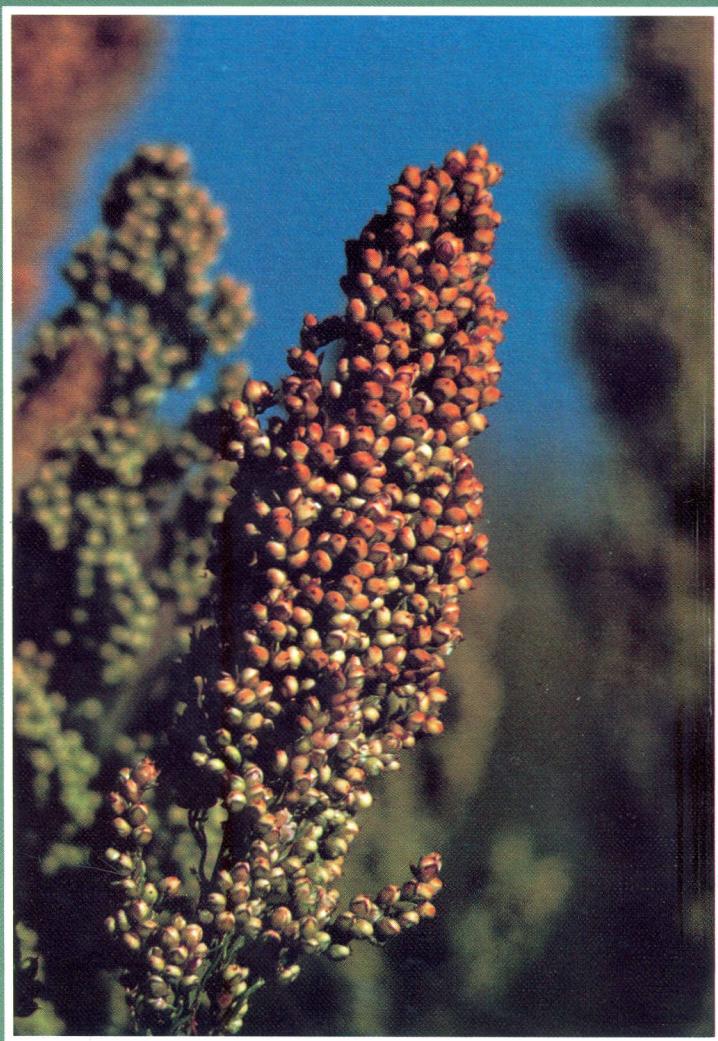


SORGHUM AND MILLETS

Chemistry and Technology



David A. V. Dendy, editor

CONTENTS

1. Sorghum and Millets: History, Taxonomy, and Distribution.

L. R. HOUSE, 1

Introduction, 1

Sorghum, 1

History • Taxonomy • Distribution

Pearl Millet, 3

History • Taxonomy • Distribution

Foxtail Millet, 4

History • Taxonomy • Distribution

Finger Millet, 6

History • Taxonomy • Distribution

Proso, 6

History • Taxonomy • Distribution

Little Millet, 7

Taxonomy • Distribution

Barnyard Millet, Sawa, 7

History • Taxonomy • Distribution

Kodo Millet, 8

History • Taxonomy • Distribution

Teff, 9

History • Distribution

Fonio, 9

2. Sorghum and the Millets: Production and Importance.

D. A. V. DENDY, 11

Introduction, 11

Sorghum, 17

The Millets, 20

Millet Consumption as Food • Millets for Feed

Forecast for Sorghum and the Millets, 25

3. Agronomic Principles.

L. R. HOUSE, M. OSMANZAI, M. I. GOMEZ, E. S. MONYO,
and S. C. GUPTA, 27

Introduction, 27

Germ Plasm Resources • The Structure of the Seed

Genetics of Sorghum Grain Characteristics, 29

Protein • Amino Acids • Carbohydrates • Tannins • Oil • Other Grain Traits

Forage Characteristics of Sorghum, 34

Brown Midrib • Other Forage Traits

Genetics of Millet Grain Characteristics, 35

Pearl Millet

Forage Characteristics of Pearl Millet, 38

Brown Midrib • Other Forage Traits

Agronomy: Nutritional Considerations, 39

Sorghum • Pearl Millet • Finger Millet

Agronomy: Management Aspects, 42

Crop Fertility • Moisture • Cropping Systems

Plant Development and Structure, 47

Sorghum • Pearl Millet • Finger Millet • Foxtail Millet • Proso • Kodo Millet • Little Millet

Sorghum Diseases, 53

Bacterial Diseases • Fungal Diseases • Viruses • Nematodes • Witchweed

Insect Pests of Sorghum, 59

Diseases of Pearl Millet, 62

Diseases of Finger Millet, 63

Insect Pests of Pearl and Finger Millets, 64

Conclusion, 64

4. Structure and Chemistry of Sorghum and Millets.

S. SERNA-SALDIVAR and L. W. ROONEY, 69

Introduction, 69

Classification, 71

Sorghum • Millets

Appearance and Genetics of Sorghum Grain, 72

Grain Morphology, 73

Sorghum • Millets

Chemical Composition, 81

Proximate Analysis • Carbohydrates • Proteins • Lipids • Minerals • Vitamins • Enzymes

Effect of Processing on Chemical Composition and Nutritional Value, 101

Decortication • Cooking and Parboiling • Malting • Fermentation

Antinutritional Factors, 108

Tannins • Phytic Acid • Cyanogenic Glycosides • Pearl Millet Goitrogens • Enzyme Inhibitors

5. Nutritional Properties of Sorghum and the Millets.

C. F. KLOPFENSTEIN and R. C. HOSENEY, 125

Introduction, 125

Sorghum, 125

Sorghum Carbohydrates • Sorghum Proteins • Protein Quality • Protein Digestibility •

Sorghum Lipids • Minerals • Vitamins • Nutritional Benefits of Composite Foods •

Antinutrients in Sorghum Grain

The Millets, 144

Pearl Millet • Proso Millet • Foxtail Millet • Finger Millet • Japanese Barnyard Millet •

Kodo Millet • Teff • Fonio Millet

Conclusion, 157

6. Storage of Sorghum and Millets: Including Drying for Storage, with Particular Reference to Tropical Areas and the Mycotoxin Problem.

J. A. McFARLANE, A. E. JOHN, and R. C. MARDER, 169

Introduction, 169

General Considerations, 170

Specific Notes on Storage, 173

Sorghum • Pearl Millet • Proso, *Setaria*, and *Eleusine* (Finger) Millets • Teff • Fonio

Drying for Storage, 176

Sorghum Drying • Millet Drying

Acquired Toxins, 180

Mycotoxins in Sorghum • Mycotoxins in Millets

7. Traditional Uses of Sorghum and Millets.

D. S. MURTY and K. A. KUMAR, 185

Introduction, **185**

Diversity of Traditional Sorghum and Millet Foods, **187**

Milling, **187**

Decortication • Grinding

Thick Porridges, **193**

Tô • *Ugali* • Quality Criteria

Thin Porridges, **198**

Ogi • Other Thin Porridges

Steam-Cooked Products, **199**

Couscous

Fermented Breads, **202**

Injera • *Kisra* • *Dosa*

Unfermented Breads, **206**

Roti • Tortillas

Boiled Ricelike Products, **208**

Alcoholic Beverages, **210**

Dolo

Nonalcoholic Beverages, **213**

Snack Foods, **215**

Special Uses, **215**

Popping • Parching • Scented Sorghums

Sweet Stalk or Chewing Sorghums

Future Research Needs, **217**

8. New Milling Technologies and Products: Whole Plant Utilization by Milling and Separation of the Botanical and Chemical Components.

L. MUNCK, 223

Scope, **223**

Sorghum and Millet Crops As Raw Materials for Milling and Separation Processes for Specific Products, **225**

Grain Preparation for Milling, **229**

Traditional Milling Techniques Compared With Mechanical Village Mills and Industrial Milling Plants, **229**

Milling Machinery, **235**

Historical Development in Sorghum-Eating Countries • Equipment for Dry and Semi-Wet

Milling of Sorghum and Millets • Roller Milling • Decortication

Dry and Semi-Wet Grain Milling Processes and Products, **249**

Wet Milling of Sorghum, **253**

Whole Sorghum Plant Milling and Separation, **256**

Utilization of The Milled Products, **258**

Industrialized Countries • Developing Countries

The Future of Sorghum and Millet Technology as a Vehicle for Agro-Industrial Development, **273**

9. Lager Beers from Sorghum. L. HALLGREN, 283

Introduction, **283**

The Lager Brewing Process, **283**

Sorghum in Lager Beer Brewing, **284**

Sorghum as Brewing Adjunct, **285**

Laboratory Testing of Sorghum Brewer's Grits • Industrial Brewing with Sorghum Adjunct

Malting of Sorghum, 293
Mash Filtration, 294
The Future, 295

10. Opaque Beers. K. H. DAIBER and J. R. N. TAYLOR, 299

Introduction, 299
Ingredients, 299
Sorghum Malts • Millet Malts • Adjuncts
Brewing Technology, 309
Souring • Cooking • Mashing • Straining • Fermentation • Millet Beers
Beer Quality, 316
Quality Specifications • Nutritive Value
New Developments in Opaque Beer, 318

11. Sorghum and Millets for Forage and Feed.

P. J. BRAMEL-COX, K. A. KUMAR, J. D. HANCOCK,
and D. J. ANDREWS, 325

Introduction, 325
Sorghum, 326
Sorghum Forage • Sorghum Grain
Pearl Millet, 339
Utilization • Crop Management • Breeding and Genetics
Minor Millets, 351
Utilization • Crop Management • Breeding and Genetics
Conclusion, 354

12. Sweet Sorghum Substrate for Industrial Alcohol.

R. E. SCHAFFERT, 365

Introduction, 365
Development of Sweet Sorghum Cultivars in Brazil, 366
Breeding Methods for Sweet Sorghum Improvement • Minimum Quality Requirements •
Culture Management • Minimum Alcohol Yield • Determining PIU • New Cultivars
Conclusions, 370
Recommendations, 375

13. Quality Evaluation and Trading Standards.

D. R. SHIPMAN and M. H. EUSTROM, 375

Introduction, 375
Marketing, 376
Grain Standards, 376
Sampling, 378
Sampling Variability • Sampling Methods and Devices
Inspection Process, 386
Sorghum Classes • Physical Condition • Grading Accuracy
Millet, 394

Index, 397