

# **Herbs, Spices, and Medicinal Plants: Recent Advances in Botany, Horticulture, and Pharmacology Volume 1**

**LYLE E. CRAKER,**

**JAMES E. SIMON,**

**Board of Editors**

# Herbs, Spices, and Medicinal Plants: Recent Advances in Botany, Horticulture, and Pharmacology Volume 1

**LYLE E. CRAKER**, *Editor-in-Chief*  
Department of Plant and Soil Sciences  
University of Massachusetts  
Amherst, MA 01003 U.S.A.

**JAMES E. SIMON**, *Editor-in-Chief*  
Department of Horticulture  
Purdue University  
West Lafayette, IN 47907 U.S.A.

## Board of Editors

**C.K. Atal**, Regional Research Laboratory, Council of Scientific and Industrial Research, Jammu-Tawi, India

**D. Palevitch**, Department of Medicinal and Aromatic Crops, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel

**T. Robinson**, Department of Biochemistry, University of Massachusetts, Amherst, MA 01003 U.S.A.

**E.J. Staba**, Department of Medicinal Chemistry and Pharmacognosy, College of Pharmacy, University of Minnesota, Minneapolis, MN 55455 U.S.A.

**P. Tétényi**, Research Institute of Medicinal Plants, Budakalasz, Hungary



**ORYX PRESS**  
1986

The rare Arabian Oryx is believed to have inspired the myth of the unicorn. This desert antelope became virtually extinct in the early 1960s. At that time several groups of international conservationists arranged to have 9 animals sent to the Phoenix Zoo to be the nucleus of a captive breeding herd. Today the Oryx population is over 400 and herds have been returned to reserves in Israel, Jordan, and Oman.

Copyright © 1986 by Lyle E. Craker and James E. Simon

Published by The Oryx Press  
2214 North Central at Encanto  
Phoenix, Arizona 85004-1483

Published simultaneously in Canada

All rights reserved

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without permission in writing from The Oryx Press

Printed and Bound in the United States of America

☞ The paper used in this publication meets the minimum requirements of American National Standard for Information Science—Permanence of Paper for Printed Library Materials, ANSI Z39.48, 1984.

**Warning:** The medicinal and other uses of herbs described in this volume have been included for informational and study purposes only. The authors and publishers neither advocate nor prescribe the use of any herb for medicinal or other purposes. Please note that some herbs mentioned in this book could be poisonous. The authors and publisher assume no liability for omissions or for use or misuse of information contained herein.

Library of Congress Cataloging in Publication Data  
Main entry under title:

Herbs, spices, and medicinal plants.

Includes bibliographies.

I. Herbs—Collected works. 2. Spices—Collected works. 3. Medicinal plants—Collected works. 4. Pharmacology—Collected works. I. Craker, Lyle E. II. Simon, James E.

SB107.H47 1985 635.7 85-11551  
ISBN 0-89774-143-9 (v. 1)

## Preface

With this publication, we initiate a new series devoted to the study of herbs, spices, and medicinal plants. Although utilized for thousands of years as condiments, medicines, fragrances, dyes, and ornaments, scientific information on the botany, horticulture, and pharmacology associated with the growing and using of this group of plants has been limited. Each of the sequential volumes of this series will review and summarize the most recent available information within selected subject areas, providing the reader with an introduction to the herbs, spices, and medicinal plants and a ready, authoritative reference for detailed study on the botany, horticulture, and pharmacology of these plants.

The more than one billion dollars per year worldwide trade in herbs, spices, and medicinal plants testifies to their market value. Yet, the importance of these plants is more than economic as the scientific study of herbs, spices, and medicinal plants has made significant contributions to the understanding of physiological processes in the biosynthesis of natural plant products and in the ecological relationships of plants within their environment. Herbs, spices, and medicinal plants continue to serve important traditional and ritualistic functions for many groups of people throughout the world.

Scientific investigations have been initiated in many countries as the potential food and health contributions of these plants are recognized. The continual search for and interest in natural plant products to use in the flavor and medicinal industries has acted as a catalyst for exploring the methodologies involved in obtaining the required plant material and probing the botanical, chemical, ecological, and pharmacological relationships among plants. With this increased interest in herbs, spices, and medicinal plants, professionals and field specialists associated with trade, horticulture, and chemistry have made an ever-increasing demand for recent and accurate information on plant culture and pharmacology. However, few scientific references that can provide an in-depth review of current research developments on herbs, spices, and medicinal plants are available.

The editors-in-chief, being plant physiologists interested in the growth and biochemistry of herbs, spices, and medicinal plants and keenly aware of the long and laborious process involved in gathering scientific information, felt a special contribution to the study of these

plants could be made by producing a forum for presentation and review of research work. After a careful and considerable exploration of ideas, an annual collection of invited papers summarizing the recent advances in herbs, spices, and medicinal plants appeared to best serve the needs of all.

We have been joined in this endeavor by the board of editors, an international group of scientists committed to the advancement of this discipline. A special acknowledgment must also be made to the contributors of this volume who, upon invitation, undertook the rigorous work and research necessary to prepare a thorough review in their specialty area.

To this beginning, Volume 1 of *Herbs, Spices, and Medicinal Plants: Recent Advances in Botany, Horticulture, and Pharmacology*, is launched.

Lyle E. Craker  
James E. Simon

## Acknowledgments

The editors-in-chief wish to express special thanks to their patient families during the dreaming, writing, and compiling involved in the publication of this first volume of *Herbs, Spices, and Medicinal Plants: Recent Advances in Botany, Horticulture, and Pharmacology, Volume 1*. We very much appreciate the initial financial support of the University of Massachusetts Graduate School and College of Food and Natural Resources. The preparation of this volume was greatly aided by the library work of Mr. John Gancarski and Ms. Alena Chadwick, the typing of Ms. Debbie Clark, and the proofreading of Ms. Marie Iken.

# Contributors to Volume 1

- T. Adzet      Department of Pharmacognosy\*and Pharmacodynamics,  
University of Barcelona, Barcelona, Spain
- J. Bernáth      Research Institute for Medicinal Plants, Budakalasz,  
Hungary
- R. Croteau      Institute of Biological Chemistry, Washington State  
University, Pullman, Washington, USA
- A. Dafni      Institute of Evolution, Haifa University, Haifa, Israel
- J. Friedman      Department of Botany, the G.S. Wise Faculty of Life  
Sciences, Tel-Aviv University, Ramat Aviv, Israel
- C. Mann      Department of Medicinal Chemistry and Pharma-  
cognosy, College of Pharmacy, University of Minnesota,  
Minneapolis, Minnesota, USA
- D. Palevitch      Department of Medicinal and Spice Crops, Agricultural  
Research Organization, The Volcani Center, Bet Dagan,  
Israel
- T. Robinson      Department of Biochemistry, University of Massachu-  
setts, Amherst, Massachusetts, USA
- E.J. Staba      Department of Medicinal Chemistry and Pharma-  
cognosy, College of Pharmacy, University of Minnesota,  
Minneapolis, Minnesota, USA
- P. Tétényi      Research Institute for Medicinal Plants, Budakalasz,  
Hungary
- A.O. Tucker      Department of Agriculture and Natural Resources,  
Delaware State College, Dover, Delaware, USA
- Z. Yaniv      Department of Medicinal and Spice Crops, Agricultural  
Research Organization, The Volcani Center, Bet Dagan,  
Israel

# Contents

**Preface**      v

**Acknowledgments**      vi

**Contributors to Volume 1**      vii

An Introduction to the Scientific Literature on Herbs, Spices, and Medicinal Plants	<i>L.E. Craker, A.F. Chadwick, and J.E. Simon</i>	1
Chemotaxonomic Aspects of Essential Oils	<i>Peter Tétényi</i>	11
Botanical Nomenclature of Culinary Herbs and Potherbs	<i>Arthur O. Tucker</i>	33
Biochemistry of Monoterpenes and Sesquiterpenes of the Essential Oils	<i>Rodney Croteau</i>	81
The Biochemical Pharmacology of Plant Alkaloids	<i>Trevor Robinson</i>	135
Polyphenolic Compounds with Biological and Pharmacological Activity	<i>T. Adzet</i>	167
Production Ecology of Secondary Plant Products	<i>Jenő Bernáth</i>	185
The Chemistry, Pharmacology, and Commercial Formulations of Chamomile	<i>Cornie Mann and E. John Staba</i>	235
Medicinal Plants of Israel: An Ethnobotanical Survey	<i>D. Palevitch, Z. Yaniv, A. Dafni, and J. Friedman</i>	281

**Index**      347

# **An Introduction to the Scientific Literature on Herbs, Spices, and Medicinal Plants**

***L.E. Craker***

**Department of Plant and Soil Sciences, University of  
Massachusetts, Amherst, MA 01003**

***A.F. Chadwick***

**Science Libraries, University of Massachusetts,  
Amherst, MA 01003**

***J.E. Simon***

**Department of Horticulture, Purdue University, West  
Lafayette, IN 47907**

The beginnings of scientific literature on herbs, spices, and medicinal plants can be linked to the very earliest of writings. Instructions for making and using plant-based medicinal preparations are recorded on Egyptian papyri dating from 2000 B.C., with this material appearing to be copied from other sources written several centuries earlier (2, 3, 12). The legendary Chinese Emperor Shen Nung is credited with composing an herbal of over 100 items in c. 2700 B.C., forming the basis for China's purportedly oldest medical text, *Shen Nung Pen Tsao* (2, 12). Other early texts, scriptures, and tablets from throughout the world indicate the use of plants as pharmaceuticals, spices, and dyes, suggesting the development and recording of recipes and methodologies for selection and application of plant material (4, 5, 8, 11, 13).

The systematic separation and categorization of herbs and other plants according to morphological traits appear to have begun with the publication of *Historia Plantarum* and *De Causis Plantarum*, both written by Theophrastus of Eresus (c. 372–286 B.C.), a colleague of Aristotle in Plato's academy and considered the father of modern



botany (6, 7). Dioscorides, a Greek physician in the first century A.D., expanded on the work of Theophrastus by assembling *De Materia Medica*, a listing of approximately 600 plants that included names, botanical and habitat descriptions, preparations, and medicinal and aromatic uses (7).

*De Materia Medica* remained the classical authority in Europe for the next 1,500 years, frequently reproduced, but seldom augmented, leaving the science of botany to be described as degenerating "into a drug list" after 200 A.D. (7). A Chinese herbal, *Tzu-I Pên Tshao Ching*, appeared in c. 500 B.C. and incorporated several earlier works (7, 12). Although the dates of writing are uncertain, ranging between 800 B.C. and 400 A.D., the Indian medical manuscripts *Charaka Samhita* and *Susruta Samhita* list approximately 500 herbal drugs (2, 12).

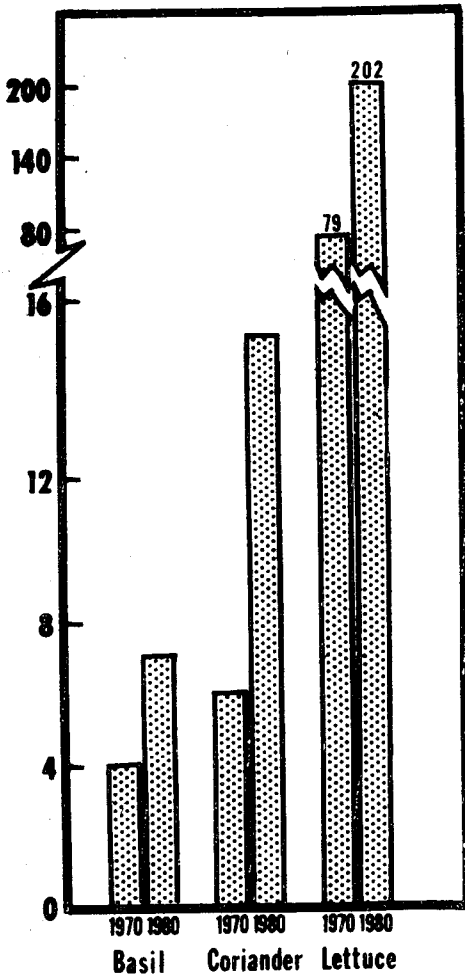
During the Middle Ages, Avicenna (Ibn Sina) and others from the Middle East, North Africa, and Moslem Spain made significant additions to the number of plants that could be used for medicinal purposes (2, 7). In Medieval Europe, herbals became the major form of codified plant knowledge but provided little enlightenment as essentially unrecognizable illustrations for describing plants and unverified directions for medicinal preparations (derived from writings of Theophrastus and Dioscorides) were utilized. The *Herbarum Vivae Eicones*, produced by Otto Brunfels in 1530, relied on Greek and Roman sources for information but did contain accurate illustrations of the plants (1).

**TABLE 1. Research Reports on Dill and Parsley for 1920 through 1980<sup>a</sup>.**

Number of Reports							
Dill	0	0	0	1	1	5	12
Parsley	0	0	3	3	7	10	42
Lettuce <sup>b</sup>	5	5	14	13	32	49	149
Tomato <sup>b</sup>	13	34	70	93	146	300	507
Year of Publication	1920	1930	1940	1950	1960	1970	1980

<sup>a</sup>From citations in *Chemical Abstracts*, Chemical Abstracts Service, The American Chemical Society, Columbus, Ohio.

<sup>b</sup>The number of research reports on lettuce and tomato have been included for comparison.



**Figure 1.** The Scientific Literature on Basil and Coriander. Numbers of research articles are from a count of 1970 and 1980 citations listed for each plant in the U.S. National Agricultural Library database, AGRICOLA. The number of research reports on lettuce has been included for comparison.

from 1971 through 1980 (10). As evidenced by dill and parsley (Table 1), the number of published scientific reports has increased throughout the last 50 years. A comparison of the amount of basil and coriander research literature listed by the United States National Agricultural Library database (AGRICOLA) in 1970 and 1980 indicates a similar increase in publications (Figure 1).

The *Herball* of Nicholas Culpeper, published in 1652, and the *Herball* of John Gerard, published in 1597 and expanded by Thomas Johnson in 1633, gained wide recognition and use. The Johnson revision of Gerard's *Herball* contained accurate descriptions of plants and was used by physicians and apothecaries. However, Culpeper's *Herball*, while extremely popular, did not contribute to scientific knowledge and erroneously connected plants with astrological events and the "Doctrine of Signatures" (13). The distillation of essential oils did become widespread in the 1500s and, during this time, physic gardens were established by medical schools and societies of apothecaries (9, 14).

"Modern" research on herbs, spices, and medicinal plants has expanded to study a wide variety of topical areas connected to the botany, horticulture, and pharmacology of these plants. A recent bibliographic review of the scientific literature on herbs of the temperate zone associated over 10,000 authors with published research articles related to this group of plants covering the period

The majority of research reports on herbs in the scientific literature during this time period were concerned with the horticulture and production ecology of the plants. Collectively, these 2 areas accounted for over 38 percent of the published work (Figure 2). In addition, significant contributions to the study of herbs have been made in botany, chemistry, and pharmacology with each of these fields of study contributing over 10 percent of the total research publications on herbs and aromatic and medicinal plants during 1971 through 1980. Differences in the distribution of research effort do occur among the plants, however, reflecting specific interests in certain species (Table 2).

**TABLE 2. Distribution of Research within Scientific Disciplines for Selected Herbs<sup>a</sup>.**

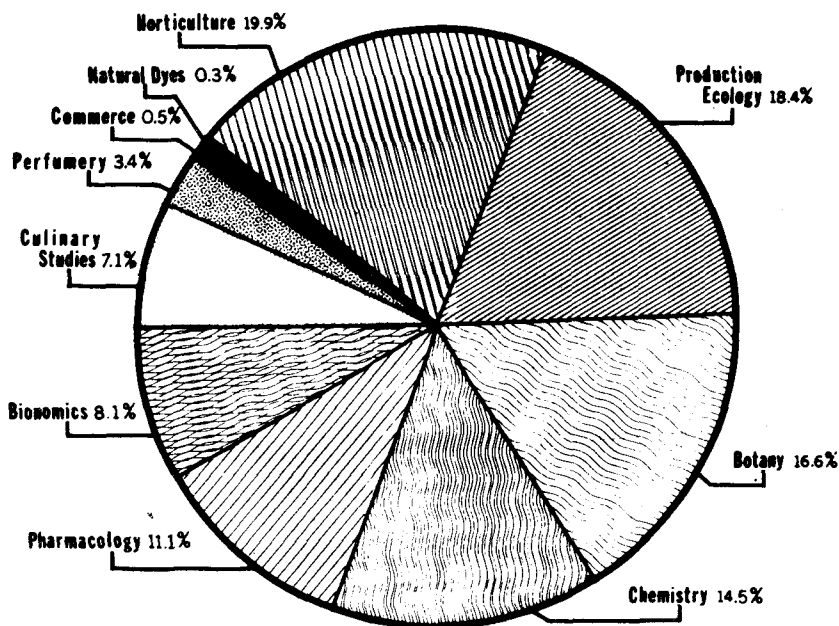
Research Area	Plant Material		
	Anise	Poppy	Saffron
	(% of published articles)		
Chemistry	31	12	14
Botany	14	17	22
Horticulture	12	28	18
Pharmacology	12	16	7
Other <sup>b</sup>	31	27	39

<sup>a</sup>Data from Simon *et al.* (10).

<sup>b</sup>Including bionomics, production ecology, culinary studies, perfumery, natural dyes and ornamental applications, and commerce.

Dividing the botanical, horticultural, and pharmacological literature on herbs into subcategories demonstrates specific areas of scientific interest in the herb plants (Figure 3). Within botany, most research publications focus on growth and development of the plants; within horticulture, most research publications report on plant breeding and crop production; within pharmacology, most research publications concern pharmacognosy of the plants or plant extracts. An area where increased numbers of scientific articles have been published in recent years is in tissue culture, which has gone from the publication of 9 reports in 1971 to 25 in 1980.

Mint was the most frequently reported herb, spice, or medicinal plant in the scientific literature during 1971 through 1980 with over 500 published research articles containing information associated with



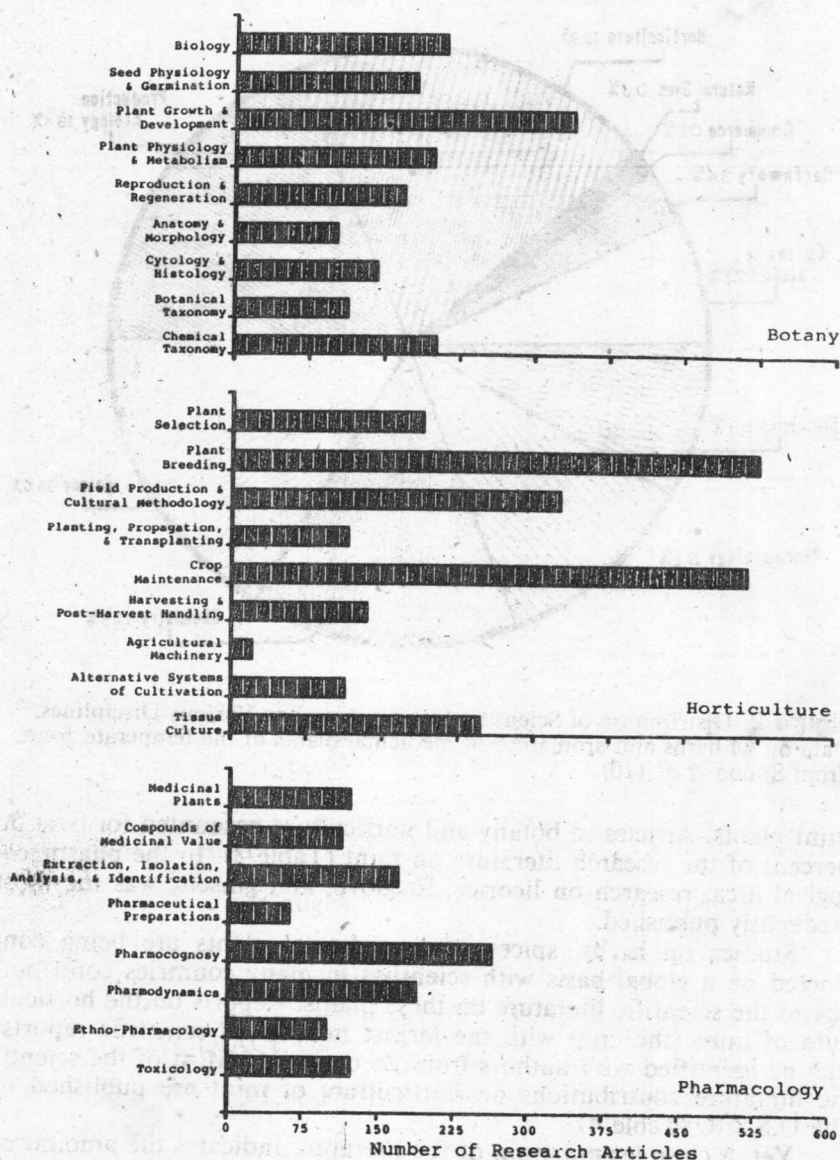
**Figure 2.** Distribution of Scientific Literature among Various Disciplines. Data on 64 herbs and aromatic and medicinal plants of the temperate zone. From Simon *et al.* (10).

mint plants. Articles in botany and horticulture accounted for over 50 percent of the research literature on mint (Table 3). In the pharmacological area, research on licorice, foxglove, and ginseng was the most frequently published.

Studies on herbs, spices, and medicinal plants are being conducted on a global basis with scientists in many countries contributing to the scientific literature on these plants. Reports on the horticulture of mint (the crop with the largest number of scientific reports) can be identified with authors from 26 countries. Most of the scientific literature contributions on horticulture of mint are published in the U.S.S.R. (Table 4).

Yet, a close examination of the literature indicates the amount of research on most herbs, spices, and medicinal plants remains quite limited; the number of reported research articles for 1971 through 1980 averaged approximately 750 per year for 64 plant categories or only about 12 articles for each plant each year. This relatively low average number of published research papers must be viewed with caution, of course, as great variation in economic value and commercial use exists among the 64 plant types examined, influencing the

## 6 Herbs, Spices, and Medicinal Plants, Volume 1



**Figure 3.** Scientific Literature on Herbs, Spices, and Medicinal Plants within Botany, Horticulture, and Pharmacology. Data from Simon *et al.* (10).

demand and need for scientific studies. An indication of the small number of research reports on the botany, horticulture, and phar-

**TABLE 3. Distribution of Botany, Horticulture, and Pharmacology Literature among Plants<sup>a</sup>.**

Botany		Horticulture		Pharmacology	
Most Publications					
Plant	No. <sup>b</sup>	Plant	No.	Plant	No.
Mint	146	Mint	255	Licorice	95
Mustard	103	Capsicum Pepper	181	Foxglove	69
Onion	73	Poppy	103	Ginseng	69
Poppy	68	Onion	96	Poppy	65
Capsicum Pepper	66	Sesame	88	Angelica	61
Least Publications					
Dittany of Crete	1	Goldenrod	2	Caper	2
Southernwood	1	Wintergreen	2	Dittany of Crete	2
Chervil	0	Caper	1	Lemon Verbena	2
Henna	0	Dittany of Crete	1	Lavender	1
Lobelia	0	Goldenseal	0	Southernwood	1
				Horehound	0
				Horseradish	0

<sup>a</sup>Data from Simon *et al.* (10).<sup>b</sup>Number of publications, 1971 through 1980.

macology of some herbs, spices, and medicinal plants is presented in Table 3. For one plant—Dittany of Crete—less than one research report per year (a total of 7 identified articles) was published over the 10-year period from 1971 through 1980. For caper, goldenseal, and southernwood, less than 2 research reports per year were published.

Unfortunately, the large number of countries doing research on herbs, spices, and medicinal plants has resulted in a wide variety of research reports scattered in numerous journals and reports, making a comprehensive bibliographic review and an accurate count of scientific publications on specific herbs difficult. For example, with basil, 73 percent of the research papers were reported in separate journals for 1971 through 1980 (Table 5). Only 13 percent of the research papers on parsley during this same time period could be associated with scientific journals having 3 or more articles on parsley.

Scientific literature is the collection of research information and, as such, serves as the reservoir of knowledge about a subject. The literature codifies the subject material, maintains a historical record on experimental trials, and aids in problem solving through education and communication about facts and ideas. As the scientific literature

**TABLE 4. Origin of Published Research Studies on Mint<sup>a</sup>.**

<u>Country</u>	<u>Contribution (%)</u>
France	9
Germany	6
India	17
USSR	19
United States	10
Other <sup>b</sup>	31
Unidentified <sup>c</sup>	8

<sup>a</sup>Data from Simon *et al.* (10). Authors were affiliated with specific countries by language and origin of publication.

<sup>b</sup>A total of 26 countries could be associated with publications on mint.

<sup>c</sup>Author(s) could not be identified with any specific country.

**TABLE 5. The Distribution of Research Reports among Literature Sources<sup>a</sup>.**

<u>Number of Sources with:</u>	<u>Basil</u>	<u>Parsley</u>
1 article	120	180
2 articles	25	40
3 articles	7	10
4 articles	8	10
5 articles	1	5
6 articles	2	5
7 articles	1	2

<sup>a</sup>Identified literature, 1971 through 1983.

on herbs, spices, and medicinal plants develops, more exchange of information should occur, helping to advance the science of these plants.

## REFERENCES

1. Arber, Agnes. 1953. From medieval herbalism to the birth of modern botany. In E.A. Underwood, ed. *Science Medicine and History*. Vol. 1. Oxford University Press, London. pp. 317-336.
2. Castiglioni, Arturo. 1958. *A History of Medicine*, 2d ed. Alfred A. Knopf, New York. 1192 p.
3. Dawson, W.R. 1953. Egypt's place in medical history. In E.A. Underwood, ed. *Science Medicine and History*. Vol. 1. Oxford University Press, London. pp. 47-60.
4. Forbes, R.J. 1964. Dyes and dyeing. In R.J. Forbes. *Studies in Ancient Technology*. Vol 4. E.J. Brill, Leiden. pp. 99-150.
5. Forbes, R.J. 1965. Cosmetics and perfumes in antiquity. In R.J. Forbes. *Studies in Ancient Technology*. Vol. 3. E.J. Brill, Leiden. pp. 1-50.
6. Greene, E.L. 1983. *Landmarks of Botanical History*. Part I. F.N. Egerton, ed. Stanford University Press, Stanford, CA. 505 p.
7. Morton, A.G. 1981. *History of Botanical Science*. Academic Press, New York. 474 p.
8. Partington, J.R. 1953. Chemistry in the ancient world. In E.A. Underwood, ed. *Science Medicine and History*. Vol. 1. Oxford University Press, London. pp. 35-46.
9. Rea, C.B. and J. Rea. 1973. *Circa Instans*. [Rea], Bryan, TX. 426 p.
10. Simon, J.E., A.F. Chadwick, and L.E. Craker. 1984. *Herbs: An Indexed Bibliography, 1971-1980—The scientific literature on selected herbs, and aromatic and medicinal plants of the temperate zone*. Archon Books, Hamden, CT. 770 p.
11. Thompson, R. Campbell. 1924. *The Assyrian Herbal*. Luzac, London. 294 p.
12. Thorwald, Juergen. 1962 *Science and Secrets of Early Medicine: Egypt, Mesopotamia, India, China, Mexico, Peru*. Thames and Hudson, London. 331 p.
13. Trease, George Edward. 1964. *Pharmacy in History*. Baillière, Tindall and Cox, London. 265 p.
14. Urdang, George. 1948. The origin and development of the essential oil industry. In Ernest Guenther, ed. *The Essential Oils*. Vol. 1. Van Nostrand, New York. pp. 3-13.



