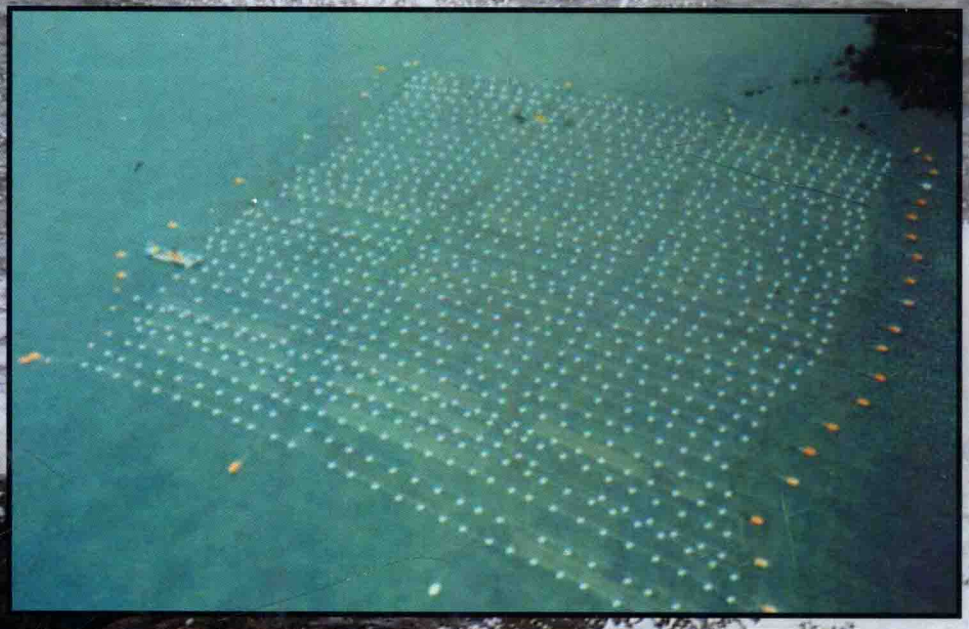
PORPHYRA

Harvesting Gold from the Sea

Ira A. Levine
Dinabandhu Sahoo



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Preface

The intent of this book is to offer a primer to any individual, family, village cooperative, NGO, state, federal funding agency, or corporation that wishes to introduce *Porphyra* (known as Nori in Japan) farming as a socio-economic development driving force. This effort is not intended to be a textbook on *Porphyra* biology but a reference tool for nori cultivation from the conchocelis culture system through blade harvest and primary processing. Our hope is to provide aquaculture extension agents a teaching guide for nori cultivation. This guide will provide step-by-step instruction for the assembly of a nori production system, care, maintenance, harvesting, and product preservation. The nori training course is one step in the support system necessary to recruit, train, and assist the formation of individual and cooperative nori growing concerns.

Farming of seaweeds in general and nori in particular represent a sustainable alternative to coastal subsistent fishing villages; increasing disposable income for the fisherman while decreasing the ecological damage that certain fishing practices exert on local environments. The historical organization of the family farm, village cooperative, or emerging corporate nori operations all represent both ecological and sustainable opportunities. With proper site selection, nori farming represents no threat to coral reef ecosystems.

The introduction and organization of nori farming has many examples to build upon. There are countless examples of well-established nori farming cooperatives, based on long-standing fishery cooperatives or village organized efforts. Unlike seaweed farming for phycocolloid extraction, "buying stations" are replaced by nori auctions or direct sales to nori marketing companies. Prices are a function of annual harvest yields and sheet quality. Farmer's income varies significantly as a function of the farm size, quality of cultivation site, and farmer's ability to match the art and science of algal farming. Nori cultivation has certain advantages over other forms of mariculture as it does not require large amounts of capital investment. Unlike other aquaculture crops, nori reaches a harvestable stage in several weeks as compared to years for fin and shellfish industries.

Fishing village receptivity to adopting algal farming as a new commercial pursuit is enhanced by the presence of, or communication by, successful algal-farming villages or entrepreneurs; availability of experienced extension agents with nori farming training courses; and the support of commercial or academic community. Fishermen can make good aquaculturists but they need training and a mindset shift. Commercial capture is philosophically different from husbandry. Seaweed farms take daily care and attention to detail. Team work and cooperation are tantamount to success.

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Dinabandhu Sahoo

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Ira A. Levine
Dinabandhu Sahoo


전남김
全南産の海苔
JeonNam Laver
무공해 자연식품 전남 김은
맛과 영양도 최고입니다.
乾海
岩海苔
돌김

Contents

1 Introduction

Figure 1. A Korean *Porphyra* advertisement. (Courtesy: D. Sahoo, India)

INTRODUCTION

Porphyra, a red seaweed or red marine algae is one of the most commercially important crops. This sea plant or sea vegetable can be called a wonder plant and one of the best gifts of nature. The plant is eaten either in dried or processed form all over the world. Today this plant is a multibillion dollar industry and can be called "Gold from the Sea" whose annual food value approaches US$ 2 billion. In fact one sheet of *Porphyra* weighing approximately 3 grams can cost up to US$ 10 and the handmade "Emperor's Nori" can reach US$ 15 per sheet. The 2008 harvest data reveals approximately 21.6 billion nori sheets were processed and the demand annually increases as the awareness of its flavor and nutritional value grows.

Porphyra, commonly known as: **Laver** – UK, USA, Canada; **Karengo** – New Zealand; **Kim** – Korea; **Nori** – Japan (most commonly referred to); **Purple Laver** – Britain and Ireland; and **Zicai** – China (Figure 1), has been recognized as an important source for food and medicine since its earliest recorded use by Chi Han in China in 300 B.C. Today, the Japanese, Chinese, Koreans and other people of Asia and the western Pacific continue to value nori as an integral part of their diet (Figure 2).

Nori contains high levels of protein (25-50%), vitamins (greater percentage of Vitamin C than in oranges), trace minerals, and dietary fiber (Table 1) (Noda, 1993; Sahoo, 2000; McDermid

Figure 2. Roasted *Porphyra* sheet with the United Kingdom and United States' traditional name of "Laver" used on the packaging. (Courtesy: D. Sahoo, India)

and Stuerck, 2003). The plant contains 17 types of free amino acids including taurine, which controls blood cholesterol levels (Tsujii *et al.*, 1983). Nori tea is actively relied on in the treatment of stomach cancers and ulcers whereby the Chinese refer to it as the happy gift from the sea.

Table 1. *Porphyra:* nutritional constituents per 100 grams fresh weight.

Nutrients	Amount present in *P. abbottae*
Food Energy (K (Cal)	279
Protein (g)	24.2
Fat (g)	1.4
Carbohydrate (g)	58.0
Crude fiber (g)	25.2
Ash (g)	16.1
Thiamine (mg)	0.37
Riboflavin (mg)	1.79
Niacin (mg)	6.7
Vitamin C (mg)	11.6
Vitamin A (Retinol equivalents)	263
Calcium (mg)	230
Phosporus (mg)	474
Sodium (mg)	3300
Potassium (mg)	3140
Magnesium (mg)	623
Copper (mg)	1.7
Zinc (mg)	1.7
Iron (mg)	10.5
Manganese (mg)	1.6

(Courtesy: D. Sahoo, India)

2 Value and Quality

Porphyra is one of the most valued maricultured seaweeds in the world (Arasaki, 1982; Miura, 1975; Okazaki, 1971; Oohusa, 1993a, b; Tseng and Fei, 1987) with total global sales exceeding U.S. $ 1.5 billion. In 2008, approximately 21.6 billion sheets (~ 65,000 dry metric tons or 1,810,000 wet metric tons) of *Porphyra* were maricultured.[1] The three major nori farming countries; Japan, Korea, and China produced 8,980,000,000, 8,600,000,000, and 4,000,000,000 sheets of nori in 2008, respectively. This number principally focuses on nori as a food product. The nori market growth potential is significant due to its utilization diversity but its use as a traditional holiday gift staple has declined due to changing economic demographics. Absolute global nori harvest and utilization data is challenging to find due to its use as a component ingredient, e.g. recipes, vitamins, neutraceuticals, cosmeceuticals, hair products, and dyes.

The Japanese originally imported nori from

Figure 3a. Ueno, Japan Nori shop with full range of quality products ($ 1.00-70.00 per package). (Courtesy: I.A. Levine, USA)

China and have become nori connoisseurs and dominate its global cultivation and marketing. The Japanese people have integrated many different applications for the sea vegetable into their daily lives and have established a rigorous set of standards by which to evaluate nori grade and quality. Nori, like cigars, can range in price from a minimum of $ 0.03 per sheet (anything less is destroyed to prevent price devaluation) to over $ 10.00 per sheet (Figure 3a).

The price at auction and subsequently at the retail level is established through a highly detailed rating system. Japanese nori is rated from grades 1-155 by one of the country's ~ 200 official nori grading officials and the farmer's sheet ratings are the basis for biding at the auction. Korean and Chinese nori are not subjected to equivalent grading rigors. Currently, they are graded from A-F by the producer who typically distributes the harvest to nori marketing companies. The grade and quality of the nori ultimately determine its final use. The highest quality nori is set aside for consumption while the lowest qualities are alternatively used as pet foods of cosmeceutical ingrediently.

Figure 3b. Nori products available in Korean market. (Courtesy: D. Sahoo, India)

3

Uses of *Porphyra*

FOOD

Dried nori sheets are packaged and are available throughout retail distribution markets and normally purchased by homemakers or cooks (Figure 4) and hand toasted over a stove or hotplate to guarantee freshness of the crispy sheet. The toasted nori sheet is offered with rice at each meal throughout the day.

Toasted or roasted nori sheets are commercially prepared at the nori marketing company's processing and packaging factories. The purchased dried nori sheets, stored in temperature controlled warehouses, are unpacked, redried and prepared for roasting. The sheets are rapidly run through a roasting conveyor system, cooled and immediately sealed in the retail packaging. The newly roasted nori is packaged

Figure 4. Dried nori sheets available in Japanese market. (Courtesy: D. Sahoo, India)

into cases and shipped to several distinct market distribution centers (Figure 5a). The roasting factories have developed flavoring processes and numerous sheet sizing configurations aimed at the fast food and younger generation markets (Figure 5b). Alternatively, Chinese *Porphyra* preparation consists of a flattened cake of nori blades made without the use of a sheet making machine, which is used as a flavor ingredient in soups.

The infusion of Chinese nori to the world market in the last 20 years has resulted in a significant drop in the retail sheet price. Ten sheets of Chinese nori in an oriental grocery store range from $ 1.60 to 2.00. Korean nori is priced in the $ 2.50 - 3.50 per ten-sheet package. Japanese nori, although difficult to locate in retail markets, is up to $ 1.00 per sheet and is usually distributed to the higher end sushi bars and Japanese restaurants in 50 to 100 sheets packages. A private US-based marketing report identified four primary retail distribution outlets for nori; natural food stores, gourmet/specialty food stores, supermarkets, and Asian/oriental groceries with > 25 brands of nori sheets penetrating these market segments.

The world nori market is currently dominated by Zen Nori (Socio-economics society of nori culture development) along with Zengyoren (National Federation of fisheries Co-operative Associations) the national nori farming and marketing cooperatives and the large nori marketing companies: Koasa Trading Co., Ltd., Yamamoto Noriten Co., Ltd, Yamamotoyama Co., Ltd, Ohmoriya Co., Ltd., Yamagataya Nori Co., Ltd, Takaokaya Co., Ltd. These companies represent the overwhelming majority of global nori sheet purchases.

PIGMENTS

Porphyra has been the principal commercial source of the fluorescent pigment r-phycoerythrin (Figure 6). R-phycoerythrin is utilized as a fluorescent "tag" for immunofluorescent

Figure 5a. Typical nori counter filled with different delicious delicacies. (Courtesy: D. Sahoo, India)

Figure 5b. Newly developed rice and nori triangular snack packaging. (Courtesy: D. Sahoo, India)

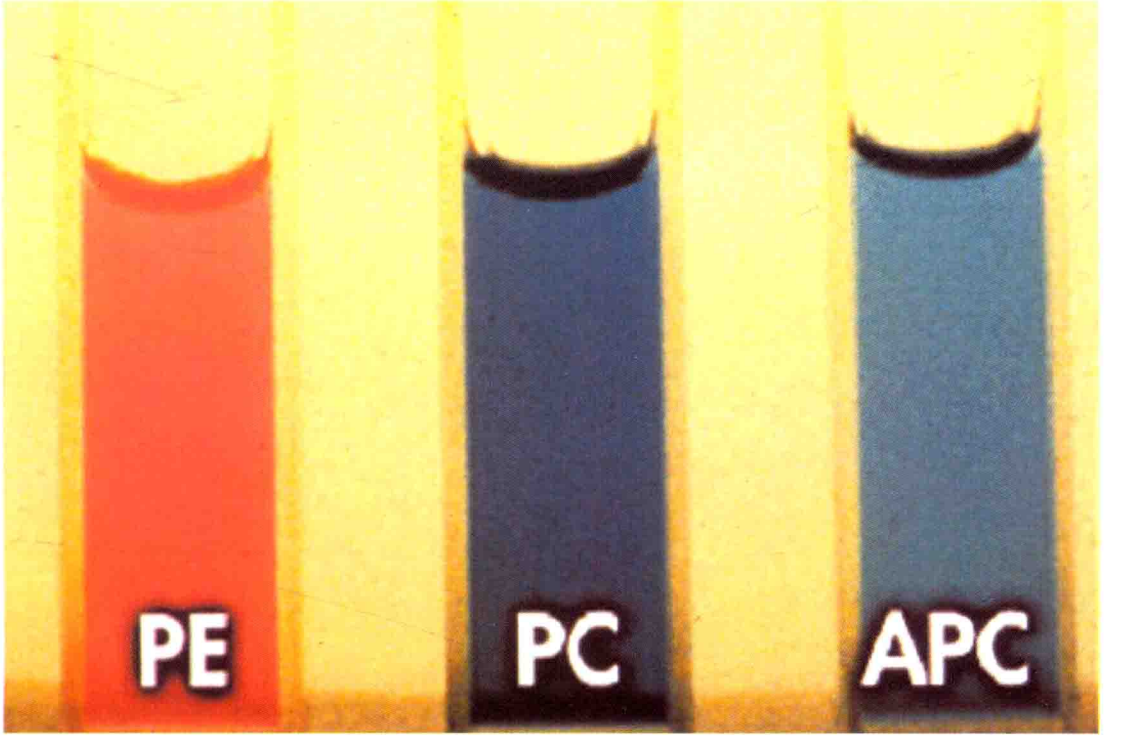

Figure 6. *Porphyra* dyes: Phycoerythrin PE, Phycocyanin PC, & Allophycocyanin APC. PE used in fluorescent labeling. (Courtesy: I.A. Levine, USA)