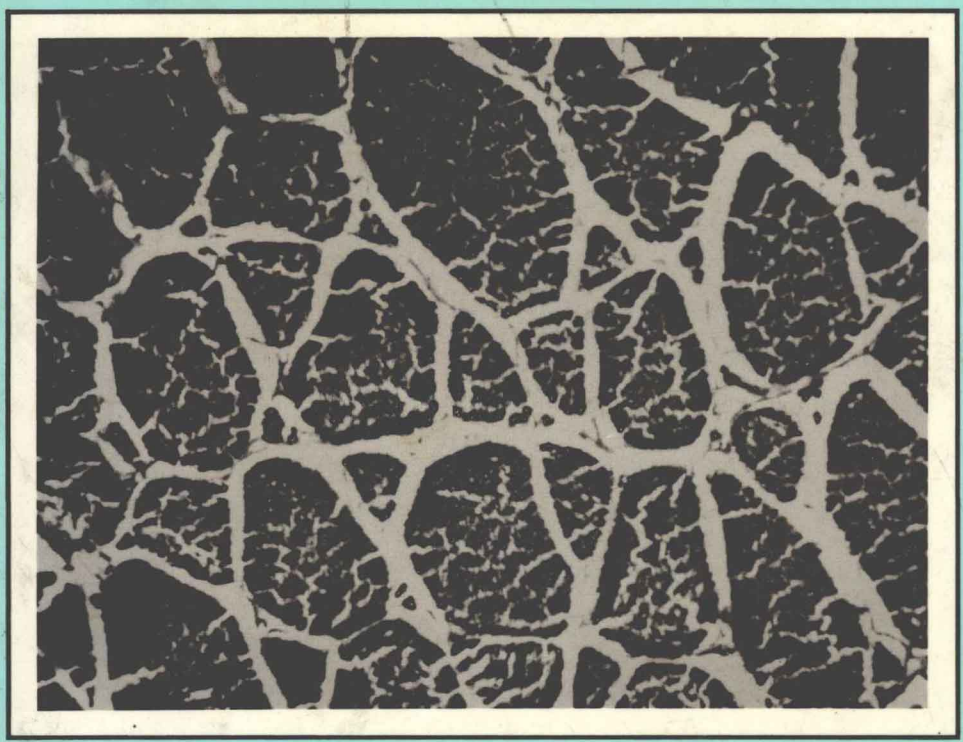
SEAFOOD
Effects of Technology on Nutrition



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MARCEL DEKKER, INC. **New York and Basel**

Library of Congress Cataloging-in-Publication Data

Pigott, George M.
Seafood: effects of technology on nutrition / George M. Pigott, Barbee W. Tucker.
p. cm. -- (Food science and technology; 39)
Includes bibliographical references.
ISBN 0-8247-7922-3
1. Seafood. 2. Fisheries processing. I. Tucker, Barbee W. II. Title. III. Series.
TX385.P54 1990
664'.949--dc20 90-3164
CIP

This book is printed on acid-free paper.

MARCEL DEKKER, INC.
270 Madison Avenue, New York, New York 10016

Current printing (last digit):
10 9 8 7 6 5 4 3 2 1

PRINTED IN THE UNITED STATES OF AMERICA

SEAFOOD

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Foreword

It is refreshing to find a book such as this that provides a new approach by relating a detailed discussion of handling and processing methods to the nutritional value of food. This is particularly true when the food involved is fish. While there undoubtedly are similar needs to relate processing and handling of agricultural foods to nutrition, the need is much greater when looking at seafoods, especially fish caught in the wild. With agricultural products, most of the factors in growing the particular food product are under the control of the grower, who can provide, for example, proper nutrients in the form of fertilizer. Contrasting to this is the complete lack of such control when fish are taken in the wild, where nutrients picked up by the fish are also completely devoid of control.

The nutritive value of such fish is consequently not subject to control by those who catch the fish. Furthermore, as compared with other food industries, the very large variety of many small processors in the fishing industry may use quite different processing methods. Thus we see that it is of considerably more importance, when one wants information on nutritive value of fish, that detailed information be available on aspects of food technology involved in catching and processing than is the case with growers of agricultural foods.

As described by the authors, this book is aimed at an audience with a very wide range of backgrounds, much greater than is the case with most readers of existing references on nutritional properties

of foods other than fish. It is, therefore, of considerable value that the authors have provided an unusually complete index where readers having very wide and differing backgrounds can readily locate the material in which they are interested.

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Preface

Over many years, as our experience in both academic and commercial phases of the food industry has broadened, we have felt that there is an artificial interface between nutrition and technology. The broad definitions of nutrition, (1) the process by which an organism takes in and assimilates food, (2) anything that nourishes: food, and (3) the study of diet and health, are indeed qualitative. The quantitative evaluation of foods that we eat and feed our animals and a review of the resultant biochemistry of the many metabolic reactions that occur when food is consumed are necessary before nutrition can have a truly meaningful value for our lives on this planet.

It is obvious that this more quantitative definition of nutrition is paramount to the research, evaluation, and marketing of foods. The portion of nutritive components present in a food, the form or classification of these components, the stability of the components prior to ingestion, and the geometry and chemical structure of various components indeed dominate all activities related to scientific and lay considerations of "diet and health." However, these factors are all dependent on the technology and commercial practices of growing, harvesting, transporting, storing, processing, packaging, and distributing of foods.

The nutrient form and composition of agricultural crops and animals ready for slaughter or harvest can vary significantly with farming practices, geography, and climate. An even more diverse situation occurs with wild plants and animals that are hunted, harvested, or captured for food. However, with the worldwide

domestication of agricultural crops and land animals, fish and shellfish are the only significant wild sources of food that are hunted and harvested on a large scale today. Since the sustainable world resource of wild fish is reaching or has reached its maximum, major increases in this food resource must come from the practice of aquaculture, or "fish farming."

For some time we have felt that references and textbooks concentrating on the composition and nutritive value of foods should combine nutrition and technology. That is, the technological practices as related to growing and preparing food products should be considered as to their effects on the final nutritive value of the marketed item. Although in the academic area the authors specialize in the application of basic scientific and engineering principles to the overall food industry, the entire subject of food and the effect of technology on nutrition cannot be covered adequately in one text. Hence, since much of our academic research and commercial interests centers on the seafood industry, we decided to concentrate on this area in the present volume.

It is difficult to find one word to define edible animals and plants from the aquatic environment. "Seafood" denotes food from the sea but does not give adequate due to freshwater plants and animals. Furthermore, fish, molluscs, and crustacea are all found in both marine and freshwater environments. Often, when referring to all edible animals from aquatic environments, we have used "fish" as the all-encompassing term to denote those aquatic animals that are commercially harvested. We also use "seafood" to apply to both plants and animals from all aquatic environs. For this we appologize to the aquatic biologists who must maintain a strict accounting of the family, genus, and species for the plant and animal worlds.

This book is intended for a widely diverse audience ranging from those studying the science and technology of fishery products and the related nutritional value of these products, or wishing to understand how the nutrients in fishery products differ from those in other foods, to those interested in a specific reference. For example, those interested in such subjects as omega-3 fatty acids in fish oils as related to health and disease, formulated foods from surimi, or smoking and drying technology can find specific information by referring to the index.

We have followed a logical chapter sequence from fishery resources through harvesting and capturing methods to handling and processing techniques, always relating each of these major topics to the effects on the nutritional value of the final marketed product. Brief discussions on the important areas of aquaculture and seaweeds, not covered in depth in the text, are presented in the appendixes.

We hope that this book not only will be of value to the reader with a particular interest in the nutrition of seafoods but will encourage the inclusion of the effects of technology and commercial practices in future books dealing with the nutrition of all foods.

We wish to express our gratitude to Maurice E. Stansby for his critical review of this manuscript and for providing its Foreword. We are delighted that he agreed to make this contribution as he is the "godfather" of fishery technology, an esteemed scientist, and a 1988 recipient of the President's Award for Distinguished Federal Civilian Service. Mr. Stansby is retired but still very active with National Marine Fisheries Service and was really the first scientist in this century to promote the use of fish oil for cardiovascular health.

George M. Pigott
Barbee W. Tucker

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Food from the Sea

I. INTRODUCTION

Humans have been eating seafood since the beginning of recorded history. Ancient Egyptians fished both the Nile and the Mediterranean and practiced pond culture. Fish was their most reliable protein food. The ancient Greeks used fish and shellfish extensively, both fresh and salted. They developed delicate sauces and herbs that were popular additions to the fish course. Salted dried fish, a stabilized all-important source of protein, has been credited with allowing the expansion of Europe. Dry fish became particularly important when the Roman church banned the eating of meat on Fridays and during Lent.

Archeological evidence indicates that seafood played an important role in the diets of early Americans (10,000–3500 years ago) living in what is now the southeastern United States. Shellfish residue heaps, bone fish hooks, and stone weights that may have been used on fishing nets have been found. The more sedentary Native Americans who followed also utilized seafood as well as meat and crops. By colonial times seafood was not only of major importance in the diet, but various methods of preservation (drying, salting, pickling, and cooling) were in wide use. Salted dried cod, the first export back to England, was produced much like that described in Egyptian hieroglyphics. Sun-dried and smoked salmon was a staple in the diet of the American Northwest Indians and Eskimos (Jerome, 1981).

About 1863, artificial freezing of fish (salt and ice method) on a commercial basis began in the United States, particularly in the Great Lakes region. By 1880, commercial freezing of fish became common in the United States, and it was an important industry by 1900. After World War II, frozen prepared foods such as fish sticks and breaded shrimp were marketed. Unfortunately, the technology then did not produce a top-quality product, and the frozen fish industry is only now overcoming a negative consumer image.

Although seafood has been eaten by humans for such a long time, there is little data about world seafood catches or harvests before the turn of the century. Furthermore, records are even more scanty about the densities or amounts of fish, shellfish, and plants that can be harvested from the ocean without upsetting the ecological balance of nature. These thoughts must be prevalent if one considers the increasing nutritional interest in fishery products. If the consumption of fish continues to increase, as is the case of any food product, something must be known about the life history of the raw material.

One may ask, "Why is all of this necessary when we just want to know about the nutritional factors involved with the eating of the product?" Herein lies the basic problem involved with all food products. The nutritional components known as proteins, carbohydrates, lipids (fats and oils), vitamins, and minerals are chemical compounds essential to the growth and health of a living body. The nutritional composition of foods is affected tremendously by the conditions under which they grow or are cultivated. Consider plants in the field. The type and amount of available nutrients (fertilizers, water, and air) help determine the composition of that plant or its products. The factors that vary from farm to farm and country to country result in the same agricultural food products having varying water content, solids content, solubility of certain constituents, shelf life (keeping quality before spoilage makes a product inedible or dangerous to eat), and many other factors that are not considered while shopping in the supermarket.

Major efforts are made by the entire food industry to standardize, as closely as possible, farming practices. This is to give consumers confidence in knowing the nutritional value of their food. Even so, under the best of conditions there are variations in the composition of any given food grown in different areas or by different people.

Now consider food from the sea, where there are many more complicating environmental factors than found on land. Animals move in the water, and the water moves past the animals and plants. Water, continually varying in composition, carries the food that