS™ Neg	Spike Detection %
Clams	8	8	0	100
Mussels	7	6	1	86
Oysters	2	2	0	100
Scallops	18	18	0	100
Whelks	2	2	0	100

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	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
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

nd = not determinable

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	14	12	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