



# Microscopic Analysis of Agricultural Products

4th Edition

Editors: James Makowski, Neil Vary, Marjorie McCutcheon, and Pascal Veys

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# Contents

## **Chapter 1. Methods of Agricultural Microscopy** **1**

### **Fundamentals of Agricultural Microscopy**

This chapter, intended for beginning agricultural microscopists, describes the principles of ingredient identification, equipment used, sample preparation techniques, observation methods, and related topics.

### **Flotation**

One of the most widely used methodologies for sample separation is flotation. In this procedure, feed samples are separated into density-dependent fractions by adding aliquots of two solvents of different specific gravities. The procedure results in samples that can be arranged in homogenous, density-dependent fractions.

## **Chapter 2. Feed Ingredients of Plant Origin** **9**

This chapter, as with subsequent sections on animal and marine ingredients, utilizes definitions recognized by the Association of American Feed Control Officials (AAFCO). This does not preclude the use of other ingredient definitions. This section discusses key stereomicroscopic and cellular or subcellular identification features.

## **Chapter 3. Feed Ingredients of Animal Origin** **43**

This chapter examines the key stereoscopic and cellular and subcellular identification features of feed ingredients derived from animals. Identification features of ingredients such as dairy products, meat meals (bovine, ovine, porcine, equine), and poultry products are discussed.

## **Chapter 4. Feed Ingredients of Marine Origin** **55**

As agriculture increases, so do the types of feed ingredients found in aquaculture diets. This chapter discusses major ingredients found in aquaculture diets, such as fish meals, shrimp meals, crab, meals, etc. As in previous sections, both macroscopic and cellular aspects are examined.

**Chapter 5. Detecting Animal Products in Feeds and Feed Ingredients 65**

This chapter deals with the detection and identification of various animal protein products. As a result of the emergence of bovine spongiform encephalopathy (BSE), or "mad cow disease," and the link between this disease and feeding practices, government bodies throughout the world (e.g., the U.S. Food and Drug Administration) have put restrictions on the use of animal protein products in animal feeds. A separate section dealing with the detection and identification of specific markers, such as hair and bone, which can be used to identify animal protein products, is included.

**Chapter 6. Fertilizer Microscopy 99**

This chapter examines various components/ingredients of fertilizers and how they can be identified using both visual and microchemical markers.

**Chapter 7. Weed Seeds of Agricultural Importance 115**

The identification of weed seeds is important to agricultural microscopists. This chapter provides agricultural microscopists with photographs and descriptions of some of the more common weed seeds.

**Chapter 8. Minerals of Agricultural Importance 135**

The mineral chapter provides microscopists with photographs and descriptions of some of the more common minerals found in animal feeds. This section is recommended as a supplement to microchemical spot testing for identification of specific minerals.

**Chapter 9. Microchemical Spot Tests 161**

This chapter details the methods of spot testing for a variety of minerals, vitamins, and drugs common to feed rations. The section includes principles of spot testing, reagents, steps for each test, results to expect, and other pertinent information.

**Appendix A: Glossary 171**

This section contains a glossary that defines the special nomenclature of agricultural microscopy drawn from the various scientific disciplines. Suggested reference sources and related information are also listed.

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# Preface to the Fourth Edition

The American Association of Feed Microscopists (AAFM) published the first edition of *The Manual of Microscopic Analysis of Feedstuffs* in 1955 (revised 1960), the second edition in 1978 and the third edition in 1992. These manuals have served veterinarians, toxicologists, scientists, and technicians in agriculture for more than 50 years.

Recognizing the tremendous increase in the area of agricultural microscopy, the Agricultural Microscopy Division of AOCS, formerly AAFM, saw a need for a new, much expanded edition. We have deliberately changed the name of the manual to *The Manual of Microscopic Analysis of Agricultural Products, Fourth Edition* to reflect our desire to provide a more inclusive approach to the microscopy of agricultural products. The area of animal protein products and their detection in light of recent outbreaks of Bovine Spongiform Encephalopathy (BSE), or "Mad Cow Disease," as well as other Transmissible Spongiform Encephalopathies (TSE's), requires a much more detailed methodology for detecting the presence of animal protein products. Returning to our roots, so to speak, we have included coverage of fertilizers and expanded the number of unusual feed ingredients.

Agricultural microscopy is both an art and applied science that draws from many academic disciplines. Plant and animal anatomy, feed technology, and analytical chemistry are just a few that have contributed. Thus this manual is designed as a study guide for the beginning microscopist and as a reference for the more experienced. It is not a complete treatise. It is a compilation of practical information that required many hours of labor by individual microscopists and others working toward common goals of agricultural product identification.

So many people have contributed to past editions that credits can no longer be equitably given. Because efforts are all voluntary, each edition represents the collective knowledge of editors and committees. Participants in this current manual are richer for their many hours spent, both as contributors to those who will follow and in honor of those who built the basic framework for agricultural microscopy. We submit our collective effort in this manual as a guide for all students and practitioners of agricultural microscopy. Please learn and enjoy the ideas and information presented here, then share your experiences and observations with other microscopists.