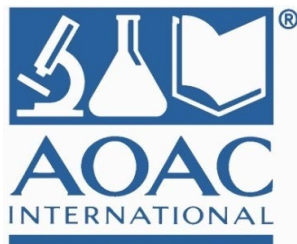


September 25-26, 2015



AOAC STAKEHOLDER PANEL ON DIETARY SUPPLEMENTS (SPDS)

Chair: Darryl Sullivan

Vice Chair: Brian Schaneberg

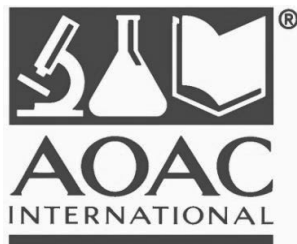
STAKEHOLDER PANEL MEETING BOOK



**Room: Santa Anita AB
Westin Bonaventure Hotel
404 South Figueroa Street
Los Angeles, California, 90071**

contact: spds@aoac.org

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Appendix W

POLICY AND PROCEDURES ON VOLUNTEER CONFLICT OF INTEREST

Statement of Policy

While it is not the intention of AOAC INTERNATIONAL (AOAC) to restrict the personal, professional, or proprietary activities of AOAC members nor to preclude or restrict participation in Association affairs solely by reason of such activities, it is the sense of AOAC that conflicts of interest or even the appearance of conflicts of interest on the part of AOAC volunteers should be avoided. Where this is not possible or practical under the circumstances, there shall be written disclosure by the volunteers of actual or potential conflicts of interest in order to ensure the credibility and integrity of AOAC. Such written disclosure shall be made to any individual or group within the Association which is reviewing a recommendation which the volunteer had a part in formulating and in which the volunteer has a material interest causing an actual or potential conflict of interest.

AOAC requires disclosure of actual or potential conflicts of interest as a condition of active participation in the business of the Association. The burden of disclosure of conflicts of interest or the appearance of conflicts of interest falls upon the volunteer.

A disclosed conflict of interest will not in itself bar an AOAC member from participation in Association activities, but a three-fourths majority of the AOAC group reviewing the issue presenting the conflict must concur by secret ballot that the volunteer's continued participation is necessary and will not unreasonably jeopardize the integrity of the decision-making process.

Employees of AOAC are governed by the provision of the AOAC policy on conflict of interest by staff. If that policy is in disagreement with or mute on matters covered by this policy, the provisions of this policy shall prevail and apply to staff as well.

Illustrations of Conflicts of Interest

1. A volunteer who is serving as a committee member or referee engaged in the evaluation of a method or device; who is also an employee of or receiving a fee from the firm which is manufacturing or distributing the method or device or is an employee of or receiving a fee from a competing firm.
2. A volunteer who is requested to evaluate a proposed method or a related collaborative study in which data are presented that appear detrimental (or favorable) to a product distributed or a position supported by the volunteer's employer.
3. A referee who is conducting a study and evaluating the results of an instrument, a kit, or a piece of equipment which will be provided gratis by the manufacturer or distributor to one or more of the participating laboratories, including his or her own laboratory, at the conclusion of the study.
4. Sponsorship of a collaborative study by an interest (which may include the referee) which stands to profit from the results; such sponsorship usually involving the privilege granted by the investigator to permit the sponsor to review and comment upon the results prior to AOAC evaluation.
5. A volunteer asked to review a manuscript submitted for publication when the manuscript contains information which is critical of a proprietary or other interest of the reviewer.

The foregoing are intended as illustrative and should not be interpreted to be all-inclusive examples of conflicts of interest AOAC volunteers may find themselves involved in.

Do's and Don't's

Do avoid the appearance as well as the fact of a conflict of interest.

Do make written disclosure of any material interest which may constitute a conflict of interest or the appearance of a conflict of interest.

Do not accept payment or gifts for services rendered as a volunteer of the Association without disclosing such payment or gifts.

Do not vote on any issue before an AOAC decision-making body where you have the appearance of or an actual conflict of interest regarding the recommendation or decision before that body.

Do not participate in an AOAC decision-making body without written disclosure of actual or potential conflicts of interest in the issues before that body.

Do not accept a position of responsibility as an AOAC volunteer, without disclosure, where the discharge of the accepted responsibility will be or may appear to be influenced by proprietary or other conflicting interests.

Procedures

Each volunteer elected or appointed to an AOAC position of responsibility shall be sent, at the time of election or appointment, a copy of this policy and shall be advised of the requirement to adhere to the provisions herein as a condition for active participation in the business of the Association. Each volunteer, at the time of his or her election or appointment, shall indicate, in writing, on a form provided for this purpose by AOAC, that he or she has read and accepts this policy.

Each year, at the spring meeting of the AOAC Board of Directors, the Executive Director shall submit a report certifying the requirements of this policy have been met; including the names and positions of any elected or appointed volunteers who have not at that time indicated in writing that they have accepted the policy.

Anyone with knowledge of specific instances in which the provisions of this policy have not been complied with shall report these instances to the Board of Directors, via the Office of the Executive Director, as soon as discovered.

* * * * *

Adopted: March 2, 1989

Revised: March 28, 1990

Revised: October 1996

Reviewed by outside counsel March 2000 (Fran Dwornik) and found to be current and relevant

Appendix U

ANTITRUST POLICY STATEMENT AND GUIDELINES

Introduction

It is the policy of AOAC INTERNATIONAL (AOAC) and its members to comply strictly with all laws applicable to AOAC activities. Because AOAC activities frequently involve cooperative undertakings and meetings where competitors may be present, it is important to emphasize the on-going commitment of our members and the Association to full compliance with national and other antitrust laws. This statement is a reminder of that commitment and should be used as a general guide for AOAC and related individual activities and meetings.

Responsibility for Antitrust Compliance

The Association's structure is fashioned and its programs are carried out in conformance with antitrust standards. However, an equal responsibility for antitrust compliance -- which includes avoidance of even an appearance of improper activity -- belongs to the individual. Even the appearance of improper activity must be avoided because the courts have taken the position that actual proof of misconduct is not required under the law. All that is required is whether misconduct can be inferred from the individual's activities.

Employers and AOAC depend on individual good judgment to avoid all discussions and activities which may involve improper subject matter and improper procedures. AOAC staff members work conscientiously to avoid subject matter or discussion which may have unintended implications, and counsel for the Association can provide guidance with regard to these matters. It is important for the individual to realize, however, that the competitive significance of a particular conduct or communication probably is evident only to the individual who is directly involved in such matters.

Antitrust Guidelines

In general, the U.S. antitrust laws seek to preserve a free, competitive economy and trade in the United States and in commerce with foreign countries. Laws in other countries have similar objectives. Competitors (including individuals) may not restrain competition among themselves with reference to the price, quality, or distribution of their products, and they may not act in concert to restrict the competitive capabilities or opportunities of competitors, suppliers, or customers.

Although the Justice Department and Federal Trade Commission generally enforce the U.S. antitrust laws, private parties can bring their own lawsuits. Penalties for violating the U.S. and other antitrust laws are severe: corporations are subject to heavy fines and injunctive decrees, and may have to pay substantial damage judgments to injured competitors, suppliers, or customers. Individuals are subject to criminal prosecution, and will be punished by fines and imprisonment. Under current U.S. federal sentencing guidelines, individuals found guilty of bid rigging, price fixing, or market allocation must be sent to jail for at least 4 to 10 months and must pay substantial minimum fines.

Since the individual has an important responsibility in ensuring antitrust compliance in AOAC activities, everyone should read and heed the following guidelines.

1. Don't make any effort to bring about or prevent the standardization of any method or product for the purpose or intent of preventing the manufacture or sale of any method or product not conforming to a specified standard
2. Don't discuss with competitors your own or the competitors' prices, or anything that might

- affect prices such as costs, discounts, terms of sale, distribution, volume of production, profit margins, territories, or customers.
3. Don't make announcements or statements at AOAC functions, outside leased exhibit space, about your own prices or those of competitors.
 4. Don't disclose to others at meetings or otherwise any competitively sensitive information.
 5. Don't attempt to use the Association to restrict the economic activities of any firm or any individual.
 6. Don't stay at a meeting where any such price or anti-competitive talk occurs.
 7. Do conduct all AOAC business meetings in accordance with AOAC rules. These rules require that an AOAC staff member be present or available, the meeting be conducted by a knowledgeable chair, the agenda be followed, and minutes be kept.
 8. Do confer with counsel before raising any topic or making any statement with competitive ramifications.
 9. Do send copies of meeting minutes and all AOAC-related correspondence to the staff member involved in the activity.
 10. Do alert the AOAC staff to any inaccuracies in proposed or existing methods and statements issued, or to be issued, by AOAC and to any conduct not in conformance with these guidelines.

Conclusion

Compliance with these guidelines involves not only avoidance of antitrust violations, but avoidance of any behavior which might be so construed. Bear in mind, however, that the above antitrust laws are stated in general terms, and that this statement is not a summary of applicable laws. It is intended only to highlight and emphasize the principal antitrust standards which are relevant to AOAC programs. You must, therefore, seek the guidance of either AOAC counsel or your own counsel if antitrust questions arise.

Adopted by the AOAC Board of Directors: September 24, 1989

Revised: March 11, 1991

Revised October 1996

Appendix V

POLICY ON THE USE OF THE ASSOCIATION NAME, INITIALS, IDENTIFYING INSIGNIA, LETTERHEAD, AND BUSINESS CARDS

Introduction

The following policy and guidelines for the use of the name, initials, and other identifying insignia of AOAC INTERNATIONAL have been developed in order to protect the reputation, image, legal integrity and property of the Association.

The name of the Association, as stated in its bylaws, is "AOAC INTERNATIONAL". The Association is also known by its initials, AOAC, and by its logo, illustrated below, which incorporates the Association name and a representation of a microscope, book, and flask. The AOAC logo is owned by the Association and is registered with the U.S. Patent and Trademark Office.



The full Association insignia, illustrated below, is comprised of the logo and the tagline, "The Scientific Association Dedicated to Analytical Excellence," shown below. The typeface used is Largo. The AOAC tagline is owned by the Association and is registered with the U.S. Patent and Trademark office.



The Scientific Association Dedicated to Analytical Excellence®

Policy

Policy on the use of the Association's name and logo is established by the AOAC Board of Directors as follows:

“The Board approves and encourages reference to the Association by name, either as AOAC INTERNATIONAL or as AOAC; or reference to our registered trademark, AOAC®, in appropriate settings to describe our programs, products, etc., in scientific literature and other instances so long as the reference is fair, accurate, complete and truthful and does not indicate or imply unauthorized endorsement of any kind.

The insignia (logo) of AOAC INTERNATIONAL is a registered trade and service mark and shall not be reproduced or used by any person or organization other than the Association, its elected and appointed officers, sections, or committees, without the prior written permission of the Association. Those authorized to use the AOAC INTERNATIONAL insignia shall use it only for

the purposes for which permission has been specifically granted.

The name and insignia of the Association shall not be used by any person or organization in any way which indicates, tends to indicate, or implies AOAC official endorsement of any product, service, program, company, organization, event or person, endorsement of which, has not been authorized by the Association, or which suggests that membership in the Association is available to any organization.”

The Executive Director, in accordance with the above stated policy, is authorized to process, approve, fix rules, and make available materials containing the Association name and insignia.

It should be noted that neither the Association's name nor its insignia nor part of its insignia may be incorporated into any personal, company, organization, or any other stationery other than that of the Association; nor may any statement be included in the printed portion of such stationery which states or implies that an individual, company, or other organization is a member of the Association.

Instructions

1. Reproduction or use of the Association name or insignia requires prior approval by the Executive Director or his designate.
2. Association insignia should not be altered in any manner without approval of the Executive Director or his designate, except to be enlarged or reduced in their entirety.
3. Artwork for reproducing the Association name or insignia, including those incorporating approved alterations, will be provided on request to those authorized to use them (make such requests to the AOAC Marketing Department). Examples of the types of alterations that would be approved are inclusion of a section name in or the addition of an officer's name and address to the letterhead insignia.
4. When the Association name is used without other text as a heading, it should, when possible, be set in the Largo typeface.
5. Although other colors may be used, AOAC blue, PMS 287, is the preferred color when printing the AOAC insignia, especially in formal and official documents. It is, of course, often necessary and acceptable to reproduce the insignia in black.
6. Do not print one part of the logo or insignia in one color and other parts in another color.
7. The letterhead of AOAC INTERNATIONAL shall not be used by any person or organization other than the Association, elected and appointed officers, staff, sections, or committees; except by special permission.

Correspondence of AOAC official business should be conducted using AOAC letterhead. However, those authorized to use AOAC letterhead shall use it for official AOAC business only.

Copies of all correspondence using AOAC letterhead or conducting AOAC official business,

whether on AOAC letterhead or not, must be sent to the appropriate office at AOAC headquarters.

8. AOAC INTERNATIONAL business cards shall not be used by any person or organization other than the Association, its staff, and elected officials, except by special permission.

Those authorized to use AOAC business cards shall use them for official AOAC business only and shall not represent themselves as having authority to bind the Association beyond that authorized.

Sanctions

1. Upon learning of any violation of the above policy, the Executive Director or a designate will notify the individual or organization that they are in violation of AOAC policy and will ask them to refrain from further misuse of the AOAC name or insignia.
2. If the misuse is by an Individual Member or Sustaining Member of the Association, and the misuse continues after notification, the Board of Directors will take appropriate action.
3. If continued misuse is by a nonmember of the Association or if a member continues misuse in spite of notification and Board action, ultimately, the Association will take legal action to protect its property, legal integrity, reputation, and image.

* * * * *

Adopted by the AOAC Board of Directors: September 24, 1989

Revised: June 13, 1991; February 26, 1992; March 21, 1995; October 1996



AOAC Stakeholder Panel Voting Members

AOAC INTERNATIONAL (AOAC) assembles stakeholder panels to develop voluntary consensus standards. While AOAC maintains transparency and openness in accordance with national and international guidance and regulations for standards development and its policies and procedures for assembling stakeholder panels, its policies and procedures also ensure that there is a balance of interests and perspectives in achieving consensus of the stakeholder panel.

Due Process and Balance

All AOAC stakeholder panels are diverse and can vary in size. Where a stakeholder panel is not balanced or if it is significantly large whereby consensus of the general assembly may be impractical, a balanced representative voting panel will be used to demonstrate consensus. AOAC encourages ALL stakeholders to participate in deliberations during stakeholder panel meetings and working group meetings, in addition to participating during any posted comment periods. To ensure that there is a balance of interests and perspectives, a **representative subset** of the stakeholder panel, the voting members, is selected to reach consensus for the development of AOAC voluntary consensus standards.

Composition

Voting members represent the perspectives of the larger stakeholder panel. The voting members consist of no more than $\frac{1}{4}$ to $\frac{1}{3}$ of the total number of stakeholders in registered. Primary and secondary representative voting members are approved. Every attempt is made to approve a panel of voting members that represents all perspectives of the stakeholder panel. In the event of a primary voting member is not able to attend, and no alternate has been approved, the stakeholder panel chair, working

with AOAC can provisionally approve an alternate from those in attendance to assure balance and lack of dominance. For stakeholder panels with scopes including diverse topics, the voting member representatives may be rotated to include other stakeholders for successive meetings to ensure a lack of dominance by any particular stakeholder.

Approval Process

AOAC works with the chair of the stakeholder panel and potentially other key stakeholders to develop a proposed representative voting member panel. Following AOAC policies and procedures, the proposed voting members and documentation are submitted to the AOAC Official Methods Board (OMB) for review and approval. The OMB's review ensures that the proposed panel is balanced in interests and perspectives representing the stakeholder panel and a lack of dominance.

Roles and Responsibilities

Every stakeholder has a voice and every stakeholder is entitled to state his/her or organizational perspective(s). This is due process. In developing AOAC standards, stakeholder consensus is demonstrated by 2/3 vote (67%) in favor of a motion to adopt a standard. It is important to note: Individual voting members do not have any additional weight, voice or status in stakeholder deliberations than other stakeholders. The role of the voting members is to demonstrate the consensus of the stakeholder panel. Voting members may vote in favor or against any motion and/or they may abstain. Stakeholder panel chair will moderate voting process. AOAC carefully documents the vote. It is important for voting members to be in the room during the time for voting. It is also important for voting members to inform the chair of his/her inability to serve as a voting member.



AOAC INTERNATIONAL

STAKEHOLDER PANEL ON DIETARY SUPPLEMENTS (SPDS) WORKING GROUP CHAIR & MEMBERS

VOLUNTEER ROLE DESCRIPTION

POSITION TITLE:	Working Group Chair and Members, AOAC SPDS Working Group
POSITION CLASSIFICATION:	Volunteer
REPORTS TO:	SPDS Chair
DATE PREPARED:	March 13, 2014

POSITION SUMMARY:

In keeping with the mission of AOAC INTERNATIONAL and the goals of the Stakeholder Panel on Dietary Supplements (SPDS), working group chairs will lead their working group in the development of standards (or other tasks as assigned by the SPDS chair) for specific priority ingredients as defined by the SPDS Advisory Panel. Working group chair(s) will work with AOAC staff and stakeholders to meet the working group's goals and disseminate recommendations to the stakeholder panel and community at-large. The working group may hold meetings in person and/or via teleconference (web and video) to complete its work. The chair of the working group will moderate the working group discussions, assist in scheduling the meetings, and report the working group's recommendation back to SPDS. Working group chairs will work with AOAC to formulate the working group's recommendations into motions for SPDS's consideration.

ELIGIBILITY CRITERIA FOR SPDS WORKING GROUP

CHAIR:

- Must be a key expert and/or thought leader in dietary supplements and the technologies used for priority ingredients as assigned for the specific working group.
- Must have the recommendation of the SPDS Chair.

WORKING GROUP CHAIR RESPONSIBILITIES:

- Chair meetings of the working group, moderate discussions of the working group and work with AOAC staff to facilitate working group's work.

- Work with AOAC staff and SPDS chair to identify working group members, any additional expertise/resources needed facilitate the work of the working group.
- Work as a team member and also independently.
- Present an overview on the specified priority ingredient under consideration including, but not limited to, regulatory implications, and public health and public safety challenges with methodology.
- Prepare a draft fitness for purpose statement for specified priority ingredient and technology to present to SPDS for consideration.
- Work with AOAC staff to reconcile actions and outcomes of working group deliberations.
- Using AOAC guidance to reconcile comments and address questions on SMPR.
- Present working group recommended SMPR to SPDS for review and approval.
- Work with AOAC staff and stakeholders to draft and review relevant methodology and working group documentation.
- Draft SMPR white paper for publication.
- Perform duties and reviews in timely fashion.
- Other tasks as agreed upon by working group chair, SPDS chair and AOAC staff.

DUTIES AND RESPONSIBILITIES OF THE SPDS WORKING GROUP MEMBERS:

The working group will meet either in person and via teleconference, web conferencing or by other means of communication. All communication and meetings of the working group must be facilitated through AOAC

staff. The working group's tasks will include developing standard method performance requirements (SMPRs), review of methodology, identifying expertise and other as may be requested by the SPDS chair. Working groups are not required to vote, but to show general consensus for its recommendations. The groups should meet to discuss their objectives and complete their assigned tasks. Individuals on the working groups may be tasked with their own action items and responsibilities. More than one meeting and one round of communication may be required to complete the working group's tasks. All working group participants are expected to contribute and are expected to have completed the SMPR Education Session. AOAC staff will document all working group decisions and actions.

AOAC RESOURCES:

- Referencing AOAC guidance documentation to assist in drafting the fitness for purpose statement,

standard method performance requirements (SMPR), and additional work as tasked.

- 1) AOAC Fitness for Purpose Statement Guideline
- 2) Appendix F: Guidelines for Standard Method Performance Requirements
- 3) Appendix K: Guidelines for Dietary Supplements and Botanicals

STAFF LIASON:

AOAC will assign staff to facilitate the work of the working group.

TERMS OF REVIEW:

This document will be reviewed biannually by the SPDS Chair and AOAC staff.

DATES REVISED:

Stakeholder Panel

Voting Panel – A vetted, representative, and balanced subset of the assembled stakeholders. Ideally the number of voters represents $\frac{1}{4}$ to $\frac{1}{3}$ of the assembly.

Voting Guidelines – A. motions to create a consensus based standard (ex: voting on fitness for purpose statements or Standard Method Performance Requirements) require a 2/3 vote for the motion to carry.
 B. Any other motion (ex: votes to clarify information for working groups, set priorities or direction, etc.) requires a majority vote to carry.

Expert Review Panel

Voting Panel – 7 – 10 vetted experts

Quorum - The presence of **7** members or **2/3** of total vetted ERP membership, whichever is greater.

Voting Guidelines – Motions to adopt a *First Action Official MethodSM of Analysis* carry by unanimous vote on first ballot. If not unanimous, negative votes must delineate scientific reasons, and can be overridden by 2/3 of voting ERP members after due consideration. Dissenting opinions are recorded.

Working Group

Voting Panel – There is no formal voting panel. Any interested and knowledgeable party may participate. Working groups sole purpose is to provide recommendations to stakeholder panels.

Voting Guidelines –majority vote carries all motions, dissenting opinions considered by assembly and recorded.

Helpful Definitions & Terminology

Quorum	The number of members who must be present in order to validly transact business. It is determined by the number of members present, not the number present and voting. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. p. 151).</i>
Representative Voting Panel Members	Every member has an obligation to vote and the right to abstain.
Abstentions	Abstentions reduce the number required to obtain a majority of those present and voting. They are only counted to confirm the presence of a quorum. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. p. 237).</i>
Order	Meetings should address only one item of business at one time (only one pending motion at a time). Chairs should not permit digression or introduction of different topics until the business at hand is resolved. No pending motions while changing topics. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. p. 1).</i> All business must be conducted with order and should be done fairly and impartially. The presiding officer should impartially ensure that each member has an opportunity to speak. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. pp. 1-2).</i>
Equality	All members have equal opportunity to propose motions, to participate in debate, to vote, to serve on committees or as an officer, to share in activities according to the member’s abilities. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. p. 2).</i>
Justice	All members have the right to ask questions, to be informed, to have complex motions explained by the chair. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. p. 2).</i>
Minority Rights	Dissenting members have equal rights to voice opposing or minority opinions and strive to become the majority. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. p. 2).</i>
Majority Rights	No members, board, or officers have the right to dictate or control decisions unless the member grant such rights Members may not take any action in conflict with federal, regional or organizational laws or policies. Decisions are based on the will of the majority. <i>(Fundamentals of Parliamentary Law and Procedure, 3rd edition. p. 2).</i>

Appendix F: Guidelines for Standard Method Performance Requirements

Contents

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Introduction to Standard Method Performance Requirements

Standard method performance requirements (SMPRs) are a unique and novel concept for the analytical methods community. SMPRs are voluntary consensus standards, developed by stakeholders, that prescribe the minimum analytical performance requirements for classes of analytical methods. In the past, analytical methods were evaluated and the results compared to a “gold standard” method, or if a gold standard method did not exist, then reviewers would decide retrospectively if the analytical performance was acceptable. Frequently, method developers concentrated on the process of evaluating the performance parameters of a method, and rarely set acceptance criteria. However, as the *Eurachem Guide* points out: “. . . the judgment of method suitability for its intended use is equally important . . .” (1) to the evaluation process.

International Voluntary Consensus Standards

An SMPR is a form of an international, voluntary consensus standard. A standard is an agreed, repeatable way of doing something that is published as document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition. SMPRs are a *consensus* standards developed by stakeholders in a very controlled process that ensures that users, research organizations, government departments, and consumers work together to create a standard that meets the demands of the analytical community and technology. SMPRs are also *voluntary* standards. AOAC cannot, and does not, impose the use of SMPRs. Users are free to use SMPRs as they see fit. AOAC is very careful to include participants from as many regions of the world as possible so that SMPRs are accepted as *international* standards.

Guidance for Standard Method Performance Requirements

Commonly known as the “SMPR Guidelines.” The first version of the SMPR Guidelines were drafted in 2010 in response to the increasing use and popularity of SMPRs as a vehicle to describe the analytical requirements of a method. Several early “acceptance

criteria” documents were prepared for publication in late 2009, but the format of the acceptance criteria documents diverged significantly from one another in basic format. AOAC realized that a guidance document was needed to promote uniformity.

An early version of the SMPR Guidelines were used for a project to define the analytical requirements for endocrine disruptors in potable water. The guidelines proved to be extremely useful in guiding the work of the experts and resulted in uniform SMPRs. Subsequent versions of the SMPR Guidelines were used in the Stakeholder Panel for Infant Formula and Adult Nutritionals (SPIFAN) project with very positive results. The SMPR Guidelines are now published for the first time in the *Journal of AOAC INTERNATIONAL* and *Official Methods of Analysis*.

Users of the guidelines are advised that they are: (1) a *guidance* document, not a statute that users must conform to; and (2) a “living” document that is regularly updated, so users should check the AOAC website for the latest version before using these guidelines.

The SMPR Guidelines are intended to provide basic information for working groups assigned to prepare SMPRs. The guidelines consist of the standard format of an SMPR, followed by a series of informative tables and annexes.

SMPR Format

The general format for an SMPR is provided in *Annex A*.

Each SMPR is identified by a unique SMPR number consisting of the year followed by a sequential identification number (YYYY.XXX). An SMPR number is assigned when the standard is approved. By convention, the SMPR number indicates the year a standard is approved (as opposed to the year the standard is initiated). For example, SMPR 2010.003 indicates the third SMPR adopted in 2010.

The SMPR number is followed by a method name that must include the analyte(s), matrix(es), and analytical technique (unless the SMPR is truly intended to be independent of the analytical technology). The method name may also refer to a “common” name (e.g., “Kjeldahl” method).

The SMPR number and method name are followed by the name of the stakeholder panel or expert review panel that approved the SMPR, and the approval and effective dates.

Information about method requirements is itemized into nine categories: (1) intended use; (2) applicability; (3) analytical technique; (4) definitions; (5) method performance requirements; (6) system suitability; (7) reference materials; (8) validation guidance; and (9) maximum time-to-determination.

An SMPR for qualitative and/or identification methods may include up to three additional annexes: (1) inclusivity/selectivity panel; (2) exclusivity/cross-reactivity panel; and (3) environmental material panels. These annexes not required.

Informative tables.—The SMPR Guidelines contain seven informative tables that represent the distilled knowledge of many years of method evaluation, and are intended as guidance for SMPR working groups. The informative tables are not necessarily AOAC

policy. SMPR working groups are expected to apply their expertise in the development of SMPRs.

Table A1: Performance Requirements. Provides recommended performance parameters to be included into an SMPR. Table A1 is organized by five method classifications: (1) main component quantitative methods; (2) trace or contaminant quantitative methods; (3) main component qualitative methods; (4) trace or contaminant quantitative methods; and (5) identification methods. The table is designed to accommodate both microbiological and chemical methods. Alternate microbiological/chemical terms are provided for equivalent concepts.

Table A2: Recommended Definitions. Provides definitions for standard terms in the SMPR Guidelines. AOAC relies on *The International Vocabulary of Metrology Basic and General Concepts and Associated Terms* (VIM) and the International Organization for Standardization (ISO) for definition of terms not included in Table A2.

Table A3: Recommendations for Evaluation. Provides general guidance for evaluation of performance parameters. More detailed evaluation guidance can be found in *Appendix D, Guidelines for Collaborative Study Procedures to Validate Characteristics of a Method of Analysis* (2); *Appendix I, Guidelines for Validation of Biological Threat Agent Methods and/or Procedures* (3); *Appendix K, AOAC Guidelines for Single-Laboratory Validation of Chemical Methods for Dietary Supplements and Botanicals* (4); *Codex Alimentarius Codex Procedure Manual* (5); and *ISO Standard 5725-1-1994* (6).

Table A4: Expected Precision (Repeatability) as a Function of Analyte Concentration. The precision of a method is the closeness of agreement between independent test results obtained under stipulated conditions. Precision is usually expressed in terms

of imprecision and computed as a relative standard deviation (RSD) of the test results. The imprecision of a method increases as the concentration of the analyte decreases. This table provides target RSDs for a range of analyte concentrations.

Table A5: Expected Recovery as a Function of Analyte Concentration. Recovery is defined as the ratio of the observed mean test result to the true value. The range of the acceptable mean recovery expands as the concentration of the analyte decreases. This table provides target mean recovery ranges for analyte concentrations from 1 ppb to 100%.

Table A6: Predicted Relative Standard Deviation of Reproducibility (PRSD_R). This table provides the calculated PRSD_R using the Horwitz formula:

$$PRSD_R = 2C^{-0.15}$$

where C is expressed as a mass fraction.

Table A7: POD and Number of Test Portions. This table provides the calculated probability of detection (POD) for given sample sizes and events (detections). A method developer can use this table to determine the number of analyses required to obtain a specific POD.

Informative annexes.—The SMPR Guidelines contain informative annexes on the topics of classification of methods, POD model, HorRat values, reference materials, and method accuracy and review. As with the informative tables, these annexes are intended to provide guidance and information to the working groups.

Initiation of an SMPR

See Figure 1 for a schematic flowchart diagram of the SMPR development process.

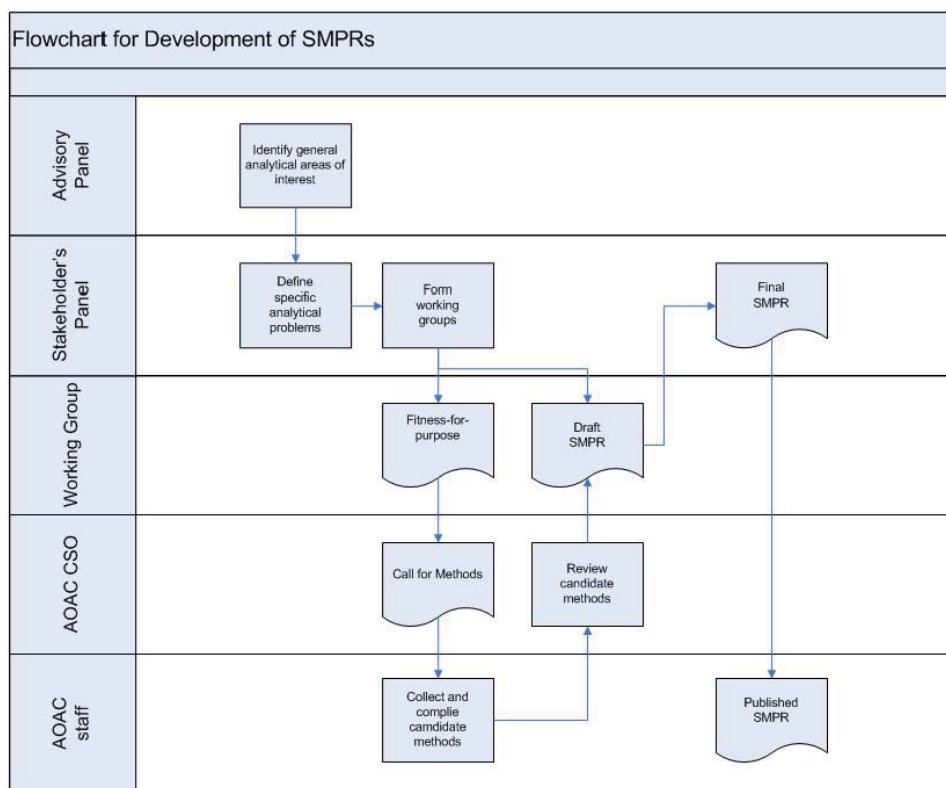


Figure 1. Schematic flowchart diagram of the SMPR development process.

Advisory panels.—Most commonly, an SMPR is created in response to an analytical need identified by an advisory panel. Advisory panels normally consist of sponsors and key stakeholders who have organized to address analytical problems. Usually, the advisory panel identifies general analytical problems, such as the need to update analytical methods for determination of nutrients in infant formula. An advisory panel, with the input of appropriate subject matter experts, also prioritizes the specific analytical problems within the general topic. This panel is critical in planning for the stakeholder panel meeting.

Stakeholder panels.—After an advisory panel has identified a general analytical problem, AOAC announces the standards development activity, identifies stakeholders, and organizes a stakeholder panel. Membership on a stakeholder panel is open to anyone materially affected by the proposed standard. AOAC recruits scientists to participate on stakeholder panels on the basis of their expertise with the analytical problem identified by the advisory panel. Experts are recruited from academia, government, nongovernmental organizations (such as ISO), industry, contract research organizations, method developers, and instrument/equipment manufacturers. AOAC employs a representative voting panel model to ensure balance with regards to stakeholder perspective, and to ensure that no particular stakeholder perspective dominates the proceedings of the stakeholder panel. All stakeholder candidates are reviewed by the AOAC Chief Scientific Officer (CSO) for relevant qualifications, and again by the Official Methods Board to ensure that the stakeholder panel is balanced and all stakeholders are fairly represented.

Stakeholder panels are extremely important as they serve several functions: (1) identify specific analytical topics within the general analytical problem described by the advisory panel; (2) form working groups to address the specific analytical topics; (3) identify additional subject matter experts needed for the working groups; (4) provide oversight of the SMPR development; and (5) formally adopt SMPRs originally drafted by working groups.

Working groups.—Working groups are formed by the stakeholder panel when a specific analytical topic has been identified. The primary purpose of a working group is to draft an SMPR. Working groups may also be formed to make general recommendations, such as developing a common definition to be used by multiple working groups. For example, SPIFAN formed a working group to create a definition for “infant formula” that could be shared and used by all of the SPIFAN working groups.

The process of drafting an SMPR usually requires several months, and several meetings and conference calls. An SMPR drafted by a working group is presented to a stakeholder panel. A stakeholder panel may revise, amend, or adopt a proposed SMPR on behalf of AOAC.

Fitness-for-Purpose Statement and Call for Methods

One of the first steps in organizing a project is creating a fitness-for-purpose statement. In AOAC, the fitness-for-purpose statement is a very general description of the methods needed. It is the responsibility of a working group chair to draft a fitness-for-purpose statement. A working group chair is also asked to prepare a presentation with background information about the analyte, matrix, and the nature of the analytical problem. A working group chair presents the background information and proposes a draft fitness-for-purpose statement to the presiding stakeholder panel. The stakeholder panel is asked to endorse the fitness-for-purpose statement.

The AOAC CSO prepares a call for methods based on the stakeholder panel-approved fitness-for-purpose statement. The call for methods is posted on the AOAC website and/or e-mailed to the AOAC membership and other known interested parties. AOAC staff collects and compiles candidate methods submitted in response to the call for methods. The CSO reviews and categorizes the methods.

Creating an SMPR

Starting the process of developing an SMPR can be a daunting challenge. In fact, drafting an SMPR should be a daunting challenge because the advisory panel has specifically identified an analytical problem that has yet to be resolved. Completing an SMPR can be a very rewarding experience because working group members will have worked with their colleagues through a tangle of problems and reached a consensus where before there were only questions.

It is advisable to have some representative candidate methods available for reference when a working group starts to develop an SMPR. These methods may have been submitted in response to the call for methods, or may be known to a working group member. In any case, whatever the origin of the method, candidate methods may assist working group members to determine reasonable performance requirements to be specified in the SMPR. The performance capabilities of existing analytical methodologies is a common question facing a working group.

Normally, a working chair and/or the AOAC CSO prepares a draft SMPR. A draft SMPR greatly facilitates the process and provides the working group with a structure from which to work.

Working group members are advised to first consider the “intended use” and “maximum time-to-determination” sections as this will greatly affect expectations for candidate methods. For example, methods intended to be used for surveillance probably need to be quick but do not require a great deal of precision, and false-positive results might be more tolerable. Whereas methods intended to be used for dispute resolution will require better accuracy, precision, and reproducibility, but time to determination is not as important.

Once a working group has agreed on the intended use of candidate methods, then it can begin to define the applicability of candidate methods. The applicability section of the SMPR is one of the most important, and sometimes most difficult, sections of the SMPR. The analyte(s) and matrix(es) must be explicitly identified. For chemical analytes, International Union of Pure and Applied Chemistry (IUPAC) nomenclature and/or Chemical Abstracts Service (CAS) registry numbers should be specified. Matrix(es) should be clearly identified including the form of the matrix such as raw, cooked, tablets, powders, etc. The nature of the matrix may affect the specific analyte. It may be advantageous to fully identify and describe the matrix before determining the specific analyte(s). It is not uncommon for working groups to revise the initial definition of the analyte(s) after the matrix(es) has been better defined.

Table 1. Example of method performance table for a single analyte

Analytical range	7.0–382.6 µg/mL	
Limit of quantitation (LOQ)	≤7.0 µg/mL	
Repeatability (RSD,)	<10 µg/mL	≤8%
	≥10 µg/mL	≤6%

Table 2. Example of method performance table for multiple analytes

	Analyte 1		Analyte 2		Analyte 3	
Analytical range	10–20 µg/mL		100–200 µg/mL		200–500 µg/mL	
Limit of quantitation (LOQ)	≤10 µg/mL		≤100 µg/mL		≤200 µg/mL	
Repeatability (RSD,)	<10 µg/mL	≤8%	<10 µg/mL	≤8%	<200 µg/mL	≤10%
	≥10 µg/mL	≤6%	≥10 µg/mL	≤6%	≥200 µg/mL	≤8%

For projects with multiple analytes, for example, vitamins A, D, E, and K in infant formula, it may be useful to organize a separate working group to fully describe the matrix(es) so that a common description of the matrix(es) can be applied to all of the analytes.

For single analyte SMPRs, it is most common to organize the method performance requirements into a table with 2–3 columns as illustrated in Table 1. For multiple analyte SMPRs, it is often convenient to present the requirements in an expanded table with analytes forming additional columns as illustrated in Table 2.

Once the intended use, analytical techniques, and method performance requirements have been determined, then a working group can proceed to consider the quality control parameters, such as the minimum validation requirements, system suitability procedures, and reference materials (if available). It is not uncommon that an appropriate reference material is not available. *Annex F* of the SMPR Guidelines provides comprehensive guidance for the development and use of in-house reference materials.

Most working groups are able to prepare a consensus SMPR in about 3 months.

Open Comment Period

Once a working group has produced a draft standard, AOAC opens a comment period for the standard. The comment period provides an opportunity for other stakeholders to state their perspective on the draft SMPR. All collected comments are reviewed by the AOAC CSO and the working group chair, and the comments are reconciled. If there are significant changes required to the draft standard as a result of the comments, the working group is convened to discuss and any unresolved issues will be presented for discussion at the stakeholder panel meeting.

Submission of Draft SMPRs to the Stakeholder Panel

Stakeholder panels meet several times a year at various locations. The working group chair (or designee) presents a draft SMPR to the stakeholder panel for review and discussion. A working group chair is expected to be able to explain the conclusions of the working group, discuss comments received, and to answer questions from the stakeholder panel. The members of the stakeholder panel may revise, amend, approve, or defer a decision on the proposed SMPR. A super majority of 2/3 or more of those voting is required to adopt an SMPR as an AOAC voluntary consensus standard.

Publication

Adopted SMPRs are prepared for publication by AOAC staff, and are published in the *Journal of AOAC INTERNATIONAL* and in the AOAC *Official Methods of Analysis*SM compendium. Often, the AOAC CSO and working group chair prepare a companion article to introduce an SMPR and describe the analytical issues considered and resolved by the SMPR. An SMPR is usually published within 6 months of adoption.

Conclusion

SMPRs are a unique and novel concept for the analytical methods community. SMPRs are voluntary, consensus standards developed by stakeholders that prescribe the minimum analytical performance requirements for classes of analytical methods. The SMPR Guidelines provide a structure for working groups to use as they develop an SMPR. The guidelines have been employed in several AOAC projects and have been proven to be very useful. The guidelines are not a statute that users must conform to; they are a “living” document that is regularly updated, so users should check the AOAC website for the latest version before using the guidelines.

References

- (1) Eurachem, *The Fitness for Purpose of Analytical Methods: A Laboratory Guide to Method Validation and Related Topics, Validation*, <http://www.eurachem.org/guides/pdf/valid.pdf>, posted December 1998, accessed March 2012
- (2) *Guidelines for Collaborative Study Procedures to Validate Characteristics of a Method of Analysis* (2012) *Official Methods of Analysis, Appendix D*, AOAC INTERNATIONAL, Gaithersburg, MD
- (3) *AOAC INTERNATIONAL Methods Committee Guidelines for Validation of Biological Threat Agent Methods and/or Procedures* (2012) *Official Methods of Analysis*, 19th Ed., *Appendix I, Calculation of CPOD and dCPOD Values from Qualitative Method Collaborative Study Data*, AOAC INTERNATIONAL, Gaithersburg, MD
- (4) *AOAC Guidelines for Single-Laboratory Validation of Chemical Methods for Dietary Supplements and Botanicals* (2012) *Official Methods of Analysis*, 19th Ed., *Appendix K*, AOAC INTERNATIONAL, Gaithersburg, MD
- (5) Codex Alimentarius Codex Procedure Manual
- (6) International Organization for Standardization, Geneva, Switzerland

ANNEX A
Format of a
Standard Method Performance Requirement

AOAC SMPR YYYY.XXX
(YYYY = Year; XXX = sequential identification number)

Method Name: Must include the analyte(s), matrix(es), and analytical technique [unless the standard method performance requirement (SMPR) is truly intended to be independent of the analytical technology]. The method name may refer to a “common” name (e.g., “Kjeldahl” method).

Approved By: Name of stakeholder panel or expert review panel

Final Version Date: Date

Effective Date: Date

1. Intended Use: Additional information about the method and conditions for use.

2. Applicability: List matrixes if more than one. Provide details on matrix such as specific species for biological analytes, or International Union of Pure and Applied Chemistry (IUPAC) nomenclature and Chemical Abstracts Service (CAS) registry number for chemical analytes. Specify the form of the matrix such as raw, cooked, tablets, powders, etc.

3. Analytical Technique: Provide a detailed description of the analytical technique if the SMPR is to apply to a specific analytical technique; or state that the SMPR applies to any method that meets the method performance requirements.

4. Definitions: List and define terms used in the performance parameter table (*see* Table A2 for list of standard terms).

5. Method Performance Requirements: List the performance parameters and acceptance criteria appropriate for each method/analyte/matrix. *See* Table A1 for appropriate performance requirements.

If more than one analyte/matrix, and if acceptance criteria differ for analyte/matrix combinations then organize a table listing each analyte/matrix combination and its minimum acceptance criteria for each performance criteria.

6. System Suitability Tests and/or Analytical Quality Control: Describe minimum system controls and QC procedures.

7. Reference Material(s): Identify the appropriate reference materials if they exist, or state that reference materials are not available. Refer to *Annex E (AOAC Method Accuracy Review)* for instructions on the use of reference materials in evaluations.

8. Validation Guidance: Recommendations for type of evaluation or validation program such as single-laboratory validation (SLV), *Official Methods of Analysis*SM (OMA), or *Performance Tested Methods*SM (PTM).

9. Maximum Time-to-Determination: Maximum allowable time to complete an analysis starting from the test portion preparation to final determination or measurement.

Annex I: Inclusivity/Selectivity Panel. Recommended for qualitative and identification method SMPRs.

Annex II: Exclusivity/Cross-Reactivity Panel. Recommended for qualitative and identification method SMPRs.

Annex III: Environmental Materials Panel. Recommended for qualitative and identification method SMPRs.

Table A1. Performance requirements

Classifications of methods ^a				
Quantitative method		Qualitative method		Identification method
Main component ^b	Trace or contaminant ^c	Main component ^b	Trace or contaminant ^c	
Parameter				
Single-laboratory validation				
Applicable range	Applicable range	Inclusivity/selectivity	Inclusivity/selectivity	Inclusivity/selectivity
Bias ^d	Bias ^d	Exclusivity/cross-reactivity	Exclusivity/cross-reactivity	Exclusivity/cross-reactivity
Precision	Precision	Environmental interference	Environmental interference	Environmental interference
Recovery	Recovery	Laboratory variance	Laboratory variance	
Limit of quantitation (LOQ)	LOQ	Probability of detection (POD) ^e	POD at AMDL ^f	Probability of identification (POI)
Reproducibility				
RSD _R or target measurement uncertainty	RSD _R or target measurement uncertainty	POD (0) POD (c) Laboratory POD ^g	POD (0) POD (c) Laboratory POD ^g	POI (c) Laboratory POI

^a See Annex B for additional information on classification of methods.

^b ≥100 g/kg.

^c <100 g/kg.

^d If a reference material is available.

^e At a critical level.

^f AMDL = Acceptable minimum detection level.

^g LPOD = CPOD.

Table A2. Recommended definitions

Bias	Difference between the expectation of the test results and an accepted reference value. Bias is the total systematic error as contrasted to random error. There may be one or more systematic error components contributing to the bias.
Environmental interference	Ability of the assay to detect target organism in the presence of environmental substances and to be free of cross reaction from environmental substances.
Exclusivity	Strains or isolates or variants of the target agent(s) that the method must not detect.
Inclusivity	Strains or isolates or variants of the target agent(s) that the method can detect.
Laboratory probability of detection (POD)	Overall fractional response (mean POD = CPOD) for the method calculated from the pooled POD_j responses of the individual laboratories ($j = 1, 2, \dots, L$). ^a See Annex C.
Limit of quantitation (LOQ)	Minimum concentration or mass of analyte in a given matrix that can be reported as a quantitative result.
POD (0)	Probability of the method giving a (+) response when the sample is truly without analyte.
POD (c)	Probability of the method giving a (–) response when the sample is truly without analyte.
POD	Proportion of positive analytical outcomes for a qualitative method for a given matrix at a given analyte level or concentration. Consult Annex C for a full explanation.
Probability of identification (POI)	Expected or observed fraction of test portions at a given concentration that gives positive result when tested at a given concentration. Consult <i>Probability of Identification (POI): A Statistical Model for the Validation of Qualitative Botanical Identification Methods</i> . ^c
Precision (repeatability)	Closeness of agreement between independent test results obtained under stipulated conditions. The measure of precision is usually expressed in terms of imprecision and computed as a standard deviation of the test results. ^d
Recovery	Fraction or percentage of the analyte that is recovered when the test sample is analyzed using the entire method. There are two types of recovery: (1) Total recovery based on recovery of the native plus added analyte, and (2) marginal recovery based only on the added analyte (the native analyte is subtracted from both the numerator and denominator). ^e
Repeatability	Precision under repeatability conditions.
Repeatability conditions	Conditions where independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time.
Reproducibility	Precision under reproducibility conditions.
Reproducibility conditions	Conditions where independent test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment.
Relative standard deviation (RSD)	$RSD = s_i \times 100/\bar{x}$
Standard deviation (s_i)	$s_i = [\sum(x_i - \bar{x})^2/n]^{0.5}$

^a AOAC INTERNATIONAL Methods Committee Guidelines for Validation of Biological Threat Agent Methods and/or Procedures (Calculation of CPOD and dCPOD Values from Qualitative Method Collaborative Study Data), *J. AOAC Int.* **94**, 1359(2011) and *Official Methods of Analysis of AOAC INTERNATIONAL* (2012) 19th Ed., Appendix I.

^b *International Vocabulary of Metrology (VIM)—Basic and General Concepts and Associated Terms* (2008) JCGM 200:2008, Joint Committee for Guides in Metrology (JCGM), www.bipm.org

^c LaBudde, R.A., & Harnly, J.M. (2012) *J. AOAC Int.* **95**, 273–285.

^d ISO 5725-1-1994.

^e *Official Methods of Analysis* (2012) Appendix D (Guidelines for Collaborative Study Procedures to Validate Characteristics of a Method of Analysis), AOAC INTERNATIONAL, Gaithersburg, MD.

Table A3. Recommendations for evaluation

Bias (if a reference material is available)	A minimum of five replicate analyses of a Certified Reference Material. ^a
Environmental interference	Analyze test portions containing a specified concentration of one environmental materials panel member. Materials may be pooled. Consult with AOAC statistician.
Exclusivity/cross-reactivity	Analyze one test portion containing a specified concentration of one exclusivity panel member. More replicates can be used. Consult with AOAC statistician.
Inclusivity/selectivity	Analyze one test portion containing a specified concentration of one inclusivity panel member. More replicates can be used. Consult with AOAC statistician.
Limit of quantitation (LOQ)	Estimate the LOQ = average (blank) + 10 × s ₀ (blank). Measure blank samples with analyte at the estimated LOQ. Calculate the mean average and standard deviation of the results. Guidance ^b : For ML ≥ 100 ppm (0.1 mg/kg): LOD = ML × 1/5. For ML < 100 ppm (0.1 mg/kg): LOD = ML × 2/5.
Measurement uncertainty	Use ISO 21748: <i>Guidance for the use of repeatability, reproducibility, and trueness estimates in measurement uncertainty estimation to analyze data collected for bias, repeatability, and intermediate precision to estimate measurement uncertainty.</i>
POD(0)	Use data from collaborative study.
POD (c)	
Repeatability	Prepare and homogenize three unknown samples at different concentrations to represent the full, claimed range of the method. Analyze each unknown sample by the candidate method seven times, beginning each analysis from weighing out the test portion through to final result with no additional replication (unless stated to do so in the method). All of the analyses for one unknown sample should be performed within as short a period of time as is allowed by the method. The second and third unknowns may be analyzed in another short time period. Repeat for each claimed matrix.
Probability of detection (POD)	Determine the desired POD at a critical concentration. Consult with Table A7 to determine the number of test portions required to demonstrate the desired POD.
Probability of identification (POI)	Consult <i>Probability of Identification (POI): A Statistical Model for the Validation of Qualitative Botanical Identification Methods</i> ^c .
Recovery	Determined from spiked blanks or samples with at least seven independent analyses per concentration level at a minimum of three concentration levels covering the analytical range. Independent means at least at different times. If no confirmed (natural) blank is available, the average inherent (naturally containing) level of the analyte should be determined on at least seven independent replicates. Marginal % recovery = $(C_f - C_u) \times 100 / C_A$ Total % recovery = $100(C_f) / (C_u + C_A)$ where C _f = concentration of fortified samples, C _u = concentration of unfortified samples, and C _A = concentration of analyte added to the test sample. ^d Usually total recovery is used unless the native analyte is present in amounts greater than about 10% of the amount added, in which case use the method of addition. ^e
Reproducibility (collaborative or interlaboratory study)	Quantitative methods: Recruit 10–12 collaborators; must have eight valid data sets; two blind duplicate replicates at five concentrations for each analyte/matrix combination to each collaborator.
	Qualitative methods: Recruit 12–15 collaborators; must have 10 valid data sets; six replicates at five concentrations for each analyte/matrix combination to each collaborator.

^a *Guidance for Industry for Bioanalytical Method Validation* (May 2001) U.S. Department of Health and Human Services, U.S. Food and Drug Administration, Center for Drug Evaluation and Research (CDER), Center for Veterinary Medicine (CVM).

^b Codex Alimentarius Codex Procedure Manual.

^c LaBudde, R.A., & Harnly, J.M. (2012) *J. AOAC Int.* **95**, 273–285.

^d *Guidelines for Collaborative Study Procedures to Validate Characteristics of a Method of Analysis* (2012) *Official Methods of Analysis*, 19th Ed., Appendix D, AOAC INTERNATIONAL, Gaithersburg, MD.

^e *AOAC Guidelines for Single-Laboratory Validation of Chemical Methods for Dietary Supplements and Botanicals* (2012) *Official Methods of Analysis*, 19th Ed., Appendix K, AOAC INTERNATIONAL, Gaithersburg, MD.

Table A4. Expected precision (repeatability) as a function of analyte concentration^a

Analyte, %	Analyte ratio	Unit	RSD, %
100	1	100%	1.3
10	10 ⁻¹	10%	1.9
1	10 ⁻²	1%	2.7
0.01	10 ⁻³	0.1%	3.7
0.001	10 ⁻⁴	100 ppm (mg/kg)	5.3
0.0001	10 ⁻⁵	10 ppm (mg/kg)	7.3
0.00001	10 ⁻⁶	1 ppm (mg/kg)	11
0.000001	10 ⁻⁷	100 ppb (µg/kg)	15
0.0000001	10 ⁻⁸	10 ppb (µg/kg)	21
0.00000001	10 ⁻⁹	1 ppb (µg/kg)	30

^a Table excerpted from AOAC Peer-Verified Methods Program, Manual on Policies and Procedures (1998) AOAC INTERNATIONAL, Gaithersburg, MD.

The precision of a method is the closeness of agreement between independent test results obtained under stipulated conditions. Precision is usually expressed in terms of imprecision and computed as a relative standard deviation of the test results. The imprecision of a method increases as the concentration of the analyte decreases. This table provides targets RSDs for a range of analyte concentrations.

Table A5. Expected recovery as a function of analyte concentration^a

Analyte, %	Analyte ratio	Unit	Mean recovery, %
100	1	100%	98–102
10	10 ⁻¹	10%	98–102
1	10 ⁻²	1%	97–103
0.01	10 ⁻³	0.1%	95–105
0.001	10 ⁻⁴	100 ppm	90–107
0.0001	10 ⁻⁵	10 ppm	80–110
0.00001	10 ⁻⁶	1 ppm	80–110
0.000001	10 ⁻⁷	100 ppb	80–110
0.0000001	10 ⁻⁸	10 ppb	60–115
0.00000001	10 ⁻⁹	1 ppb	40–120

^a Table excerpted from AOAC Peer-Verified Methods Program, Manual on Policies and Procedures (1998) AOAC INTERNATIONAL, Gaithersburg, MD.

Recovery is defined as the ratio of the observed mean test result to the true value. The range of the acceptable mean recovery expands as the concentration of the analyte decreases. This table provides target mean recovery ranges for analyte concentrations from 100% to 1 ppb.

Table A6. Predicted relative standard deviation of reproducibility (PRSD_R)^a

Concentration (C)	Mass fraction (C)	PRSD _R , %
100%	1.0	2
1%	0.01	4
0.01%	0.0001	8
1 ppm	0.000001	16
10 ppb	0.00000001	32
1 ppb	0.000000001	45

^a Table excerpted from *Definitions and Calculations of HorRat Values from Intralaboratory Data*, HorRat for SLV.doc, 2004-01-18, AOAC INTERNATIONAL, Gaithersburg, MD.

Predicted relative standard deviation = PRSD_R. Reproducibility relative standard deviation calculated from the Horwitz formula:

$$\text{PRSD}_R = 2C^{-0.15}, \text{ where } C \text{ is expressed as a mass fraction}$$

This table provides the calculated PRSD_R for a range of concentrations. See *Annex D* for additional information.

Table A7. POD and number of test portions^{a,b}

Sample size required for proportion							
Assume	1. Binary outcome (occur/not occur). 2. Constant probability rho of event occurring. 3. Independent trials (e.g., simple random sample). 4. Fixed number of trials (N)						
Inference	95% Confidence interval lies entirely at or above specified minimum rho						
Desired	Sample size N needed						
Minimum probability rho, %	Sample size (N)	Minimum No. events (x)	Maximum No. nonevents (y)	1-Sided lower confidence limit on rho ^c , %	Expected lower confidence limit on rho, %	Expected upper confidence limit on rho, %	Effective AOQL ^d rho, %
50	3	3	0	52.6	43.8	100.0	71.9
50	10	8	2	54.1	49.0	94.3	71.7
50	20	14	6	51.6	48.1	85.5	66.8
50	40	26	14	52.0	49.5	77.9	63.7
50	80	48	32	50.8	49.0	70.0	59.5
55	4	4	0	59.7	51.0	100.0	75.5
55	10	9	1	65.2	59.6	100.0	79.8
55	20	15	5	56.8	53.1	88.8	71.0
55	40	28	12	57.1	54.6	81.9	68.2
55	80	52	28	55.9	54.1	74.5	64.3
60	5	5	0	64.9	56.5	100.0	78.3
60	10	9	1	65.2	59.6	100.0	79.8
60	20	16	4	62.2	58.4	91.9	75.2
60	40	30	10	62.4	59.8	85.8	72.8
60	80	56	24	61.0	59.2	78.9	69.1
65	6	6	0	68.9	61.0	100.0	80.5
65	10	9	1	65.2	59.6	100.0	79.8
65	20	17	3	67.8	64.0	94.8	79.4
65	40	31	9	65.1	62.5	87.7	75.1
65	80	59	21	65.0	63.2	82.1	72.7
70	7	7	0	72.1	64.6	100.0	82.3
70	10	10	0	78.7	72.2	100.0	86.1
70	20	18	2	73.8	69.9	97.2	83.6
70	40	33	7	70.7	68.0	91.3	79.7
70	80	63	17	70.4	68.6	86.3	77.4
75	9	9	0	76.9	70.1	100.0	85.0
75	10	10	0	78.7	72.2	100.0	86.1
75	20	19	1	80.4	76.4	100.0	88.2
75	40	35	5	76.5	73.9	94.5	84.2
75	80	67	13	75.9	74.2	90.3	82.2
80	11	11	0	80.3	74.1	100.0	87.1
80	20	19	1	80.4	76.4	100.0	88.2
80	40	37	3	82.7	80.1	97.4	88.8
80	80	70	10	80.2	78.5	93.1	85.8
85	20	20	0	88.1	83.9	100.0	91.9
85	40	38	2	86.0	83.5	98.6	91.1
85	80	74	6	86.1	84.6	96.5	90.6
90	40	40	0	93.7	91.2	100.0	95.6
90	60	58	2	90.4	88.6	99.1	93.9
90	80	77	3	91.0	89.5	98.7	94.1
95	60	60	0	95.7	94.0	100.0	97.0
95	80	80	0	96.7	95.4	100.0	97.7
95	90	89	1	95.2	94.0	100.0	97.0
95	96	95	1	95.5	94.3	100.0	97.2
98	130	130	0	98.0	97.1	100.0	98.6
98	240	239	1	98.2	97.7	100.0	98.8
99	280	280	0	99.0	98.6	100.0	99.3
99	480	479	1	99.1	98.8	100.0	99.4

^a Table excerpted from Technical Report TR308, *Sampling plans to verify the proportion of an event exceeds or falls below a specified value*, LaBudde, R. (June 4, 2010) (not published). The table was produced as part of an informative report for the Working Group for Validation of Identity Methods for Botanical Raw Materials commissioned by the AOAC INTERNATIONAL Presidential Task Force on Dietary Supplements. The project was funded by the Office of Dietary Supplements, National Institutes of Health.

^b Copyright 2010 by Least Cost Formulations, Ltd. All rights reserved.

^c Based on modified Wilson score 1-sided confidence interval.

^d AOQL = Average outgoing quality level.

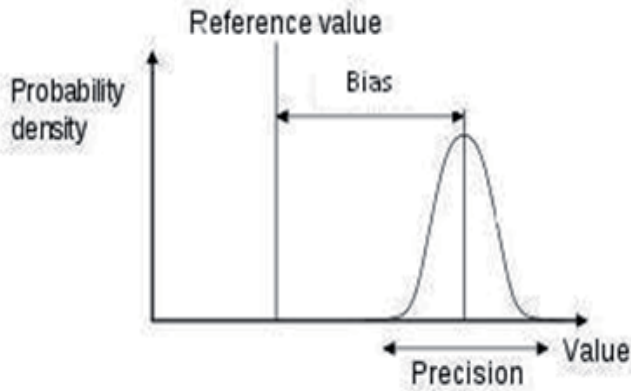


Figure A1. Relationship between precision versus bias (trueness). Trueness is reported as bias. Bias is defined as the difference between the test results and an accepted reference value.

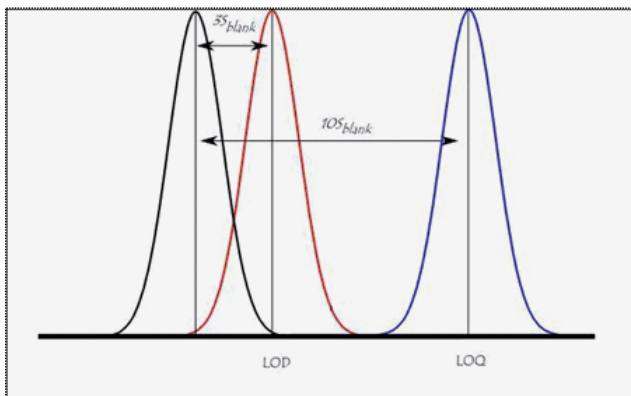


Figure A2. Relationship between LOD and LOQ. LOD is defined as the lowest quantity of a substance that can be distinguished from the absence of that substance (a blank value) within a stated confidence limit. LOQ is the level above which quantitative results may be obtained with a stated degree of confidence.

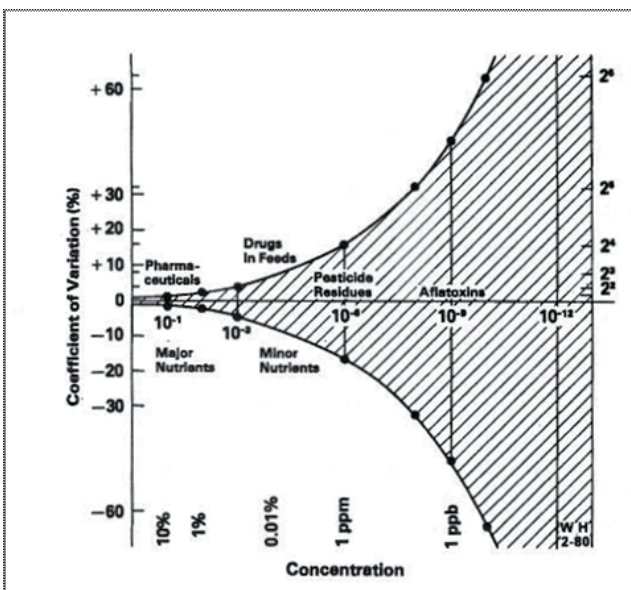


Figure A3. Horwitz Curve, illustrating the exponential increase in the coefficient of variation as the concentration of the analyte decreases [J. AOAC Int. 89, 1095(2006)].

ANNEX B Classification of Methods

The following guidance may be used to determine which performance parameters in Table A1 apply to different classifications of methods. AOAC INTERNATIONAL does not recognize the term “semiquantitative” as a method classification. Methods that have been self-identified as semiquantitative will be classified into one of the following five types:

Type I: Quantitative Methods

Characteristics: Generates a continuous number as a result.

Recommendation: Use performance requirements specified for quantitative method (main or trace component). Use recovery range and maximum precision variation in Tables A4 and A5.

In some cases and for some purposes, methods with less accuracy and precision than recommended in Tables A4 and A5 may be acceptable. Method developers should consult with the appropriate method committee to determine if the recommendations in Tables A4 and A5 do or do not apply to their method.

Type II: Methods that Report Ranges

Characteristics: Generates a “range” indicator such as 0, low, moderate, and high.

Recommendation: Use performance requirements specified for qualitative methods (main component). Specify a range of POD for each range “range” indicator.

Type III: Methods with Cutoff Values

Characteristics: Method may generate a continuous number as an interim result (such as a CT value for a PCR method), which is not reported but converted to a qualitative result (presence/ absence) with the use of a cutoff value.

Recommendation: Use performance requirements specified for qualitative methods.

Type IV: Qualitative Methods

Characteristics: Method of analysis whose response is either the presence or absence of the analyte detected either directly or indirectly in a specified test portion.

Recommendation: Use performance requirements specified for qualitative methods.

Type V: Identification Methods

Characteristics: Method of analysis whose purpose is to determine the identity of an analyte.

Recommendation: Use performance requirements specified for identification methods.

ANNEX C Understanding the POD Model

Excerpted from AOAC INTERNATIONAL Methods Committee Guidelines for Validation of Biological Threat Agent Methods and/or Procedures, J. AOAC Int. 94, 1359(2011) and Official Methods of Analysis of AOAC INTERNATIONAL (2012) 19th Ed., Appendix I.

The Probability of Detection (POD) model is a way of characterizing the performance of a qualitative (binary) method. A binary qualitative method is one that gives a result as one of two possible outcomes, either positive or negative, presence/absence, or +/-.

The single parameter of interest is the POD, which is defined as the probability at a given concentration of obtaining a positive response by the detection method. POD is assumed to be dependent on concentration, and generally, the probability of a positive response will increase as concentration increases.

For example, at very low concentration, the expectation is that the method will not be sensitive to the analyte, and at very high concentration, a high probability of obtaining a positive response is desired. The goal of method validation is to characterize how method response transitions from low concentration/low response to high concentration/high response.

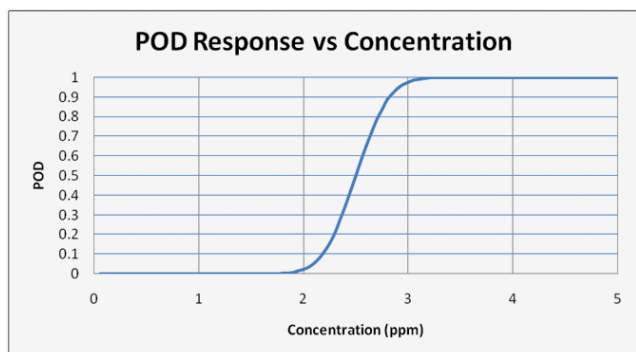


Figure C1. Theoretical POD curve for a qualitative detection method.

POD is always considered to be dependent upon analyte concentration. The POD curve is a graphical representation of method performance, where the probability is plotted as a function of concentration (*see, for example, Figure C1*).

The POD model is designed to allow an objective description of method response without consideration to an a priori expectation of the probabilities at given concentrations. The model is general enough to allow comparisons to any theoretical probability function.

The POD model is also designed to allow for an independent description of method response without consideration to the response of a reference method. The model is general enough to allow for comparisons between reference and candidate method responses, if desired.

Older validation models have used the terms “sensitivity,” “specificity,” “false positive,” and “false negative” to describe method performance. The POD model incorporates all of the performance concepts of these systems into a single parameter, POD.

For example, false positive has been defined by some models as the probability of a positive response, given the sample is truly negative (concentration = 0). The equivalent point on the POD curve for this performance characteristic is the value of the curve at Conc = 0.

Similarly, false negative has sometimes been defined as the probability of a negative response when the sample is truly positive (concentration >0). In the POD curve, this would always be specific to a given sample concentration, but would be represented as the distance from the POD curve to the POD = 1 horizontal top axis at all concentrations except C = 0.

The POD model incorporates all these method characteristics into a single parameter, which is always assumed to vary by concentration. In other models, the terms “false positive,” “false negative,” “sensitivity,” and “specificity” have been defined in a variety of ways, usually not conditional on concentration. For these reasons, these terms are obsolete under this model (*see Table C1*).

The terms “sensitivity,” “specificity,” “false positive,” and “false negative” are obsolete under the POD model (*see Figure C2*).

Table C1. Terminology

Traditional terminology	Concept	POD equivalent	Comment
False positive	Probability of the method giving a (+) response when the sample is truly without analyte	POD(0) POD at conc = 0	POD curve value at conc = 0; “Y-intercept” of the POD curve
Specificity	Probability of the method giving a (-) response when the sample is truly without analyte	1-POD(0)	Distance along the POD axis from POD = 1 to the POD curve value
False negative (at a given concentration)	Probability of a (-) response at a given concentration	1-POD(c)	Distance from the POD curve to the POD = 1 “top axis” in the vertical direction
Sensitivity (at a given concentration)	Probability of a (+) response at a given concentration	POD(c)	Value of the POD curve at any given concentration
True negative	A sample that contains no analyte	C = 0	Point on concentration axis where c = 0
True positive	A sample that contains analyte at some positive concentration	C > 0	Range of concentration where c > 0

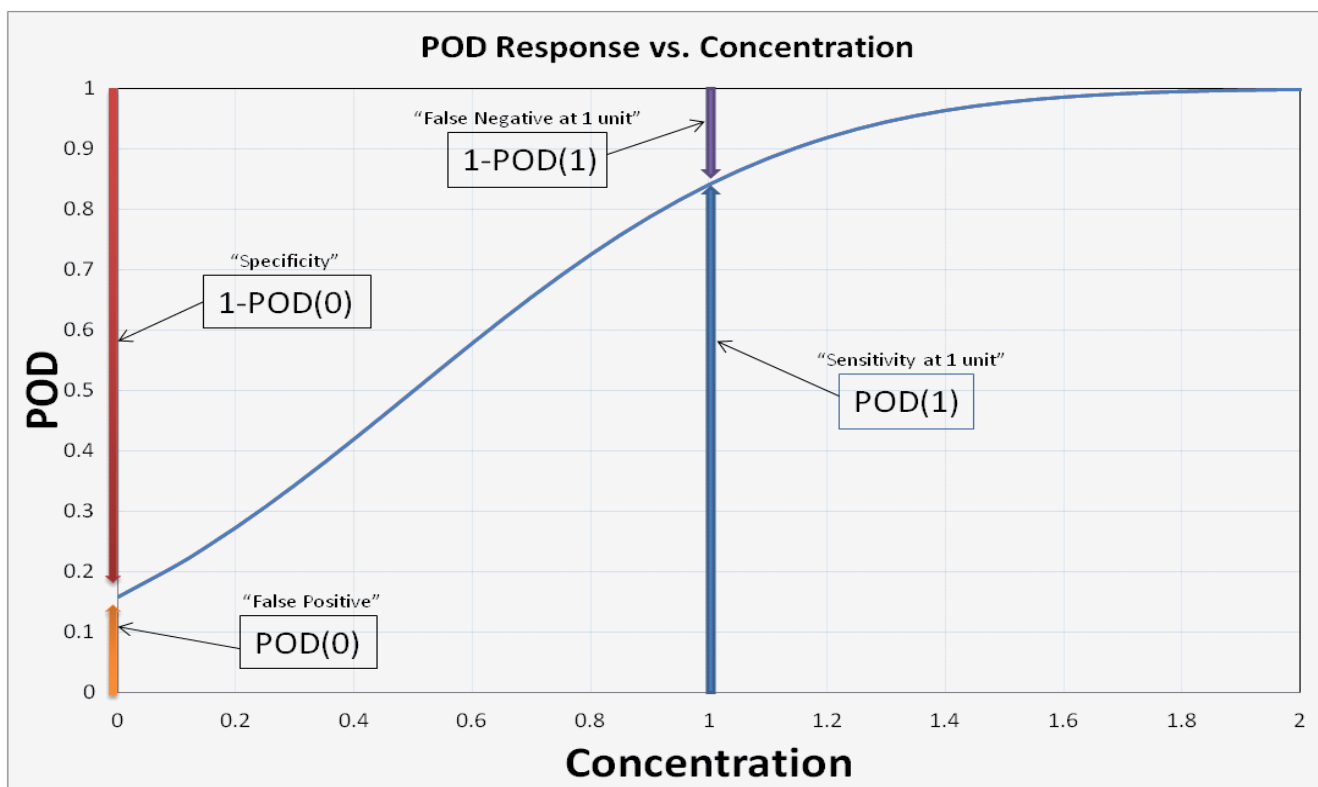


Figure C2. Comparison of POD model terminology to other obsolete terms.

ANNEX D
Definitions and Calculations
of HorRat Values from Intralaboratory Data

Excerpted from *Definitions and Calculations of HorRat Values from Intralaboratory Data*, AOAC INTERNATIONAL, HorRat for SLV.doc, 2004-01-18.

1. Definitions

1.1 Replicate Data

Data developed under common conditions in the same laboratory: simultaneous performance, or, if necessary to obtain sufficient values, same series, same analyst, same day. Such data provides “repeatability statistical parameters.”

1.2 Pooled Data

Replicate data developed in the same laboratory under different conditions but considered sufficiently similar that, for the purpose of statistical analysis, they may be considered together. These may include different runs, different instruments, different analysts, and different days.

1.3 Average

\bar{x} = Sum of the individual values, x_i , divided by the number of individual values, n .

$$\bar{x} = (\sum x_i) / n$$

1.4 Standard Deviation

$$s_i = [\sum(x_i - \bar{x})^2 / n]^{0.5}$$

1.5 Relative Standard Deviation

$$RSD = s_i \times 100 / \bar{x}$$

1.5.1 Repeatability Relative Standard Deviation [RSD(r) or RSD_r]

The relative standard deviation calculated from within-laboratory data.

1.5.2 Reproducibility Relative Standard Deviation [RSD(R) or RSD_R]

The relative standard deviation calculated from among-laboratory data.

Table D1. Predicted relative standard deviations

Concentration (C)	Mass fraction (C)	PRSD _R , %
100%	1.0	2
1%	0.01	4
0.01%	0.0001	8
1 ppm	0.000001	16
10 ppb	0.00000001	32
1 ppb	0.000000001	45

1.6 Mass Fraction

Concentration, C, expressed as a decimal fraction. For calculating and reporting statistical parameters, data may be expressed in any convenient units (e.g., %, ppm, ppb, mg/g, µg/g; µg/kg; µg/L, µg/µL, etc.). For reporting HorRat values, data must be reported as a mass fraction where the units of the numerator and denominator are the same: e.g., for 100% (pure materials), the mass fraction C = 1.00; for 1 µg/g (ppm), C = 0.000001 = (E-6). See Table D1 for other examples.

1.7 Predicted Relative Standard Deviation [PRSD(R) or PRSD_r]

The reproducibility relative standard deviation calculated from the Horwitz formula:

$$PRSD(R) = 2C^{-0.15}$$

where C is expressed as a mass fraction. See Table D1.

In spreadsheet notation: PRSD(R) = 2 * C ^(-0.15).

1.8 HorRat Value

The ratio of the reproducibility relative standard deviation calculated from the data to the PRSD(R) calculated from the Horwitz formula:

$$HorRat = RSD(R)/PRSD(R)$$

To differentiate the usual HorRat value calculated from reproducibility data from the HorRat value calculated from repeatability data, attach an R for the former and an r for the latter. But note that the denominator always uses the PRSD(R) calculated from reproducibility data because this parameter is more predictable than the parameter calculated from repeatability data:

$$HorRat(R) = RSD_R/PRSD(R)$$

$$HorRat(r) = RSD_r/PRSD(R)$$

Some expected, predicted relative standard deviations are given in Table D1.

2 Acceptable HorRat Values

2.1 For Interlaboratory Studies

HorRat(R): The original data developed from interlaboratory (among-laboratory) studies assigned a HorRat value of 1.0 with limits of acceptability of 0.5 to 2.0. The corresponding within-laboratory relative standard deviations were found to be typically 1/2 to 2/3 the among-laboratory relative standard deviations.

Table D2. Predicted relative standard deviations

Concentration (C)	PRSD _R , %	PRSD _r , %
100%	2	1
1%	4	2
0.01%	8	4
1 ppm	16	8
10 ppb	32	16
1 ppb	45	22

2.1.1 Limitations

HorRat values do not apply to method-defined (empirical) analytes (moisture, ash, fiber, carbohydrates by difference, etc.), physical properties or physical methods (pH, viscosity, drained weight, etc.), and ill-defined analytes (polymers, products of enzyme reactions).

2.2 For Intralaboratory Studies

2.2.1 Repeatability

Within-laboratory acceptable predicted target values for repeatability are given in Table D2 at 1/2 of PRSD(R), which represents the best case.

2.2.2 HorRat(r)

Based on experience and for the purpose of exploring the extrapolation of HorRat values to SLV studies, take as the minimum acceptability 1/2 of the lower limit (0.5 × 0.5 ≈ 0.3) and as the maximum acceptability 2/3 of the upper limit (0.67 × 2.0 ≈ 1.3).

Calculate HorRat(r) from the SLV data:

$$HorRat(r) = RSD(r)/PRSD(R)$$

Acceptable HorRat(r) values are 0.3–1.3. Values at the extremes must be interpreted with caution. With a series of low values, check for unreported averaging or prior knowledge of the analyte content; with a series of high values, check for method deficiencies such as unrestricted times, temperatures, masses, volumes, and concentrations; unrecognized impurities (detergent residues on glassware, peroxides in ether); incomplete extractions and transfers and uncontrolled parameters in specific instrumental techniques.

2.3 Other Limitations and Extrapolations

The HorRat value is a very rough but useful summary of the precision in analytical chemistry. It overestimates the precision at the extremes, predicting more variability than observed at the high end of the scale (C > ca 0.1; i.e., >10%) and at the low end of the scale (C < E-8; i.e., 10 ng/g; 10 ppb).

ANNEX E

AOAC Method Accuracy Review

Accuracy of Method Based on Reference Material

Reference material (RM) used.—The use of RMs should be seen as integral to the process of method development, validation, and performance evaluation. RMs are not the only component of a quality system, but correct use of RMs is essential to appropriate quality management. RMs with or without assigned quantity values can be used for measurement precision control, whereas only RMs with assigned quantity values can be used for calibration or measurement trueness control. Method development and validation for matrices within the scope of the method is done to characterize attributes such as recovery, selectivity, “trueness” (accuracy, bias), precision (repeatability and reproducibility), uncertainty estimation, ruggedness, LOQ or LOD, and dynamic range. RMs should be chosen that are fit-for-purpose. When certified reference materials (CRMs) are available with matrices that match the method scope, much of the work involved in method development has already been completed, and that work is documented through the certificate. RMs with analyte values in the range of test samples, as well as “blank” matrix RMs, with values below or near detection limits, are needed.

Availability of RM.—Consideration needs to be given to the future availability of the chosen RM. Well-documented methods that cannot be verified in the future due to lack of material may lose credibility or be seen as inferior.

Fit to method scope.—Natural matrix CRMs provide the greatest assurance that the method is capable of producing accurate results for that matrix. When selecting an RM to perform a method validation, analysts should consider the method to material fit. An example of a good fit would be a method for specified organic molecules in infant formula and using an infant formula or powder milk RM. A poor fit would be a method for specified organic molecules in infant formula and using a sediment material.

Stability.—Providing a stable RM can be challenging where analytes are biologically active, easily oxidized, or interactive with other components of the matrix. CRM producers provide assurance of material stability, as well as homogeneity. CRMs are accompanied by a certificate that includes the following key criteria:

- (1) Assigned values with measurement uncertainty and metrological traceability
- (2) Homogeneity
- (3) Stability, with the expiration date for the certificate
- (4) Storage requirements
- (5) Information on intended use
- (6) Identity of matrix

For some RMs, such as botanical RMs, the source and/or authenticity can be a very important piece of information that should be included with the certificate. Even under ideal storage conditions, many analytes have some rate of change. Recertification may be done by the supplier, and a certificate reissued with a different expiration date and with certain analyte data updated or removed.

Definition of CRM.—Refer to the AOAC TDRM document for definitions from ISO Guide 30, Amd. 1 (2008), <http://www.aoc.org/divisions/References.pdf>.

Information on source of RM is available.—It is the responsibility of the material producer to provide reliable authentication of the RM and make a clear statement in the accompanying documentation. This should be an as detailed listing as possible, including handling of ingredients, identification of plant materials as completely as feasible (species, type, subtype, growing region), etc. This is comparable to other required information on an RM for judging its suitability for a specific application purpose (e.g., containing how much of the targeted analyte, stabilized by adding acid—therefore not suited for certain parameters/procedures, etc.).

Separate RM used for calibration and validation.—A single RM cannot be used for both calibration and validation of results in the same measurement procedure.

Blank RM used where appropriate.—Blank matrix RMs are useful for ensuring performance at or near the detection limits. These are particularly useful for routine quality control in methods measuring, for instance, trace levels of allergens, mycotoxins, or drug residues.

Storage requirements were maintained.—Method developers should maintain good documentation showing that the RM producer’s recommended storage conditions were followed.

Cost.—The cost of ongoing method checks should be considered. Daily use of CRMs can be cost prohibitive. Monthly or quarterly analysis of these materials may be an option.

Concentration of analyte fits intended method.—Concentration of the analyte of interest is appropriate for standard method performance requirements (SMPRs).

Uncertainty available.—Every measurement result has an uncertainty associated with it, and the individual contributions toward the combined uncertainty arise from multiple sources. Achieving the target measurement uncertainty set by the customer for his/her problem of interest is often one of the criteria used in selecting a method for a given application. Estimation of measurement uncertainty can be accomplished by different approaches, but the use of RMs greatly facilitates this part of a method validation.

Demonstration of Method Accuracy when No Reference Material Is Available

If an RM is not available, how is accuracy demonstrated?

There are many analytes for which a CRM with a suitable matrix is not available. This leaves the analyst with few options. For some methods, there may be proficiency testing programs that include a matrix of interest for the analyte. Proficiency testing allows an analyst to compare results with results from other laboratories, which may or may not be using similar methods. Spiking is another technique that may be used. When alternative methods are available, results may be compared between the different methods. These alternatives do not provide the same level of assurance that is gained through the use of a CRM.

Spike recovery.—In the absence of an available CRM, one technique that is sometimes used for assessing performance is the spiking of a matrix RM with a known quantity of the analyte. When this method is used, it cannot be assumed that the analyte is bound in the same way as it would be in a natural matrix. Nevertheless, a certified blank RM would be the preferred choice for constructing a spiked material.

When preparing reference solutions, the pure standards must be completely soluble in the solvent. For insoluble materials in a liquid suspension or for powdered forms of dry materials, validation is required to demonstrate that the analyte is homogeneously distributed and that the response of the detection system to the analyte is not affected by the matrix or preparation technique. When a matrix material is selected for spiking, it should be reasonably

The document, *AOAC Method Accuracy Review*, was prepared by the AOAC Technical Division on Reference Materials (TDRM) and approved by the AOAC Official Methods Board in June 2012.

characterized to determine that it is sufficiently representative of the matrix of interest. Spiked samples must be carried through all steps of the method. Many analytes are bound in a natural matrix and whether the spiked analyte will behave the same as the analyte in a natural matrix is unknown.

Other.—Use of a substitute RM involves the replacement of the CRM with an alternative matrix RM matching the matrix of interest as close as possible based on technical knowledge.

ANNEX F Development and Use of In-House Reference Materials

The use of reference materials is a vital part of any analytical quality assurance program. However, you may have questions about their creation and use. The purpose of this document is to help answer many of these questions.

- What is a reference material?
- Why use reference materials?
- What certified reference materials are currently available?
- Why use an in-house reference material?
- How do I create an in-house reference material?
- How do I use the data from an in-house reference material?

What Is a Reference Material?

The International Organization for Standardization (ISO) defines a reference material as a “material or substance one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials” (1). In plain English, natural-matrix reference materials, such as those you might prepare for use in-house, can be used to validate an analytical method or for quality assurance while you’re using your method to analyze your samples. (Natural-matrix materials are not generally used as calibrants because of the increased uncertainty that this would add to an analysis.) The assigned values for the target analytes of an in-house reference material can be used to establish the precision of your analytical method and, if used in conjunction with a CRM, to establish the accuracy of your method.

ISO defines a certified reference material (CRM) as a “reference material, accompanied by a certificate, one or more of whose property values are certified by a procedure which establishes traceability to an accurate realization of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence” (1).

Why Use Reference Materials?

Certified reference materials can be used across the entire scope of an analytical method and can provide traceability of results to the International System of Units (SI). During method development, CRMs can be used to optimize your method. During method validation, they can be used to ensure that your method is capable of producing the “right” answer, and to determine how close your result is to that answer. During routine use, they can be used to determine within-day and between-day repeatability, and so demonstrate that your method is in control and is producing accurate results every time it is used.

Excerpted from *Development and Use of In-House Reference Materials*, Rev. 2, 2009. Copyright 2005 by the AOAC Technical Division on Reference Materials (TDRM).

Natural-matrix reference materials should mimic the real samples that will be analyzed with a method. They should behave just as your samples would during a procedure, so if you obtain accurate and precise values for your reference material, you should obtain accurate and precise values for your samples as well.

What Certified Reference Materials Are Currently Available?

CRMs are available from a number of sources, including (but not limited to):

- American Association of Cereal Chemists (AACC)
- American Oil Chemists Society (AOCS)
- International Atomic Energy Agency (IAEA)
- Institute for Reference Materials and Measurements (IRMM)
- LGC Promochem
- National Institute of Standards and Technology (NIST)
- National Research Council Canada (NRC Canada)
- UK Food Analysis Proficiency Assessment Program (FAPAS)

A number of websites provide general overviews and catalogs of producers’ and distributors’ reference materials:

<http://www.aocs.org/tech/crm/>
<http://www.comar.bam.de>
<http://www.erm-crm.org>
<http://www.iaea.org/oregrammes/laqcs>
<http://www.aaccnet.org/checksample>
<http://www.irmm-ire.be/mrm.html>
<http://www.lgcpromochem.com>
<http://www.naweb.iaea.org/nahu/nmrm/>
<http://www.nist.gov/srm>
<http://www.fapas.com/index.cfm>
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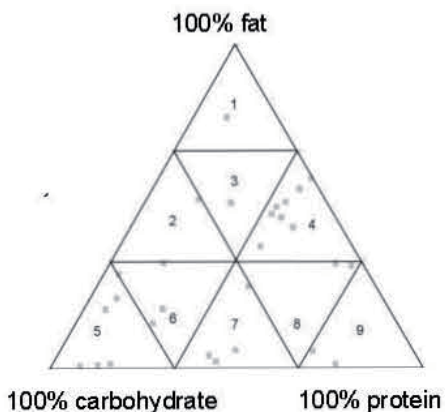
Because new reference materials are produced regularly, it is important to check these websites to determine what is currently available.

Why Use an In-House Reference Material?

There are many benefits to the use of a CRM. CRMs have been prepared to be homogeneous and, if stored under the proper conditions, stable. You are provided with a certified value as well as the statistical data for the concentration of your analyte; this is about as close as you can come to knowing the true value of the concentration of the analyte. The material has been tested by experienced analysts in leading laboratories, so you have the security of knowing that your method is generating values similar to those generated in other competent laboratories. The CRMs from the sources mentioned above are nationally and/or internationally recognized, so when you obtain acceptable results for a CRM using your analytical method, you give credibility to your methodology and traceability to your results.

But there are some drawbacks associated with CRMs. Unfortunately, many analyte/matrix combinations are not currently available. When testing food products for nutrient content, for example, a laboratory can be asked to analyze anything that might be found in a kitchen or grocery store. Reference materials that represent all of the types of foods that need to be tested are not available, and most CRMs are certified for a limited number of analytes. It is important to match the reference material matrix to your sample matrix. (Food examples dominate the discussion below, but the same processes apply to the development of in-house RMs in other areas of analytical chemistry.)

To demonstrate the applicability of an analytical method to a wide variety of food matrices, AOAC INTERNATIONAL’s Task



Force on Methods for Nutrition Labeling developed a triangle partitioned into sectors in which foods are placed based on their protein, fat, and carbohydrate content (2, 3). Since ash does not have a great impact on the performance of an analytical method for organic-material foods, and water can be added or removed, it can be assumed that the behavior of an analytical method is determined to large extent by the relative proportions of these proximates. AOAC INTERNATIONAL anticipated that one or two foods in a given sector would be representative of other foods in that sector and therefore would be useful for method assessment. Similarly, one or two reference materials in a given sector (or near each other in adjacent sectors) should be useful for quality assurance for analyses involving the other foods in the sector. The positions of many of the food-matrix CRMs from the sources listed above are shown in the triangle and are provided in the list.

These food-matrix reference materials are spread through all sectors of the triangle, thereby making it likely that you can find an appropriate CRM to match to your samples. Ultimately, however, the routine use of a CRM can be cost prohibitive, and is not really the purpose of CRMs. For example, in order to use NIST’s Standard Reference Material (SRM) 2387 Peanut Butter for all mandatory nutrition labeling analyses, you could buy one sales unit (three jars, each containing 170 g material) for \$649 (2009 price). If you charge your customer about \$1000 for analysis of all mandatory nutrients in a test material, the control material would account for more than 60% of your fees. Therefore, many laboratories have found it more cost-effective to create in-house reference materials for routine quality control and characterize them in conjunction with the analysis of a CRM (4). You can prepare larger quantities of a reference material by preparing it in-house, and you have more flexibility in the types of matrices you can use. There are not many limitations on what can be purchased.

How Do I Create an In-House Reference Material?

There are basically three steps to preparing an in-house reference material: selection (including consideration of homogeneity and stability), preparation, and characterization. Additional guidance through these steps can be provided from TDRM as well as in ISO Guides 34 (5) and 35 (6).

References

(1) JCGM 200:2008, *International vocabulary of metrology—Basic and general concepts and associated terms (VIM)*, International Bureau of Weights and Measures (www.bipm.org)

Sector	RM No.	Matrix
	NIST 1563	Coconut oil
1	NIST 3274	Fatty acids in botanical oils
1	NIST 3276	Carrot extract in oil
1	LGC 7104	Sterilized cream
2	NIST 2384	Baking chocolate
3	NIST 2387	Peanut butter
4	NIST 1546	Meat homogenate
4	LGC 7106	Processed cheese
4	LGC 7000	Beef/pork meat
4	LGC 7150	Processed meat
4	LGC 7151	Processed meat
4	LGC 7152	Processed meat
4	SMRD 2000	Fresh meat
4	LGC 7101	Mackerel paste
4	LGC QC1001	Meat paste 1
4	LGC QC1004	Fish paste 1
5	BCR-382	Wheat flour
5	BCR-381	Rye flour
5	LGC 7103	Sweet digestive biscuit
5	LGC 7107	Madeira cake
5	LGC QC1002	Flour 1
6	NIST 1544	Fatty acids
6	NIST 1548a	Typical diet
6	NIST 1849	Infant/adult nutritional formula
6	LGC 7105	Rice pudding
7	LGC 7001	Pork meat
7	NIST 1566b	Oyster tissue
7	NIST 1570a	Spinach leaves
7	NIST 2385	Spinach
8	NIST 1946	Lake trout
8	LGC 7176	Canned pet food
9	NIST 1974a	Mussel tissue
9	NIST 3244	Protein powder

(2) Wolf, W.R., & Andrews, K.W. (1995) *Fresenius’ J. Anal. Chem.* **352**, 73–76

(3) Wolf, W.R. (1993) *Methods of Analysis for Nutrition Labeling*, D.R. Sullivan & D.E. Carpenter (Eds), AOAC INTERNATIONAL, Gaithersburg, MD

(4) European Reference Materials (2005) *Comparison of a Measurement Result with the Certified Value*, Application Note 1

(5) *ISO Guide 34 General Requirements for the Competence of Reference Material Producers* (2009) 2nd, International Organization for Standardization, Geneva, Switzerland

(6) *Guide 35 Certification of Reference Materials—General and Statistical Principles* (2006) International Organization for Standardization, Geneva, Switzerland

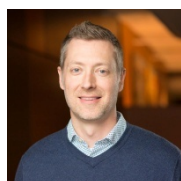
For more information about the AOAC Technical Division on Reference Materials, visit <http://aoac.org/divisions/tdrm>.

STAKEHOLDER PANEL CHAIR



DARRYL SULLIVAN, COVANCE LABORATORIES **Chair, AOAC Stakeholder Panel on Dietary Supplements**

Darryl Sullivan is a Fellow of AOAC and has been an active member since 1980. He has served terms as secretary, president-elect, president, past president, and director of the Board of Directors, and previously served a three-year term as chair of the Official Methods Board, and is currently serving as Chair of the AOAC Stakeholder Panel on Infant Formula and Adult Nutritionals. In 2012 Darryl led a very successful AOAC engagement with government and industry thought leaders in India and China on behalf of SPIFAN. He is also active with the Stakeholder Panel for Strategic Food Analytical Methods and the Stakeholder Panel for Agent Detection Assays. Sullivan also served a three-year term as a director on the AOAC Research Institute Board of Directors. He was a founding member and chair of the Presidential Task Force on Dietary Supplements and a member of the Task Force on Bacillus anthracis, as well as the AOAC Task Force on Nutrition Labeling and the AOAC Task Force on Sulfites. Prior to chairing the OMB, he served as a member and chair of the Methods Committee on Commodity Foods and Commodity Products. Sullivan was a founding member of the AOAC Technical Division on Reference Materials and served three terms on the Division's Executive Board. A staunch supporter of the Association, Sullivan was active in the e-CAM and Scholar I projects at AOAC, has exhibited at the annual meetings for many years, has presented hundreds of papers and posters at AOAC meetings and regularly publishes his research in the journal of the AOAC. He has also presented a significant number of papers on behalf of AOAC at other scientific meetings in many different parts of the world.



BRIAN SCHANEBERG, STARBUCKS COFFEE CO. **Vice Chair, AOAC Stakeholder Panel on Dietary Supplements**

Brian Schaneberg, Ph.D., is the Global Scientific & Regulatory Affairs Director for Starbucks Coffee Company. Brian participates in the execution of company strategies while ensuring compliance and regulatory guidelines are met and followed by the company across all products: Starbucks, Teavana, Tazo, Evolution Fresh, La Boulange, and Ethos. Brian has over 15 years of natural products experience in the area of dietary supplements and herbals. Brian was also the Quality & Food Safety and Scientific & Regulatory Affairs Director for Mars Botanical, a division of Mars, Inc. focusing on cocoa flavanol science and products. Before Mars Botanical, he was the Director of Technical Services at ChromaDex, Inc. in Irvine, California and was an Associate Research Scientist at the National Center for Natural Products Research at the University of Mississippi under the guidance of Dr. Ikhlas Khan, in a position funded by the US FDA for the development of methods to ensure the quality and safety of botanicals and dietary supplements. Over the years, Brian has worked closely with trade groups, industry, academia and government leaders. He has been a member of various review committees including NIH grants, analytical validation ERPs at AOAC and the Registry of Carcinogens. Brian also had the pleasure of holding an adjunct faculty position at the University of Colorado, Denver, advising a student that received his MS in Analytical Chemistry isolating phytochemicals and developing analytical testing procedures for Horse Chestnut. Brian has a Ph.D. in Organic Chemistry from Virginia Commonwealth University and a B.A. in Chemistry with a minor in Biology from Central College in Iowa. He has authored or co-authored more than 50 publications and presentations.

PRESENTER BIOS

JOHN AUSTAD, COVANCE LABORATORIES

SPDS VITAMIN D WORKING GROUP

John Austad is Global Analytical Support Manager in the Nutritional Chemistry and Food Safety Department at Covance Laboratories. In this role, he is directly responsible for leading a group of senior chemists supporting domestic and global sites with methodology including technical issue resolution, SOP and instrumentation harmonization, instrument maintenance, and new laboratory and capability set up within the Nutritional Chemistry and Food Safety business unit of Covance. He is also responsible for working with clients to develop and validate client specific methods.



Mr. Austad has been with Covance Laboratories for over 14 years where he has held various positions of increasing responsibility. During his tenure, he has held positions of increasing responsibility. During his tenure, he has held positions in several analytical testing groups that include: Method Development, Mineral Analysis, Fat Soluble Vitamins, Amino Acid Analysis, and Sugar Analysis. Mr. Austad is actively involved in AOAC INTERNATIONAL. Mr. Austad has co-authored several poster presentations at the AOAC Annual Meeting. Mr. Austad is a member of the SPIFAN and SPDS Stakeholder Panels and has Chaired several Method Centric Review Committees. Mr. Austad holds a B.S. degree in Chemistry from the University of Wisconsin-Stevens Point. He resides in Sun Prairie, WI, with his son, Landon.

PRASHANT INGLE, HERBALIFE

SPDS ALOIN WORKING GROUP

Prashant Ingle is a Quality Control Manager at Herbalife International of American Inc. His main responsibilities are managing Herbalife quality control laboratory for testing and disposition of raw materials and finished products. He is also part of the key team member at Herbalife for Botanical Identification Program. He has rich experience in testing of Aloe raw materials and finished products by HPLC and NMR for identification and quantitation of various Aloe maker compounds and impurities. He has managed ISO 17025 Accreditation of Herbalife laboratories and is member of Life Sciences Advisory Committee (LSAC), Measurement Advisory Committee (MAC) and product Certification Advisory Committee (PCAC) of A2LA for ISO 17025 accreditation of laboratories.



He has more than 16 years of experience in various positions in quality control and quality assurance with Food, Dietary Supplement, Pharmaceutical and Biotech companies. He has contributed toward method development and setting up laboratories for Herbalife at various manufacturing locations. He has contributed to AHP monograph development for Aloe as a reviewer from Herbalife team.

PRESENTER BIOS (Continued)

ANIKÓ SÓLYOM

SPDS TURMERIC WORKING GROUP

Anikó Sólyom, Ph.D. is the founder of GAAS Analytical, an independent contract testing laboratory with a focus on natural products and dietary supplements. She has 30+ years of comprehensive experience in analytical method development and method validation, using wide variety of analytical techniques to solve diverse problems.

Dr. Sólyom was selected in 2015 to serve a 5 year term as the member of the USP's Non-botanical Dietary Supplements Expert Committee. She is a member of the NIST/NIH DSQAP Advisory Board and serves on the AOAC's Expert Review Panel. She is the Chair of the AOAC SPDS Turmeric Working Group and a current member of several other AOAC working groups.

She has more than 40 papers published in peer-reviewed journals, and author of a patent. She holds B.S, M.S. and Ph.D. degrees in the areas of organic and analytical chemistry.

YANJUN ZHANG, HERBALIFE

SPDS TEA WORKING GROUP

Dr. Yanjun Zhang is currently a Principal Scientist at Herbalife International of America in Torrance, California. Dr. Zhang obtained his PhD degree from Chinese Academy of Medical Science & Peking Union Medical College. Prior to joining Herbalife he has more than 29 years of work experience in the field of phytochemical analysis. Dr. Zhang was the director of the Phytochemistry Core Laboratory at the UCLA Center for Human Nutrition and was also assistant researcher at the UCLA's David Geffen School of medicine. Throughout his career, Dr. Zhang has held positions as lecturer, associate professor and director at Chengde Medical College in China, was a guest professor at the National Museum of Natural History in France, and received his postdoctorate at the Bioactive Natural Products and Phytoceuticals Laboratory at Michigan State University. Dr. Zhang was instrumental in launch the Botanical Identification Program at Herbalife in 2009. Under his technical direction, the team has developed more than 90 botanical identification methods for raw material botanical ingredients used globally in Herbalife products.

Since the tea chemical project launch in 2008 at UCLA, Dr. Zhang's science team has developed chemical analytical methods for analysis of tea catechins, tea amino acids, and tea purine alkaloids content. Dr. Zhang's team also optimized tea extraction conditions to obtain the high quality tea extracts for Herbalife products. In addition to his work at Herbalife, Dr. Zhang also developed analytical methods for pomegranate extract and pioneered analytical methods for the authentication of pomegranate juice. Currently, Dr. Zhang is a member of the American Chemical Society and the American Society of Pharmacognosy. His research has been widely reported in peer-reviewed journals and book chapters. Dr. Zhang's current work is directed towards the authentication and evaluation of foods, spices and the establishment of analytical methods for botanical dietary supplements quality control.



The Scientific Association Dedicated to Analytical Excellence®

Stakeholder Panel on Dietary Supplements (SPDS)

September 25, 2015 | 8:00AM – 5:00PM PT

Registration Opens at 7:00 a.m.

Westin Bonaventure Hotel | 404 South Figueroa Street | Los Angeles, California, USA

Conference Room: Santa Anita AB

A G E N D A

I. Welcome and Introductions (8:00am – 8:15am)

Jim Bradford, AOAC INTERNATIONAL and Darryl Sullivan, Covance (Chair, SPDS)

II. Policies and Procedures (8:15am – 8:30 am)

Darryl Sullivan, Covance (Chair, SPDS)

III. Ingredient Updates (8:30am – 12:00pm)

- a. Set 1(Anthocyanins, Chondroitin, PDE5 Inhibitors) ERP Update (8:30am – 9:00 am)
Brian Schaneberg, Starbucks; Chair, Set 1 ERP and Vice Chair, SPDS
- b. Set 2 (Ashwagandha, Cinnamon, Folin C, Kratom) Call for Methods and Experts (9:00am – 9:30am)
Darryl Sullivan, Covance (Chair, SPDS)
- c. Set 3 (list) SMPRs for Approval (9:30 am – 12:00 pm)
 - i. Aloin* - *Prashant Ingle, Herbalife; Chair, Aloin Working Group (9:30 am – 10:15 am)*
 - ii. Tea* –*Yanjun Zhang, Herbalife; Chair, Tea Working Group (10:30 am – 11:15 am)*
 - iii. Vitamin D* – *John Austad, Covance; Chair, Vitamin D Working Group (11:15 am - 12:00 pm)*

12:00pm – 1:00pm: Lunch (On Your Own)

IV. Launch of Set 4 Working Groups (1:00pm – 4:15pm)

- a. Turmeric* (1:00 pm – 2:00 pm)
Aniko Solyom, GAAS Corporation (Chair, Turmeric Working Group)
- b. Lutein* (2:00 pm – 3:00 pm)
Rick Meyers, Kemin (Chair, Lutein Working Group)
- c. Collagen* (3:15 pm – 4:15 pm)
Suhail Ishaq, BioCell Technology, LLC

V. SPDS Advisory Panel Update (4:15 pm – 4:30 pm)

Darryl Sullivan, Covance (Chair, SPDS)

- a. December 2015 Advisory Panel Meeting / Future Priorities

VI. Saturday Working Group Schedule (4:30 pm – 4:45 pm)

Brian Schaneberg, Starbucks (Vice Chair, SPDS)

VII. Next Steps and Adjourn (4:45 pm – 5:00 pm)

Darryl Sullivan, Covance (Chair, SPDS)

**Item requires a vote by SPDS*

AOAC INTERNATIONAL Stakeholder Panel on Dietary Supplements
Working Group Sessions – September 26, 2015 (Day 2)
9:00 a.m. – 4:30 p.m., Palos Verdes Room

I. Collagen (9:00 a.m. – 11:00 a.m.)

Chair: Suhail Ishaq, BioCell Technology, LLC

- a. Review Fitness for Purpose
- b. SMPR Development

II. Lutein (11:15 a.m. – 2:15 p.m.)**

Chair: Rick Myers, Kemin Industries, Inc.

- a. Review Fitness for Purpose
- b. SMPR Development

III. Turmeric (2:30 p.m. – 4:30 p.m.)

Chair: Aniko Solyom, GAAS Corporation

- a. Review Fitness for Purpose
- b. SMPR Development

****Day 2 Lunch: On your own, 12:00 p.m. – 1:00 p.m.**



AOAC INTERNATIONAL STAKEHOLDER PANEL ON DIETARY SUPPLEMENTS

Prashant Ingle, Herbalife
Working Group on Aloin
September 25, 2015

Los Angeles, CA, USA

Aloin in Aloe Working Group Members

- Prashant Ingle (Chair)
- Brad Barrett
- Joseph Betz
- Clyde Don
- Nour Eddine Es-Safi
- James Griffiths
- George Joseph
- David Kennedy
- Elizabeth Mudge
- Melissa Phillips
- Tom Phillips
- Catherine Rimmer
- Brian Schaneberg
- Aniko Solyom
- Darryl Sullivan
- James Traub
- Lanette Varesi
- Yanjun Zhang
- Garrett Zielinski



Aloin Working Group Work to Date

- ❑ 1 In Person Meeting
- ❑ 3 teleconferences (March – June 2015)
- ❑ 1 SMPR Drafted
- ❑ Public comment period (July 2nd 2015 – August 7th, 2015)
- ❑ SMPRs made ready for SPDS review and approval



September 25th, 2015

AOAC Working group on Aloin
Prashant Ingole

3

Applicability

The method must be able to quantitate Aloin A and Aloin B separately in:

- Raw materials
- Dietary supplement finished products in liquid, gel, powder, tablet, and soft gel matrices; and aloe vera leaf juice and dry juice ingredients



September 25th, 2015

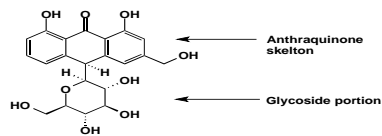
AOAC Working group on Aloin
Prashant Ingole

4

Definitions

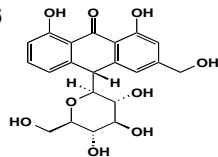
- Aloin A**

1,8-Dihydroxy-10-(β -D-glucopyranosyl)-3-(hydroxymethyl)-9(10H)-anthracenone. Also known as barbaloin, CAS No.: 1415-73-2. 22



- Aloin B**

(10R)-1,8-dihydroxy-3-(hydroxymethyl)-10-[(2S,3R,4R,5S,6R)-3,4,5-trihydroxy-6-25 hydroxymethyl)oxan-2-yl]-10H-anthracen-9-one, Also known as beta-D-isomer barbaloin 26 or isobarbaloin. CAS No.: 28371-16-6



September 25th, 2015

AOAC Working group on Aloin
Prashant Ingle

5

Analytical Range and LOQ Requirements

Following analytical range and LOQ parameters were discussed since March 2015:

Aloin in Aloe (Aloin A or Aloin B):

Parameter	Finished Products	Raw Material
Analytical range (ppm)	0.01 to 100	0.01 to 12,500
LOQ (ppm)	0.005	0.005



September 25th, 2015

AOAC Working group on Aloin
Prashant Ingle

6

Recovery, Repeatability, and Recovery for Aloin A and Aloin B

Performance Parameters for Aloin A or B:

Parameter	Ranges (ppm)					
	Finish Product and Raw ingredients				Raw ingredients	
	0.01 - 1	>1 - 10	>10 - 30	>30 - 100	>100 - 1000	>1000 - 12,500
% Repeatability (RSD _r)	21	11	7	6	5	3
Recovery (%)	60-115	80-110			90-107	95-105
% Reproducibility (RSD _R)	32	16	11	9	7	4



Motion

- Move to accept the *Standard Method Performance Requirements* for Aloin in Aloe as presented.



Comments Submitted (if any)



September 25th, 2015

AOAC Working group on Aloin
Prashant Ingole

9

Discussion?



September 25th, 2015

AOAC Working group on Aloin
Prashant Ingole

10

2
3 **Method Name: Determination of Aloin A and Aloin B in Dietary Supplement**
4 **Products and Raw Materials**

5
6 **Intended Use:**

7
8 **1. Applicability:**

9 The method must be able to quantitate aloin A and aloin B separately in: raw materials;
10 dietary supplement finished products in liquid, gel, powder, tablet, and softgel matrices; and
11 aloe vera leaf juice and dry juice ingredients.

12
13
14 **2. Analytical Technique:**

15 Any analytical technique that meets the following method performance requirements is
16 acceptable.

17
18 **3. Definitions:**

19
20 **Aloin A**

21 1,8-Dihydroxy-10-(β -D-glucopyranosyl)-3-(hydroxymethyl)-9(10H)-anthracenone. Also
22 known as barbaloin. See figure 1. CAS No.: 1415-73-2.

23
24 **Aloin B**

25 (10R)-1,8-dihydroxy-3-(hydroxymethyl)-10-[(2S,3R,4R,5S,6R)-3,4,5-trihydroxy-6-
26 hydroxymethyl]oxan-2-yl]-10H-anthracen-9-one. Also known as beta-D-isomer barbaloin
27 or isobarbaloin. See figure 2. CAS No.: 28371-16-6.

28
29 **Dietary ingredients.**

30 A vitamin; a mineral; an herb or other botanical; an amino acid; a dietary substance for use
31 by man to supplement the diet by increasing total dietary intake; or a concentrate,
32 metabolite, constituent, extract, or combination of any of the above dietary ingredients.
33 {United States Federal Food Drug and Cosmetic Act §201(ff) [U.S.C. 321 (ff)]}

34
35 **Dietary supplements.—**

36 A product intended for ingestion that contains a “dietary ingredient” intended to add
37 further nutritional value to (supplement) the diet. Dietary supplements may be found in
38 many forms such as tablets, capsules, gels, softgels, gelcaps, liquids, or powders.

39
40 **Limit of Quantitation (LOQ)**

41 The minimum concentration or mass of analyte in a given matrix that can be reported as a
42 quantitative result

43
44 **Repeatability**

45 Variation arising when all efforts are made to keep conditions constant by using the
46 same instrument and operator and repeating during a short time period. Expressed as
47 the repeatability standard deviation (SD_r); or % repeatability relative standard deviation
48 (%RSD_r).

51 Reproducibility
 52 The standard deviation or relative standard deviation calculated from among-laboratory
 53 data. Expressed as the reproducibility relative standard deviation (SD_R); or %
 54 reproducibility relative standard deviation (% RSD_R).
 55

56 Recovery
 57 The fraction or percentage of spiked analyte that is recovered when the test sample is
 58 analyzed using the entire method.
 59

60 **4. Method Performance Requirements:**

61
 62

63 **5. METHOD PERFORMANCE REQUIREMENTS:**

64
 65
 66

Table 1a: Analytical Ranges and LOQ for Aloin A or B

	Finished Products	Raw Material
Analytical range (ppm)	0.01 to 100	0.01 to 12,500
LOQ (ppm)	0.005	0.005

67
 68
 69

Table 1b: Performance Parameters for Aloin A or B

Parameter	ranges (ppm)					
	finished product and raw ingredients				raw ingredients	
	0.01 – 1	>1 – 10	>10 – 30	>30 – 100	>100 – 1000	>1000- 12,500
% Repeatability (RSD_r)	21	11	7	6	5	3
Recovery (%)	60-115	80-110			90-107	95-105
% Reproducibility (RSD_R)	32	16	11	9	7	4

70
 71
 72

73
 74 **6. System suitability tests and/or analytical quality control:**

75 Suitable methods will include blank check samples, and check standards at the lowest point
 76 and midrange point of the analytical range. A control sample must be included.
 77

78 **6. Reference Material(s):** Refer to Annex F of Appendix F in OMA. Refer to 19th Edition of the
 79 AOAC INTERNATIONAL Official Methods of Analysis (2012). Annex F: *Development and Use*
 80 *of In-House Reference Materials* in [Appendix F: Guidelines for Standard Method Performance](http://www.eoma.aoac.org/app_f.pdf)
 81 *Requirements*. Available at: http://www.eoma.aoac.org/app_f.pdf
 82

83 **7. Validation Guidance:**

84 Recommended level of validation: *Official Methods of Analysis*SM

85 [Appendix D](#): Guidelines for Collaborative Study Procedures To Validate Characteristics of a
86 Method of Analysis; 19th Edition of the AOAC INTERNATIONAL Official Methods of Analysis
87 (2012). Available at: http://www.eoma.aoac.org/app_d.pdf
88

89 [Appendix N](#): ISPAM Guidelines for Validation of Qualitative Binary Chemistry Methods of the
90 19th edition of the *AOAC INTERNATIONAL Official Methods of Analysis*. Available at
91 http://www.eoma.aoac.org/app_n.pdf
92

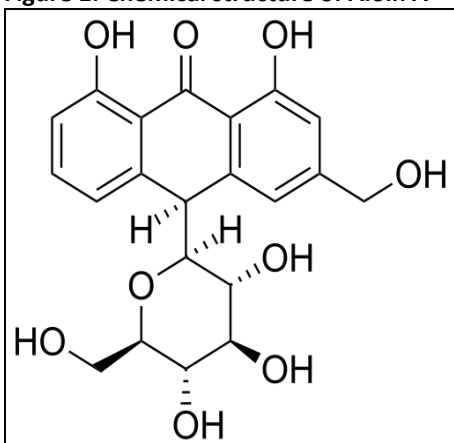
93 [Appendix K](#): Guidelines for Dietary Supplements and Botanicals 19th Edition of the AOAC
94 INTERNATIONAL Official Methods of Analysis (2012). Also at: . AOAC Int. 95, 268(2012); DOI:
95 10.5740/jaoacint.11-447 and available at: http://www.eoma.aoac.org/app_k.pdf
96

97 **8. Maximum Time-To-Signal:** No maximum time.
98

DRAFT

99

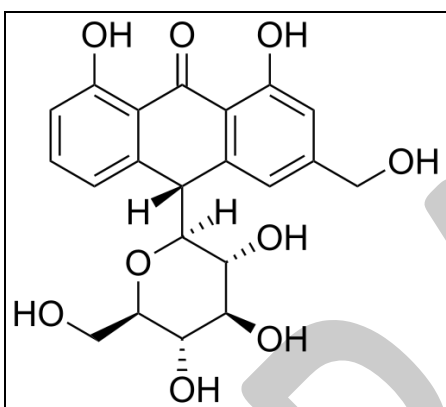
Figure 1: Chemical structure of Aloin A



100
101

102

Figure 2: Chemical structure of Aloin B



103
104



AOAC INTERNATIONAL STAKEHOLDER PANEL ON DIETARY SUPPLEMENTS

Yanjun Zhang, Herbalife
Working Group on Tea
September 25, 2015

Los Angeles, CA, USA

Fitness for Purpose

Quantitative determination of catechins,
methyl xanthenes, theaflavins and theanine
in tea dietary ingredients and supplements.



Tea Working Group Members

- Yanjun Zhang
- Joseph Betz
- James Griffiths
- Jana Hildreth
- Martha Jennens-Clough
- David Ji
- George Joseph
- David Kennedy
- Elizabeth Mudge
- Maria Ofitserova
- Melissa Phillips
- Tom Phillips
- Catherine Rimmer
- Steve Royce
- Aniko Solyom
- John Szpylka
- James Traub
- Lanette Varesi
- Laura Wood
- Jinchuan Yang
- Seong-Jae Yoo
- Joseph Zhou
- Joyce Zhu
- Garrett Zielinski



Tea Working Group Work to Date

- 1 In Person Meeting
- 4 teleconferences (March – June 2015)
- 1 SMPR Drafted
- Public comment period (July 2, 2015 – August 7, 2015)
- SMPRs made ready for SPDS review and approval



Background

Current Analytical Techniques

For past years, many analytical techniques have been used in tea components analysis including

1. Chromatographic methods-HPLC-UV, HPLC-MS, GC, GC MS and HPTLC
2. Spectroscopic methods-NMR and NIR.



Background

Challenges

1. Multiple methods may needed because of the analytes properties (e.g.Catechins and theanine) ;
2. Special processing and extraction methods may needed because the contents of analytes in the target products (from micro grams to grams);
3. The availability of quantitative standards.



Background

- **Purpose:** This SMPR describe the minimum recommended performance characteristics to be used during the evaluation of a method or methods on “Quantitative determination of catechins, methyl xanthines, theaflavins and theanine in tea dietary ingredients and supplements”.



Target Matrices Panel

Dietary Supplements Forms:

Tablets
Capsules
Softgels
Gelcaps
Gummies
Chewables
Liquids
Powders

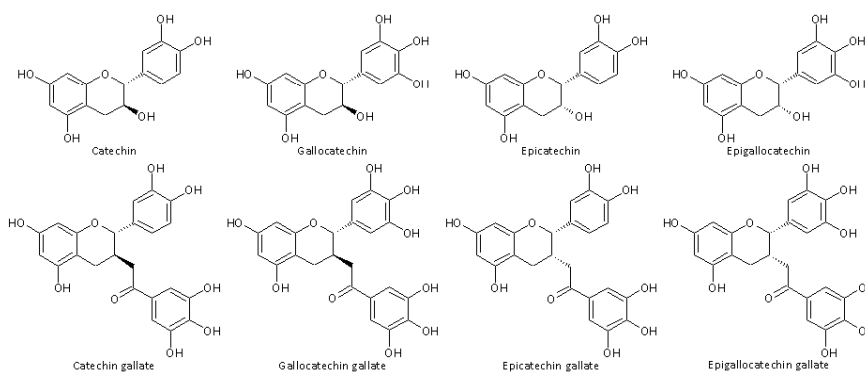


Target Compounds Panel-1 Catechins

Common name	IUPAC Nomenclature	CAS No.
Catechin	(2R,3S)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol	154-23-4
epicatechin	(2R,3R)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol	490-46-0
epigallocatechin	(2R,3R)-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol	970-74-1
catechin gallate	[(2R,3R)-2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3,4-dihydro-2H-chromen-3-yl] 3,4,5-trihydroxybenzoate	130405-40-2
epicatechin gallate	(2R,3R)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-5,7-dihydroxy-2H-1-benzopyran-3-yl-ester-3,4,5-trihydroxy-benzoic acid	1257-08-5
epigallocatechin	(-)-cis-3,3',4',5,5',7'-Hexahydroxyflavane, (-)-cis-2-(3,4,5-Trihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol	970-74-1
Gallate	3,4,5-Trihydroxybenzoic acid	149-91-7
gallocatechin	(2S,3R)-2-(3,4,5-Trihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol	3371-27-5



Target Compounds Panel-1 Catechins



Catechins structures



Target Compounds Panel-2

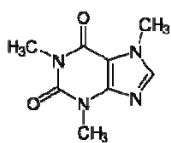
Methyl xanthenes

Common name	IUPAC Nomenclature	CAS No.
Caffeine	1,3,7-trimethylpurine-2,6-dione	58-08-2
theobromine	3,7-dimethyl-1H-purine-2,6-dione	83-67-0
theophylline	1,3-dimethyl-7H-purine-2,6-dione	58-55-9

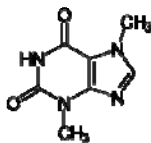


Target Compounds Panel-2

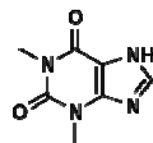
Methyl xanthenes



Caffeine



Theobromine



Theophylline



Target Compounds Panel-3

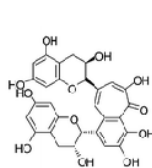
Theaflavins

Common name	IUPAC Nomenclature	CAS No.
theaflavin	3,4,5-Trihydroxy-1,8-bis[(2R,3R)-3,5,7-trihydroxy-3,4-dihydro-2H-chromen-2-yl]-6H-benzo[7]annulen-6-one	4670-05-7
theaflavin-3-gallate	[(2R,3R)-5,7-dihydroxy-2-[3,4,5-trihydroxy-6-oxo-8-[(2R,3R)-3,5,7-trihydroxychroman-2-yl]benzo[7]annulen-1-yl]chroman-3-yl] 3,4,5-trihydroxybenzoate	30462-34-1
theaflavin-3'-gallate	[(2R,3R)-5,7-dihydroxy-2-[3,4,5-trihydroxy-6-oxo-8-[(2R,3R)-3,5,7-trihydroxychroman-2-yl]benzo[7]annulen-1-yl]chroman-3-yl] 3,4,5-trihydroxybenzoate	28543-07-9
theaflavin-3-3'-digallate	[1-[(2R,3R)-3,5-Dihydroxy-7-(3,4,5-trihydroxybenzoyl)oxochroman-2-yl]-3,5-dihydroxy-6-oxo-8-[(3R)-3,5,7-trihydroxychroman-2-yl]benzo[7]annulen-4-yl] 3,4,5-trihydroxybenzoate	33377-72-9

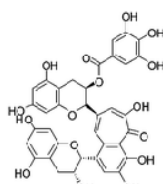


Target Compounds Panel-3

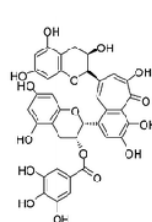
Theaflavins



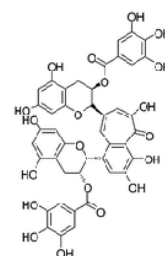
theaflavin



theaflavin-3-gallate



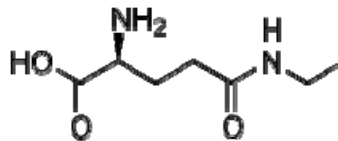
theaflavin-3'-gallate



theaflavin-3-3'-digallate



Target Compounds Panel-4 Theanine



N-ethyl-L-glutamine; (2S)-2-ammonio-5-(ethylamino)-5-oxopentanoate. CAS registry number: 3081-61-6.



Analytical Range and LOQ Requirements All Analytes

Component	catechins	methyl xanthines	theaflavins	theanine
Analytical range (ppm)	10 – 500,000	10 – 500,000	10 – 100,000	10 – 100,000
LOQ (ppm)	5			



Recovery, Repeatability, and Recovery for All Analytes

Ranges (ppm)	10 – 50	51 - 500	501.– 4,000	4,001 – 20,000	>20,000
Recovery (%)	80 -110	90-107	95-105	97-103	98-102
RSD _r (%)	≤ 7	5	4	2	2
RSD _R (%)	≤ 10	8	6	3	3



SMPR Key Points

- Complex of dietary supplement matrix;
-need specialized extraction and sample preparation
- Wide range of contents of analytes;
-need precise analytical techniques
- Four classes of analytes-Tea catechins (8), Methyl xanthines (3), Theaflavins (4), and Theanine (1).
-need quantitative standards



Comments Submitted (if any)



Motion

- Move to accept the Standard Method Performance Requirements for **“Determination of Catechins, Methyl Xanthines, Theaflavins, and Theanine in Tea Dietary Ingredients And Supplements”** as presented.



Discussion?



2
3 **Method Name: Determination of Catechins, Methyl Xanthines, Theaflavins, and**
4 **Theanines in Tea Dietary Ingredients And Supplements**

5
6 **Purpose:** AOAC SMPR's describe the minimum recommended performance characteristics to be
7 used during the evaluation of a method. The evaluation may be an on-site verification, a single-
8 laboratory validation, or a multi-site collaborative study. SMPRs are written and adopted by
9 AOAC Stakeholder Panels composed of representatives from the industry, regulatory
10 organizations, contract laboratories, test kit manufacturers, and academic institutions. AOAC
11 SMPRs are used by AOAC Expert Review Panels in their evaluation of validation study data for
12 method being considered for *Performance Tested Methods* or *AOAC Official Methods of*
13 *Analysis*, and can be used as acceptance criteria for verification at user laboratories.¹

14
15 **Approved by:** Stakeholder Panel on Dietary Supplements (SPDS)

16
17 **Intended Use:** Quality control, routine testing and dispute resolution.

18
19 **1. Applicability:**

20 Quantitative determination of catechins, methyl xanthenes, theaflavins and theanine in tea
21 dietary ingredients and supplements.

22
23 **2. Analytical Technique:**

24 Any analytical technique(s) that measures the analytes of interest and meets the following
25 method performance requirements is/are acceptable. It is acceptable to have a different
26 analytical method for each class of analytes.

27
28 **3. Definitions:**

29
30 **Catechins**

31 Catechin, epicatechin, epigallocatechin, catechin gallate, epicatechin gallate,
32 epigallocatechin gallate, and galocatechin. Refer to table 3 for IUAC nomenclature and CAS
33 registry numbers. See figure 1 for chemical structures.

34
35 **Dietary Ingredients**

36 A vitamin; a mineral; an herb or other botanical; an amino acid; a dietary substance for use
37 by man to supplement the diet by increasing total dietary intake; or a concentrate,
38 metabolite, constituent, extract, or combination of any of the above dietary ingredients.²

39
40 **Dietary supplements**

41 A product intended for ingestion that contains a "dietary ingredient" intended to add
42 further nutritional value to (supplement) the diet. Dietary supplements may be found in
43 many forms such as tablets, capsules, softgels, gelcaps, liquids, or powders.

44
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¹ Refer to [Appendix F: Guidelines for Standard Method Performance Requirements](#) in the 19th Edition of the AOAC INTERNATIONAL Official Methods of Analysis (2012).

² United States Federal Food Drug and Cosmetic Act §201(ff) [U.S.C. 321 (ff)]

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Limit of Quantitation (LOQ):

The minimum analyte concentration for which quantitative results may be obtained with 95% confidence.

Methyl xanthines

Caffeine; theobromine; and theophylline. Refer to table 4 for IUPAC nomenclature and CAS registry numbers. See figure 2 for chemical structures.

Repeatability:

Variation arising when all efforts are made to keep conditions constant by using the same instrument and operator, and repeating during a short time period. Expressed as the repeatability standard deviation (SD_r), or % repeatability relative standard deviation (% RSD_r).

Reproducibility:

The standard deviation or relative standard deviation calculated from among-laboratory data. Expressed as the reproducibility relative standard deviation (SD_R) or %reproducibility relative standard deviation (% RSD_R).

Recovery:

The fraction or percentage of the analyte that is recovered when the test sample is analyzed using the entire method.

Theaflavins

Theaflavin, theaflavin-3-gallate, theaflavin-3'-gallate, and theaflavin-3-3'-digallate. Refer to table 6 for IUPAC nomenclature and CAS registry numbers. See figure 3 for chemical structures.

Theanine

N-ethyl-L-glutamine; (2S)-2-ammonio-5-(ethylamino)-5-oxopentanoate. CAS registry number: 3081-61-6. See figure 4 for chemical structure.

4. Method Performance Requirements:

Table 1: Analytical Ranges and LOQs

Component	catechins	methyl xanthenes	theaflavins	theanine
Analytical range (ppm)	10 – 500,000	10 – 500,000	10 – 100,000	10 – 100,000
LOQ (ppm)	5			

Table 2: Method Performance Requirements by Range

Ranges (ppm)	10 – 50	51 - 500	501– 4,000	4,001 – 20,000	>20,000
Recovery (%)	80 -110	90-107	95-105	97-103	98-102
RSD_r (%)	≤ 7	5	4	2	2
RSD_R (%)	≤ 10	8	6	3	3

- 85 **5. System suitability tests and/or analytical quality control**
86 Suitable methods will include blank check samples, and check standards at the lowest point and
87 midrange point of the analytical range, and a protocol to demonstrate suitability.
88
- 89 **6. Reference Material(s)**
90
91 ISO Guide 34:2009 General requirements for the competence of reference material
92 producers.
93
94 SRM 3254 *Camellia sinensis* (Green Tea) Leaves
95 SRM 3255 *Camellia sinensis* (Green Tea) Extract
96 SRM 3256 Green Tea-Containing Solid Oral Dosage Form
97 SRM 3257 Catechil Calibration Materials
98
99 Other compounds?
100
- 101 **7. Validation Guidance:**
102 All matrices listed in Table 3 must be evaluated for LOQ, repeatability, and recovery for First
103 Action *Official Methods of Analysis* approval.
104
105 [Appendix D](http://www.eoma.aoac.org/app_d.pdf): Guidelines for Collaborative Study Procedures To Validate Characteristics of a
106 Method of Analysis; 19th Edition of the AOAC INTERNATIONAL Official Methods of Analysis
107 (2012). Available at: http://www.eoma.aoac.org/app_d.pdf
108
109 [Appendix K](http://www.eoma.aoac.org/app_k.pdf): Guidelines for Dietary Supplements and Botanicals 19th Edition of the AOAC
110 INTERNATIONAL Official Methods of Analysis (2012). Also at: . AOAC Int. 95, 268(2012); DOI:
111 10.5740/jaoacint.11-447 and available at: http://www.eoma.aoac.org/app_k.pdf
112
113
- 114 **8. Maximum Time-To-Result:** No maximum time to result.
115

116 **Table 3: Matrices**

117 Tablets
 118 Capsules
 119 Softgels
 120 Gelcaps
 121 Gummies
 122 Chewables
 123 Liquids
 124 Powders

125 **Table 4: Catechins**

Common name	IUPAC Nomenclature	CAS No.
Catechin	(2R,3S)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol	154-23-4?
epicatechin	(2R,3R)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol	490-46-0
epigallocatechin	(2R,3R)-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol	970-74-1
catechin gallate	[(2R,3R)-2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3,4-dihydro-2H-chromen-3-yl] 3,4,5-trihydroxybenzoate	130405-40-2
epicatechin gallate	(2R,3R)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-5,7-dihydroxy-2H-1-benzopyran-3-yl-ester-3,4,5-trihydroxy-benzoic acid	1257-08-5
epigallocatechin	(-)- <i>cis</i> -3,3',4',5,5',7-Hexahydroxyflavane, (-)- <i>cis</i> -2-(3,4,5-Trihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol	970-74-1
Gallate	3,4,5-Trihydroxybenzoic acid	149-91-7
gallo catechin	(2S,3R)-2-(3,4,5-Trihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol	3371-27-5

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128 **Table 5: Methyl xanthenes**

Common name	IUPAC Nomenclature	CAS No.
Caffeine	1,3,7-trimethylpurine-2,6-dione	58-08-2
theobromine	3,7-dimethyl-1H-purine-2,6-dione	83-67-0
theophylline	1,3-dimethyl-7H-purine-2,6-dione	58-55-9

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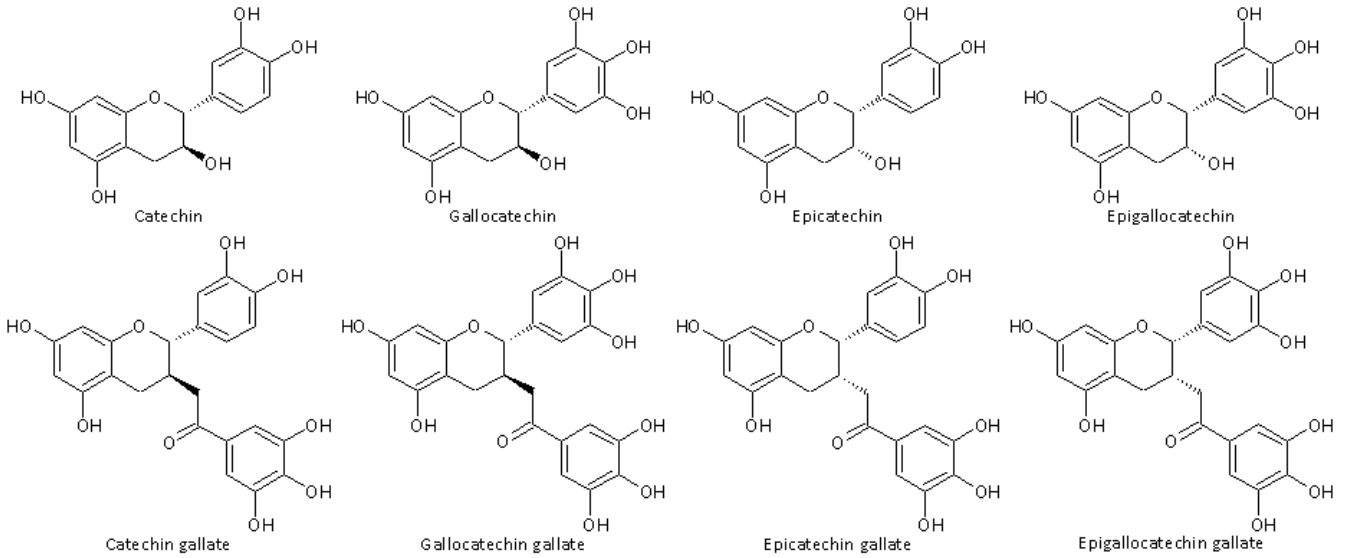
131 **Table 6: Theaflavins**

Common name	IUPAC Nomenclature	CAS No.
theaflavin	3,4,5-Trihydroxy-1,8-bis[(2R,3R)-3,5,7-trihydroxy-3,4-dihydro-2H-chromen-2-yl]-6H-benzo[7]annulen-6-one	4670-05-7
theaflavin-3-gallate	[(2R,3R)-5,7-dihydroxy-2-[3,4,5-trihydroxy-6-oxo-8-[(2R,3R)-3,5,7-trihydroxychroman-2-yl]benzo[7]annulen-1-yl]chroman-3-yl] 3,4,5-trihydroxybenzoate	30462-34-1
theaflavin-3'-gallate	[(2R,3R)-5,7-dihydroxy-2-[3,4,5-trihydroxy-6-oxo-8-[(2R,3R)-3,5,7-trihydroxychroman-2-yl]benzo[7]annulen-1-yl]chroman-3-yl] 3,4,5-trihydroxybenzoate	28543-07-9
theaflavin-3-3'-digallate	[1-[(2R,3R)-3,5-Dihydroxy-7-(3,4,5-trihydroxybenzoyl)oxochroman-2-yl]-3,5-dihydroxy-6-oxo-8-[(3R)-3,5,7-trihydroxychroman-2-yl]benzo[7]annulen-4-yl] 3,4,5-trihydroxybenzoate	33377-72-9

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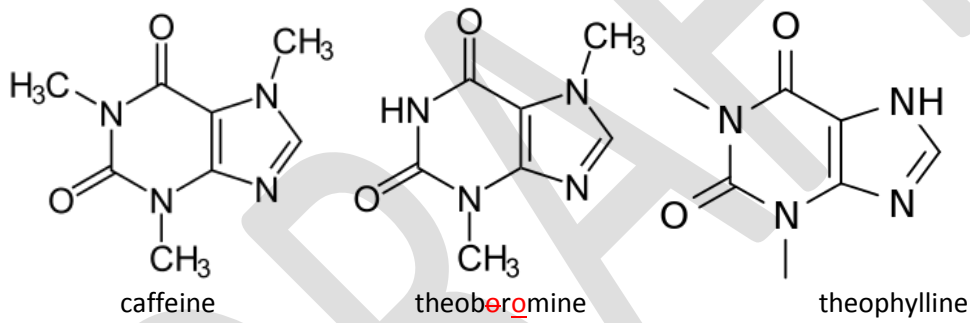
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Figure 1: Chemical structure for catechin and derivatives



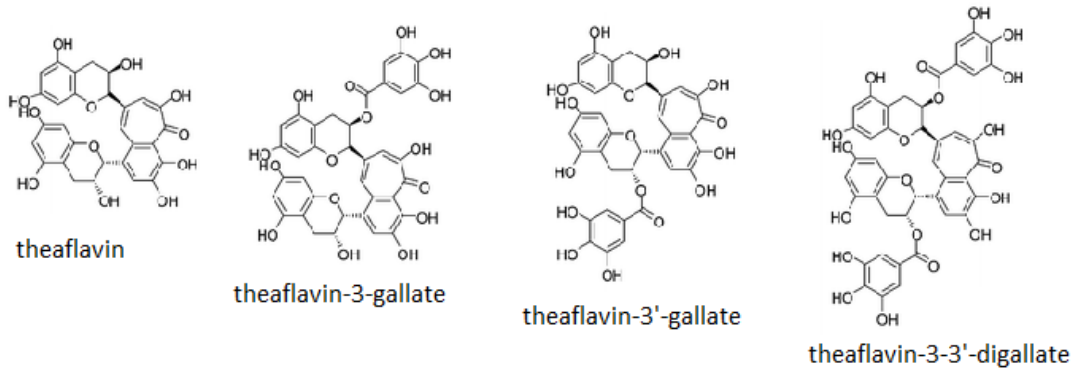
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Figure 2: Chemical structure of methyl xanthines



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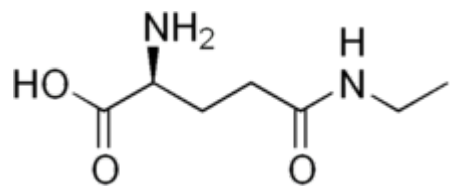
Figure 3: Chemical structures for theaflavins



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147 **Figure 4: Chemical structure of theanine**

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AOAC INTERNATIONAL STAKEHOLDER PANEL ON DIETARY SUPPLEMENTS

John Austad, Covance
Working Group on Vitamin D
September 25, 2015

Los Angeles, CA, USA

Fitness for Purpose

The method will separate and accurately quantitate vitamin D₂ (ergocalciferol), vitamin D₃ (cholecalciferol), and their previtamin d and hydroxy forms in dietary supplement consumer products and the raw materials used to formulate these products.



Vitamin D Working Group Members

- John Austad
- W. Barrett
- Joseph Betz
- Carolyn Burdette
- Clyde Don
- Andy Erickson
- James Griffiths
- Jana Hildreth
- Prashant Ingle
- Martha Jennens-Clough
- David Ji
- George Joseph
- David Kennedy
- Adam Kuszak
- Elizabeth Mudge
- Matthew Noestheden
- Melissa Phillips
- Curtis Phinney
- Catherine Rimmer
- Nandakumara (nandu kumara) Sarma
- Brian Schaneberg
- Aniko Solyom
- John Szpylka
- James Traub
- Lanette Varesi
- Denise Walters
- JP Woods
- Jinchuan Yang
- Seong-Jae Yoo
- Troy Zhang
- Weiguo Zhang
- Yanjun Zhang
- Joyce Zhu
- Garrett Zielinski



Vitamin D Working Group Work to Date

- 1 In Person Meeting
- 2 teleconferences (April – June 2015)
- 1 SMPR Drafted
- Public comment period (July 7, 2015 – August 7, 2015)
- SMPRs made ready for SPDS review and approval



SMPR Key Points

1. Method Performance Requirements:

Table 1: Analytical Range & LOQ Based on Matrix

Parameter	Finished Products	Raw Materials
Analytical range ppm*	0.5 – 338	1,250 - 12,500
Limit of Quantitation ppm*	0.4	1,000

Table 2: Method Performance Requirements as a Function of Range

Parameter	Ranges (µg/g)*				
	< 10 - 15	>15 - 50	>50 - 500	>500 - 4,000	>4000 - 12,500
Recovery (%)	80 - 110	90 - 107	95 - 105	95 - 105	97 - 103
% Repeatability (RSD _r)	8	7	5	4	3
% Reproducibility (RSD _D)	12	10	8	6	4

* Measured as individual forms of Vitamin D and pre-Vitamin D



Comments Submitted (if any)

- One Comment Submitted
 - “The two certified reference materials I mentioned were vitamin D2 and vitamin D3. We have other vitamin D standards in the attached but they are the metabolites.”
 - Cerilliant Vitamin D2V-024 Vitamin D3V-025
 - 1 mg/ml CRM in Ethanol
 - Stakeholders: Do we add to SMPR as a requirement to use?



Motion

- Move to accept the Standard Method Performance Requirements for Vitamin D as presented.



Discussion?



2
3 **Method Name:** **Determination of Vitamin D in Dietary Supplement Consumer Products**
4 **and Raw Materials**

5
6 **Approved by:** Stakeholder Panel on Dietary Supplements

7
8 **Intended Use:**

9
10 **1. Applicability:**

11 The method will separate and accurately quantitate vitamin D₂ (ergocalciferol), vitamin D₃
12 (cholecalciferol), and their previtamin d and hydroxy forms in dietary supplement consumer
13 products and the raw materials used to formulate these products.

14
15 **2. Analytical Technique:**

16 Any analytical technique that meets the following method performance requirements is
17 acceptable.

18
19 **3. Definitions:**

20
21 *Dietary ingredients.*— A vitamin; a mineral; an herb or other botanical; an amino acid; a
22 dietary substance for use by man to supplement the diet by increasing total dietary intake;
23 or a concentrate, metabolite, constituent, extract, or combination of any of the above
24 dietary ingredients. {United States Federal Food Drug and Cosmetic Act §201(ff) [U.S.C. 321
25 (ff)]}

26
27 *Dietary supplements.*— A product intended for ingestion that contains a “dietary
28 ingredient” intended to add further nutritional value to (supplement) the diet. Dietary
29 supplements may be found in many forms such as tablets, capsules, softgels, gelcaps,
30 liquids, or powders.

31
32 *Limit of Quantitation (LOQ).*— The minimum concentration or mass of analyte in a given
33 matrix that can be reported as a quantitative result

34
35 *Repeatability.*— Variation arising when all efforts are made to keep conditions constant by
36 using the same instrument and operator and repeating during a short time period.
37 Expressed as the repeatability standard deviation (SD_r); or % repeatability relative standard
38 deviation (%RSD_r).

39
40 *Reproducibility.*— The standard deviation or relative standard deviation calculated from
41 among-laboratory data. Expressed as the reproducibility relative standard deviation (SD_R); or
42 % reproducibility relative standard deviation (% RSD_R).

43
44 *Recovery.*— The fraction or percentage of spiked analyte that is recovered when the test
45 sample is analyzed using the entire method.
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4. Method Performance Requirements:

Table 1: Analytical Range & LOQ Based on Matrix

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Table 2: Method Performance Requirements as a Function of Range

Parameter	Ranges (µg/g)*				
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% Repeatability (RSD _r)	8	7	5	4	3
% Reproducibility (RSD _R)	12	10	8	6	4

* Measured as individual forms of Vitamin D and pre-Vitamin D

5. System suitability tests and/or analytical quality control:

Suitable methods will include blank check samples, and check standards at the lowest point and midrange point of the analytical range. A control sample must be included.

6. Reference Material(s): NIST Standard Reference Material® 3280; the reference value of vitamin D₂ in NIST 3280 is 8.6 micrograms/gram (±2.6) mg/kg of vitamin D₂.

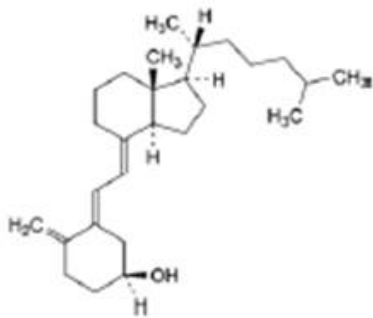
7. Validation Guidance:

Appendix D: Guidelines for Collaborative Study Procedures To Validate Characteristics of a Method of Analysis; 19th Edition of the AOAC INTERNATIONAL Official Methods of Analysis (2012). Available at: http://www.eoma.aoc.org/app_d.pdf

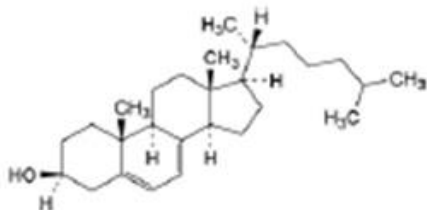
Appendix K: Guidelines for Dietary Supplements and Botanicals 19th Edition of the AOAC INTERNATIONAL Official Methods of Analysis (2012). Also at: . AOAC Int. 95, 268(2012); DOI: 10.5740/jaoacint.11-447 and available at: http://www.eoma.aoc.org/app_k.pdf

8. Maximum Time-To-Determination: No maximum time.

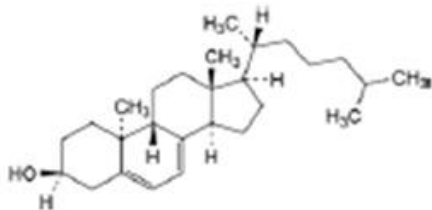
Figure 1: Chemical structure of vitamin D₂ (ergocalciferol), vitamin D₃ (cholecalciferol), and their previtamin d and hydroxy forms



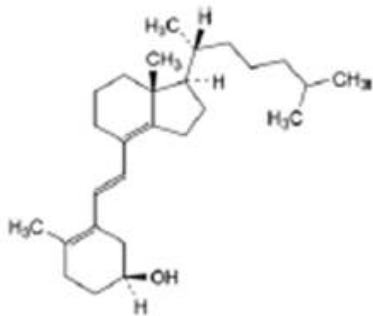
A. (5*E*,7*E*)-9,10-secocholesta-5,7,10(19)-trien-3 β -ol
(*trans*-cholecalciferol, *trans*-vitamin D₃),



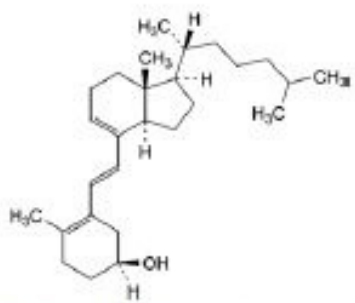
B. cholesta-5,7-dien-3 β -ol (7,8-didehydrocholesterol,
provitamin D₃),



C. 9 β ,10 α -cholesta-5,7-dien-3 β -ol (lumisterol₃),

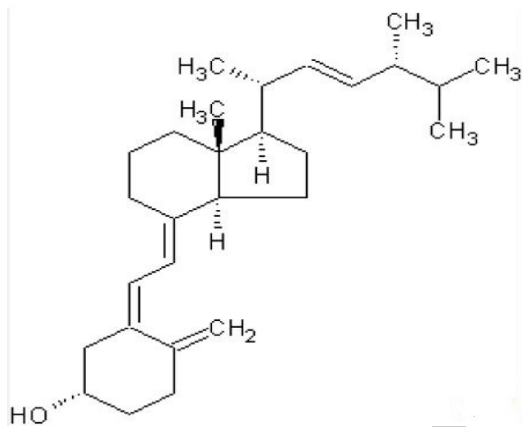


D. (6*E*)-9,10-secocholesta-5(10),6,8(14)-trien-3 β -ol
(*iso*-tachysterol₃),



E. (6E)-9,10-secocholesta-5(10),6,8-trien-3 β -ol (tachysterol).

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The Scientific Association Dedicated
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Stakeholder panel on dietary supplements

Background & Fitness for Purpose

Lutein, esters, congeners & metabolites

Rick Myers, PhD
AOAC Annual Meeting
Log Angeles, CA
25 September 2015



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to Analytical Excellence[®]

Background on analytes

- Carotenoids are a diverse family of botanical pigments
- Minimal biosynthesis in animals; so must derive from diet
- Botanical function
 - Mediate photoinduced electron transfer to chlorophyll
 - Quench singlet/triplet-chlorophyll that can damage allied tissues during very active photosynthesis
- Two relevant carotenoid families
 - *Carotenes*: hydrocarbons (orange)
 - *Xanthophylls*: hydroxylated carotenes (yellow)
- **Only xanthophylls of interest here. Dozens exist!**
- **Often exists as fatty acid esters in nascent tissue**



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Proposal for analytes:

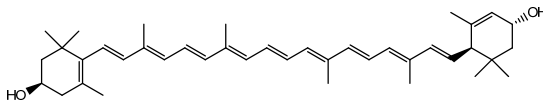
1. Limit to only principal isomers of the four most relevant, co-chromatographing compounds
 - a. Lutein
 - b. 3'-Epilutein (significant epimer loss of lutein)
 - c. Zeaxanthin
 - d. β -Cryptoxanthin
2. Saponify initial extract
 - a. Analyze free compounds only



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1. Lutein

- (3R,3'R,6'R)- β,ϵ -carotene-3,3'-diol; **dietary**
- Commercial and supplemental roles
 - Accumulates throughout human retina
 - Reportedly rescues AMD
 - Present in other tissues, relevance under study
 - Colors white egg yolks yellow
 - Antioxidant
 - Colorant (E161b)
- Structure



- Proposed daily dose: 10 mg

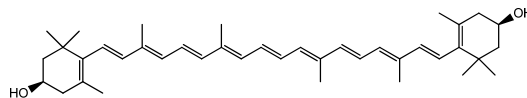


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2. Zeaxanthin

- β,β -carotene-3,3'-diol; **dietary**
- Zeaxanthin differs from lutein only by placement of single double bond.
- Commercial and supplemental roles
 - Also accumulates in human retina; predominates in *macula lutea*
 - Reportedly rescues AMD
 - Colors white egg yolks yellow
 - Colorant (E161h)

- Structure



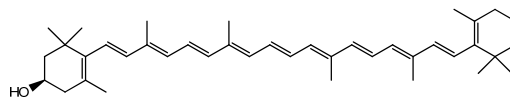
- Proposed daily dose: 2 mg



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3. β -Cryptoxanthin

- (3R,3'R,6'R)- β,ϵ -carotene-3,3'-diol; **dietary**
- Commercial and supplemental roles
 - Provitamin in humans; converted to vitamin A
 - Possible antioxidative DNA protection, bone health, others
 - Colorant (E161c) in Australia and New Zealand; not in US or EU
- Structure



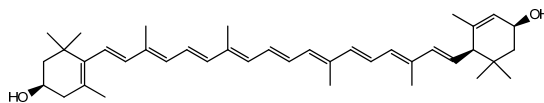
- Proposed daily dose: 4 mg



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4. 3'-Epilutein

- (3R,3'S,6'R)-lutein
- **Not dietary**—no biological or commercial role
- Significant epimer product and loss of lutein
 - Occurs in aqueous acid
 - Reaction likely proceeds by S_N1 and S_N2 , but mostly S_N2 since conversion exceeds 50%
- Structure



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General Analytical Needs

Method should

- Quantitatively de-esterify all analyte forms
- Separate and accurately quantify relevant free analytes
 - Lutein
 - Zeaxanthin
 - β -Cryptoxanthin
 - 3'-Epilutein (principal lutein metabolite)
- Determine the above in
 - Raw materials used in dietary supplement formulations
 - Finished products?



*The Scientific Association Dedicated
to Analytical Excellence[®]*

Challenges

- Quantitative recovery from finished product forms, e.g., beadlets, softgels, etc.
- Dozens of carotenoids co-extract from their botanical sources
- Analytes are difficult to separate from one each other, isomers, and metabolites



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Existing Methods - General

- HPLC – UV
- U/HPLC – MS/MS



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Representative existing methods

- **USP FCC 7 monograph**
 - Total carotenoids
 - HPLC-UV
 - Normal phase (silica)
 - Mobile phases: hexane, EtOAc
- **AOAC 2009.04**
 - Lycopene in dietary supplements and raw materials
 - Protease digestion and extraction with DCM:EtOH
 - HPLC-UV (alkylamide-bonded silica)
 - Mobile phase: IPA:NH₄OAc: ACN:MeOH:alkylamine



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A complex extract requires both normal and reversed phase chromatography for robust separation

- **Khachik et al. (1997) and Khachik et al. (1992)**
 - Carotenoids and their metabolites in human milk and serum, and Carotinoids and their oxidation products in human plasma, respectively
 - Two complementary chromatographic methods
 1. Reversed phase (C₁₈), ACN:MeOH:DCM, UV/MS
 2. Normal phase (Nitrile-bonded silica), hexane:DCM:MeOH:alkylamine, UV/MS
- **AOAC 2005.07**
 - β-Carotene in dietary supplements and raw materials
 - Protease digestion and extraction with DCM:EtOH
 - Two complementary HPLC chromatographic methods
 1. Reversed phase (C₁₈), IPA:NH₄OAc: ACN:MeOH:alkylamine, UV
 2. Reversed phase (C₃₀), MeOH:MTBE:alkylamine, UV



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Regulatory Guidance

- Evaluation of the Joint FAO/WHO Expert Committee on Food Additives (JECFA), 2004
- The FDA has confirmed the Joint Expert Committee on Food Additives' (JECFA) ruling (Sept 8, 2004) that free lutein and zeaxanthin are safe for human consumption.
- Vitamin status in some countries



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General Method Requirements

1. Quantitative extraction from matrices
 - a. Raw materials from which dosage forms are formulated
 - b. Finished products (e.g., softgels, beadlets) including proteolytic or other matrix release methods
2. Ensure against losses (e.g., oxidation, photolysis) during extraction, workup and analysis
3. Separation from matrix interferent for accurate and reproducible quantitation
4. The analytical range of the chosen method must encompass below 1 mg



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Fitness for Purpose (proposal)

Quantitative measurement of lutein, 3'-epilutein, zeaxanthin and β -cryptoxanthin in both raw materials from which dosage forms are formulated; and in finished products (e.g., softgels, beadlets). Methods must be able to accurately measure in the analytical range below 1 mg per dosage unit.



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Questions to address

- Address extraction from botanical tissues?
- Esters? Or **free compounds only** (saponify first)?
- Quantify losses:
 - To **epilutein**?
 - Only **all-trans species** (or include *cis* species)?
 - Oxidized species?
- Lutein only, or include:
 - **Zeaxanthin**?
 - **β -Cryptoxanthin**?
 - Others?



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QUESTIONS?





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STAKEHOLDER PANEL ON DIETARY SUPPLEMENTS COLLAGEN



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OUTLINE

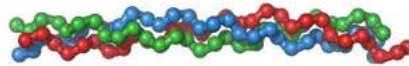
- Background on collagen and its different types.
- Health Significance.
- General Analytical Needs.
- General Overview of the Existing Analytical Methods & Techniques.
- Analytical Challenges.
- Fitness for purpose statement.
- Questions???



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BACKGROUND ON COLLAGEN AND ITS DIFFERENT TYPES

Collagen is the most abundant protein found in the body of animals making up about 25% to 35% of whole body protein. It is fibrous in nature and provides the structural support to the framework of the body. It connects and supports body tissues such as skin, bone, tendons and cartilage. It is a large triple helical molecule in its native form.



Collagen Fibril



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BACKGROUND ON COLLAGEN AND ITS DIFFERENT TYPES

So far 28 types of collagen have been identified. Types I, II, III are the most commonly used in dietary supplements.

- Type I Collagen is found in skin, muscle, tendon, ligament and bone tissue. (Most Abundant Type)
- Type II Collagen is found in cartilage.
- Type III Collagen is found alongside with Type I Collagen.



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BACKGROUND ON COLLAGEN AND ITS DIFFERENT TYPES

Collagen in Dietary Supplements

Given the large molecular weight of native collagen (~300k) most commercial collagen dietary ingredients are predigested/hydrolyzed (fragmented) to improve bioavailability.

Type I & III Collagen (aka Gelatin) - Bovine, Porcine, Marine Carcass Derived. Economical due to lower production cost and higher yield.

Type II Collagen – Chicken Cartilage Derived. Lower Yield. Higher Cost.



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HEALTH SIGNIFICANCE

The collagen supplements that exist in the market are wide ranging in molecular composition, molecular weight distribution, source (animal species), mechanism of action, and clinical efficacy.

Used by consumers to promote:

- Joint health
- Skin health
- Connective tissue health
- Hair and nail health



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GENERAL ANALYTICAL NEEDS

- Method should
 - Quantify collagen Type I, II & III in raw materials and finished product matrices.
 - Specific enough to individually separate and quantify collagen type I, II & III if blended together.
 - Identify the species of the collagen whether it is derived from marine, chicken, bovine or porcine sources.
 - Identify the adulterant(s) as other protein in the collagen samples.



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GENERAL OVERVIEW OF THE EXISTING METHODS & TECHNIQUES

- Nitrogen based protein analysis methods to calculate the collagen content (**unspecific**)
- Other total protein analysis methods (**unspecific**)
- Western blot using specific collagen antibodies. (**Not effective in hydrolyzed collagen samples**)
- ELISA for specific type of collagen. (**Not effective in hydrolyzed collagen samples**)
- Hydroxyproline based collagen assay method. (**Not type or species specific**)



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ANALYTICAL CHALLENGES

- Collagen is a complex molecule to purify and analyze.
- Testing is complicated once the collagen is hydrolyzed and fragmented into peptides, which can widely vary in size, length and molecular weight distribution depending on a host of factors including production method, process time, hydrolysis method, and raw material source.
- Need cost effective, quick turnaround analysis time and simple test method that can be run in an in-house laboratory.



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COMMON ADULTERANTS

- Type I & III Collagen / Gelatin products are sometimes adulterated with lower cost proteins.
- Type II Collagen is adulterated with type I & III collagen/gelatin and other lower cost proteins.



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FITNESS FOR PURPOSE STATEMENT

The method should be able to:

- Quantify total collagen type I, II & III in the raw materials and final finished dosage forms including but not limited to dry powders, tablets, capsules, softgels and liquids .
- Individually separate and quantify collagen type I, II & III if blended together.
- Identify the specie of the collagen samples whether they are derived from bovine, porcine, marine or chicken.
- Identify the adulterants present in the form of other protein within the collagen samples.



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QUESTIONS???



SPDS

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Useful Web Links:

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SPDS Microsite: <http://bit.ly/1rU4BmU>

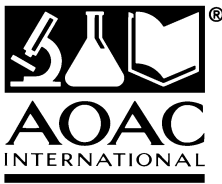
SPDS Standards Development: Working Group Sign Up: <http://tinyurl.com/p8pvf6f>

SPDS Conformity Assessment: Call for Experts / ERP Application: <http://tinyurl.com/o4ekd6w>

SPDS Conformity Assessment: Set 2 Ingredient Call for Methods: <http://tinyurl.com/oh8n54w>

AOAC Communications Survey: <http://tinyurl.com/oq4a5qz>





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**AOAC INTERNATIONAL Stakeholder Panel on Dietary Supplements
Working Group Sessions – September 26, 2015 (Day 2)
9:00 a.m. – 4:30 p.m., Palos Verdes Room**

I. Collagen (9:00 a.m. – 11:00 a.m.)

Chair: Suhail Ishaq, BioCell Technology, LLC

- a. Review Fitness for Purpose
- b. SMPR Development

II. Lutein (11:15 a.m. – 2:15 p.m.)**

Chair: Rick Myers, Kemin Industries, Inc.

- a. Review Fitness for Purpose
- b. SMPR Development

III. Turmeric (2:30 p.m. – 4:30 p.m.)

Chair: Aniko Solyom, GAAS Corporation

- a. Review Fitness for Purpose
- b. SMPR Development

****Day 2 Lunch: On your own, 12:00 p.m. – 1:00 p.m.**