

Handbook of Vegetables & Vegetable Processing



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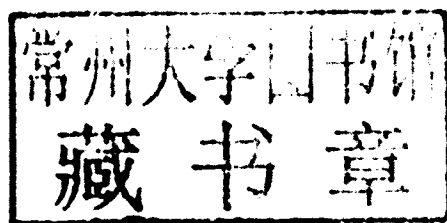
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Handbook of Vegetables and Vegetable Processing

Preface

Fresh and processed vegetables are a fast-growing segment of the food industry and occupy an important place in the global commerce and economy of many countries. Various studies have demonstrated the importance of vegetables to human health, contributing fiber, vitamins, minerals, bioactive phytochemicals, and other nutrients in our diet. Botanically and organoleptically diverse vegetables are primarily grown on regional and seasonal basis. Because of their highly perishable nature, search for efficient and better methods of preservation has been continuing along side the developments in production, postharvest handling, processing, and quality improvements. This handbook with 37 chapters contributed by more than 50 authors from North America, Europe, Australia, Asia, and Middle East is organized in five parts, which review and discuss important developments in vegetables and vegetable processing.

Part I of the handbook has 7 chapters on physiology, biochemistry, sensory and flavor properties, nutrition, phytochemical properties, genetic engineering, and microbiology.

Part II has 2 chapters on postharvest physiology and technology.

Part III has 12 chapters covering various aspects of vegetable processing including fresh-cut vegetables, vegetable parts, herbs and essential oils, vegetable juices, minimal processing and new technologies, refrigeration and freezing, drying, computer applications, packaging, and waste management.

Part IV includes 3 chapters on product and plant safety, including microbial safety, GAP and GMP, and HACCP.

Part V covers processing of important vegetables including green, leafy, tuber and root, and other vegetables. It also includes chapters on dry beans, olives, and avocados which are used as vegetables.

This handbook is intended as a contemporary source book on vegetable and vegetable processing for the industry, students, academia, libraries, research institutes, laboratories, and other interested professionals. To our knowledge, there are few books on vegetables and vegetable processing with associated coverage of scientific aspects and industrial practices. Although the readers are the final judge, we hope this handbook would meet the growing need for a quality book in this field. The editorial team acknowledges many individuals for their supports during the conception and development of this book. Our sincere thanks and gratitude to all authors for their contributions and for bearing with us during the review process. We would like to thank the publishing and copy editing departments, especially, Mark Barrett, Susan Engelken and Ronald D'souza for their supports to this project. We are grateful to the institutions we are associated with and to our families for their supports.

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Part I

**Biology, Biochemistry, Nutrition, Microbiology,
and Genetics**

Chapter 1

Biology and Classification of Vegetables

Theodore J. K. Radovich

Introduction

Vegetables enrich and diversify the human diet. They are the primary source of mineral nutrients, vitamins, secondary plant metabolites, and other compounds that support human health and nutrition. Vegetables, especially roots and tubers, can also possess significant caloric value, serving as staple crops in many parts of the world, particularly in the tropics. Although vegetables account for less than 1% of the world's plants, the genetic, anatomical, and morphological diversity of vegetables as a group is astounding (Graham et al. 2006; Maynard and Hochmuth 2007). Hundreds of vegetable taxa are grown for food in subsistence and commercial agricultural systems worldwide. This chapter reviews and explains the biology and classification of vegetables.

Biology and Classification of Vegetables

A primary reason for the diversity among vegetable crops is the broad definition of the word “vegetable” itself. Any plant part consumed for food that is not a mature fruit or seed is by definition a vegetable. These include petioles (e.g., celery, *Apium grave-*

olens Dulce group), entire leaves (e.g., lettuce, *Lactuca sativa*), immature fruits (e.g., cucumber, *Cucumis sativus*), roots (e.g., carrot, *Dacus carota*), and specialized structures such as bulbs (e.g., onion, *Allium cepa* Cepa group) and tubers (e.g., white potato, *Solanum tuberosum*).

Further expanding this already generous definition is the inclusion of mature fruits that are consumed as part of a main meal rather than dessert (e.g., tomato, *Solanum lycopersicum*). This culinary exception to the anatomical rule was given legal precedence in the US Supreme Court decision *Nix v. Hedden* (1893) that confirmed common usage of “vegetable” in reference to tomato. This has since been extended to beans and other fruits. Even dessert melons (e.g., cantaloupe, *Cucumis melo* Cantalupensis group), which are fruits by every botanical, legal, and culinary definition, are frequently “lumped” in with vegetables because of similarities in biology and culture that they share with their more vegetal cousins in the *Cucurbitaceae* (Iltis and Doebley 1980) (Table 1.1).

The biological diversity among vegetables necessitates a systematic method for grouping vegetables in order to efficiently access information and make management decisions. Understanding the biology of vegetable crops will aid decision making associated with production, postharvest handling, and marketing. Ultimately, vegetable classification is inextricably linked with crop biology. Three

Table 1.1 Botanical names, common names, and edible parts of select vegetables by family. Families in the Monocotyledons are listed first (shaded) followed by families in Dicotyledons

Family	Botanical name	Common name	Edible plant part
Alliaceae (Onion family)			
	<i>Allium ampeloprasum</i> L. Ampeloprasum group	Great-headed garlic	Bulb and leaf
	<i>Allium ampeloprasum</i> L. Kurrat group	Kurrat	Pseudostem
	<i>Allium ampeloprasum</i> L. Porrum group	Leek	Pseudostem and leaf
	<i>Allium cepa</i> L. Aggregatum group	Shallot	Bulb
	<i>Allium cepa</i> L. Cepa group	Onion	Aerial bulb
	<i>Allium cepa</i> L. Proliferum group	Tree onion, Egyptian onion	Bulb
	<i>Allium chinense</i> G. Don.	Rakkyo	Pseudostem and leaf
	<i>Allium fistulosum</i> L.	Welsh onion, Japanese bunching onion	
	<i>Allium grayi</i> Regel	Japanese garlic	Leaf
	<i>Allium sativum</i> L.	Garlic	Bulb and leaf
	<i>Allium schoenoprasum</i> L.	Chive	Leaf
	<i>Allium scorodoprasum</i> L.	Sand leek, giant garlic	Leaf and bulb
	<i>Allium tuberosum</i> Rottler ex Sprengel	Chinese chive	Leaf, immature flower
	<i>Allium victorialis</i> L. Platyphyllum group, Hult.	Longroot onion	Bulb, leaf
Araceae (Arum family)			
	<i>Alocasia macrorrhiza</i> (L.) Schott	Giant taro, alocasia	Corn, immature leaf, petiole
	<i>Amorphophallus paeoniifolius</i> (Dennst.) Nicolson	Elephant yam	Corn
	<i>Colocasia esculenta</i> (L.) Schott	Taro, dasheen, cocoyam	Corn, immature leaf
	<i>Cyrtosperma chamissonis</i> (Schott) Merr.	Giant swamp taro	Corn
	<i>Cyrtosperma merkusii</i> (Hassk.) Schott.	Gallan	Corn
	<i>Xanthosoma brasiliense</i> (Desf.) Engler	Tannier spinach, catalou	Immature leaf
	<i>Xanthosomas agnitifolium</i> (L.) Schott	Tannia, yellow yautia	Corn and young leaf
Cyperaceae (Sedge family)			
	<i>Cyperus esculentus</i> L.	Rushnut, chufa	Tuber
	<i>Eleocharis dulcis</i> (Burm.f.) Trin. Ex Henschel	Water chestnut, Chinese water chestnut	Corn
	<i>Eleocharis kuroguwaii</i> Ohwi	Wild water chestnut	Corn
Dioscoreaceae (Yam family)			
	<i>Dioscorea alata</i> L.	White yam, water yam	Tuber
	<i>Dioscorea batatas</i> Decue.	Chinese yam	Tuber
	<i>Dioscorea bulbifera</i> L.	Potato yam, aerial yam	Tuber
	<i>Dioscorea cayenensis</i> Lam.	Yellow yam	Tuber

<i>Dioscorea dumetorum</i> (Kunth) Pax. <i>Dioscorea esculenta</i> (Lour.) Burk. <i>Dioscorea rotundata</i> Poir. <i>Dioscorea trifida</i> L. f.	Bitter yam Lesser yam White Guinea yam Indian yam	Tuber Tuber Tuber Tuber
Liliaceae (Lily family) <i>Asparagus officinalis</i> L. <i>Hemerocallis</i> spp.	Asparagus Daylily	Shoot Flower
Musaceae (Banana family) <i>Musa x paradisiaca</i> L. Paradisiaca group	Plantain	Fruit, flower bud
Poaceae (Grass family) <i>Bambusa</i> spp. <i>Dendrocalamus latiflorus</i> Munro <i>Phyllostachys</i> spp. <i>Zea mays</i> L. subsp. <i>mays</i>	Bamboo shoots Bamboo shoots Bamboo shoots Sweet corn	Young shoot Young shoot Young shoot Immature kernels and immature cob with kernel
Zingiberaceae (Ginger family) <i>Alpinia galanga</i> (L.) Sw. <i>Curcuma longa</i> L. <i>Zingiber officinale</i> Roscoe	Greater galangal Turmeric Ginger	Floral sprout and flower, tender shoot, rhizome Rhizome Rhizome and tender shoot
Amaranthaceae (Amaranth family) <i>Amaranthus</i> spp.	Amaranthus, tampala	Tender shoot, leaf, sprouted seed
Apiaceae (Carrot family) <i>Angelica</i> spp. <i>Anthriscus cerefolium</i> (L.) Hoffm. <i>Apium graveolens</i> L. Dulce group (Mill.) Pers. <i>Apium graveolens</i> L. Rapaceum group (Mill.) Gaud. <i>Coriandrum sativum</i> L. <i>Daucus carota</i> L. subsp. <i>sativus</i> (Hoffm.) Arcang. <i>Foeniculum vulgare</i> <i>Pastinaca sativa</i> L. <i>Petroselinum crispum</i> (Mill.) Nym. Crispum group <i>Petroselinum crispum</i> (Mill.) Nym. Tuberosum group <i>Petroselinum crispum</i> (Mill.) Nym. Neapolitanum group	Angelica Chervil Celery Celeriac, turnip-rooted celery Coriander Carrot Fennel Parsnip Parsley Turnip-rooted parsley Italian parsley	Tender shoot and leaf Leaf Petiole, leaf Root, leaf Leaf and seed Root and leaf Leaf, Petiole Root and leaf Leaf Root and leaf Leaf

(Continued)