CARRAGEENAN AND AGAR

Indonesia, beyond the land of cottonii and gracilaria
SWISS IMPORT PROMOTION PROGRAMME

SIPPO, the Swiss Import Promotion Programme is a mandate of the State Secretariat for Economic Affairs (SECO) within the framework of its economic development cooperation. It helps SMEs in selected partner countries and sectors to export their high-quality products to the European Union, Switzerland and other EFTA countries. SIPPO ensures qualified trade contacts are established between SMEs from partner countries and the Swiss and European import economy, by providing information, training and matchmaking services. SIPPO works in close cooperation with local business support organisations in order to guarantee a consistent and sustainable knowledge transfer for SMEs.

MINISTRY OF MARINE AFFAIRS AND FISHERIES
Foreword

The publication “Indonesia, beyond the land of cottonii and gracilaria” serves as an initial reading to understand the basics about seaweed production and processing in Indonesia. It gives purchasers and importers of carrageenan and agar an overview of main stakeholders and suppliers.

The updated report provides the reader with an insight into the supply chain of processed seaweed products and should lead to a better understanding of the Indonesian seaweed industry. Aimed at fostering trade relationships between European purchasing companies and Indonesian suppliers, the publication is an intervention of the Swiss Import Promotion Programme (SIPPO) in collaboration with the Ministry of Marine Affairs and Fisheries (MMAF) to disseminate market information.

The European Union is the world’s largest single market with over 500 million consumers and a GDP of 25,000 Euro per capita. It is a good region to do business. Transparent rules and regulations, a secure legal framework and a trade policy fostering sustainable development offer trading partners an opportunity for economic growth. However, the EU market is also a very challenging place to access, with thousands of enterprises competing for share, on the one hand, and strict market access standards set by a selective consumer base.

For consumers in Europe sustainable economic development, including social and environmental aspects, takes on a major importance. When it comes to food, people would like to know how it has been produced and under which circumstances. It’s time to rethink. For example about the impact of volatile energy prices on supply chains, about the carbon footprint of transportation. With costs of transport and emissions becoming more and more key constraining factors for global food supply chains, long-term strategies and a clear vision are needed. Indonesia has that vision. The archipelago country is a leading producer of seaweed, the raw material for carrageenan and agar. Until 2020 half of the seaweed production will be processed domestically. Processing carrageenan and agar at the source – therefore in the country where the raw material comes from – makes not only sense. It is a key factor to success. Not only for Indonesia and its fast growing economy. But also for European importing companies and the strong market drive for new sustainable business models.

Indonesia will be become more and more important when it comes to supplying Europe with agar and carrageenan. At this moment in time, little information about the agar and carrageenan supply chain and its players in Indonesia is available. This publication is the first step for importers in Europe to gain more knowledge about the Indonesian seaweed industry and to find the right suppliers in Indonesia.

We wish you a pleasant reading!

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Director Market Access and Promotion
Ministry of Marine Affairs and Fisheries (MMAF)
# Table of contents

1. **INTRODUCTION**

2. **SEAWEED PRODUCTION IN INDONESIA**
   - 2.1 Seaweeds as products of aquaculture
   - 2.2 Classification of seaweed
   - 2.3 Seaweed cultivation
   - 2.3.1 Seaweed cultivation methods
   - 2.3.2 Seaweed reproduction methods
   - 2.4 Global seaweed production
   - 2.4.1 Global seaweed production volumes
   - 2.4.2 Global seaweed production species
   - 2.4.3 Major producing countries
   - 2.5 Seaweed cultivation in Indonesia
   - 2.5.1 Comparative advantages
   - 2.5.2 Seaweed production areas in Indonesia
   - 2.5.3 Seaweed production potential in Indonesia
   - 2.5.4 Seaweed crops in Indonesia
   - 2.6 Quality, traceability and standards of seaweed in Indonesia
   - 2.7 Social and economic dimensions of seaweed farming in Indonesia

3. **SEAWEED PROCESSING IN INDONESIA**
   - 3.1 Agar
   - 3.1.1 Raw material for agar production
   - 3.1.2 Current processing technologies of agar
   - 3.1.3 Applications of agar
   - 3.2 Semi-refined and refined carrageenan
   - 3.2.1 Raw material for carrageenan production
   - 3.2.2 Current processing technologies of carrageenan
   - 3.2.3 Applications of carrageenan
   - 3.3 History of Indonesian seaweed industry and future outlook

4. **EXPORTER PROFILES**
   - 4.1 Agarindo Bogotama
   - 4.2 Agar Swallow
   - 4.3 Algalindo Perdana
   - 4.4 Cahaya Cemerlang
   - 4.5 Galic Artabahari
   - 4.6 Hydrocolloid Indonesia
   - 4.7 Gumindo Perkasa Industri
   - 4.8 Phoenix Food
   - 4.9 Surya Indoalgas
   - 4.10 Wahyu Putra Bimasakti

5. **LIST OF ORGANISATIONS**
   - 5.1 Ministry of Marine Affairs and Fisheries (MMAF)
   - 5.2 Indonesian Seaweed Industry Association (ASTRULI)
   - 5.3 Indonesian Association of Seaweed (ARLI)
   - 5.4 State Secretariat for Economic Affairs (Seco)

6. **LIST OF ASTRULI MEMBERS**

7. **LIST OF TABLES**

8. **LIST OF ABBREVIATIONS**

9. **REFERENCES**
INTRODUCTION

Indonesia – one of the global players in seaweed production – is increasingly focusing on in-country processing of the raw material. Short supply chains and state-of-the-art processing units guarantee high quality hydrocolloids such as agar (E-406), semi-refined carrageenan (E-407a) and refined carrageenan (E-407).
Indonesia seems to be a hidden gem when it comes to hydrocolloids. Since years the country is a leading producer of the raw material for agar, refined and semi-refined carrageenan. For decades most of the raw material produced in Indonesia has been exported. Only a few players were involved in adding value in Indonesia and processing dried seaweed to agar and carrageenan domestically.

In the last couple of years, the processing industry in Indonesia became very dynamic and several new players got involved in processing seaweed to hydrocolloids. In addition, the Indonesian processing industry is more and more focusing on exporting agar and carrageenan.

The shift from exporting dried seaweed as a raw material to exporting processed agar and carrageenan from Indonesia will have an impact on global supply chains for hydrocolloids. Importers of agar and carrageenan in Europe will, for example, have to rethink their supply chains and mitigate risks since other processing countries won’t be in the position to have unlimited access to the raw material anymore.

At the end, importers of hydrocolloids benefit from this shift. A simplified and shorter supply chain guarantees not only a better product traceability and a lower carbon footprint. Indonesian processors are also in a better position to work with seaweed farmers on quality standards and cultivation practices, thus ensuring a stable high-quality hydrocolloid product. In addition, many Indonesian processors have established long-term relationships with seaweed farmers in order to avoid price instability which puts especially coastal communities in remote areas at risk. The need for more sustainability in the seaweed industry is also reflected by the decision of the Marine Stewardship Council (MSC) to include various groups of seaweeds in its sustainability standard beyond wild-capture fish and invertebrate fisheries.

Indonesia is pushing hard to become the one-spot location for seaweed production and processing. The tropical country with its over 17,500 islands and the unique geographical situation to farm seaweed, is developing essential infrastructure in remote areas and reducing transport costs for the raw material within Indonesia. Several initiatives from the Ministry of Marine Affairs and Fisheries (MMAF) to process seaweed domestically are bearing fruit. More and more state-of-the-art processing units are established in Indonesia. MMAF has also invested heavily in its National Seaweed Research Centers to optimize seaweed cultivation and standardize crop yield and final gel strength. Additional measurements of the Indonesian seaweed industry to position the country as the number one in seaweed production and processing, are among other things working on international food safety standards, improving product quality and production efficiency. While some challenges still need to be overcome, the country can claim sustainability and security of supply. The eager plan to unlock Indonesia’s potential as a seaweed nation is already offering exciting opportunities for investors and purchasers alike.
The following chapter gives an overview of the different types of seaweed, the seaweed production and cultivation methods in Indonesia as well as information about production areas and the potential of seaweed farming in Indonesia.
2.1 Seaweeds as products of aquaculture

Aquaculture enterprises are firmly established as the foundation of global seaweed value chains. The Indonesian seaweed industry is based almost entirely on farmed macroalgae. This reflects a global situation where seaweed production is dominated by marine macroalgae cultivated both in marine and in brackish waters. According to FAO data, cultivation accounted for almost 96 percent of global seaweed production with algae collected from the wild accounting for a steadily diminishing percentage of production and currently accounting for 4 percent.

2.2 Classification of seaweed

Marine macroalgae, better known as seaweeds, are algae which – in contrast to microalgae or phytoplankton – are visible to the naked eye. Seaweeds can be classified according to their pigmentation, use or colloid content.

The four main groups of marine macroalgae are:

a) Red algae or Rhodophyta
b) Brown algae or Phaeophyta
c) Green algae or Chlorophyta
d) Blue-green algae or Cyanophyta

Whereas some of the green and blue-green algae can be used in the human food industry as vegetables or salad ingredients, the different types of brown and red algae are used in the human and pet food industry for its colloid content. Thus, seaweed from Rhodophyta and Phaeophyta is the raw material for the production of hydrocolloids. They are widely used in the food and non-food industry as thickeners, gelling agents and stabilisers.

The hydrocolloids which can be obtained from the different types of red macroalgae are agar and carrageenan. Different types of brown seaweed can be processed to alginate. Depending on the colloid content and therefore on the type of seaweed which is used for the production of hydrocolloids, also the division of marine macroalgae into agarophytes, carrageenophytes and alginophytes exists.

Out of seaweed, Indonesia is producing especially the following three hydrocolloids: Kappa carrageenan, iota carrageenan and agar. The raw material for these three hydrocolloids are mainly three different types of seaweed: Kappaphycus alvarezii, Eucheuma denticulatum and Gracilaria, which all classified as “red algae” or Rhodophyta. Table 1 shows the hydrocolloids and the scientific names and trade names of the respective raw materials.

<table>
<thead>
<tr>
<th>HYDROCOLLOID</th>
<th>SCIENTIFIC NAME OF MAIN RAW MATERIAL</th>
<th>GROUP</th>
<th>TRADE NAME OF RAW MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agar</td>
<td>Gracilaria</td>
<td>Rhodophyta</td>
<td>Graciliaria</td>
</tr>
<tr>
<td>Kappa carrageenan</td>
<td>Kappaphycus alvarezii or Eucheuma cottonii</td>
<td>Rhodophyta</td>
<td>Cottonii</td>
</tr>
<tr>
<td>Iota carrageenan</td>
<td>Eucheuma denticulatum or Eucheuma spinosum</td>
<td>Rhodophyta</td>
<td>Spinosum</td>
</tr>
</tbody>
</table>

Carrageenan is labeled according to the way it has been produced. There is a division in refined and semi-refined carrageenan.

<table>
<thead>
<tr>
<th>HYDROCOLLOID</th>
<th>E-NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refined carrageenan</td>
<td>E-407</td>
</tr>
<tr>
<td>Semi-refined carrageenan</td>
<td>E-407a</td>
</tr>
<tr>
<td>Agar</td>
<td>E-406</td>
</tr>
</tbody>
</table>

Table 1: Hydrocolloids and names of raw material

Table 2: Hydrocolloids and its characteristics
2.3 Seaweed cultivation

Marine macroalgae can easily be cultivated in coastal areas. Quite often, cultivation of tropical seaweed is conducted in shallow water close to the beach. Seaweed extracts the nutrients provided from the water. It is accounted for as non-fed aquaculture. Successful seaweed cultivation cannot take place close to big industrial zones or harbours. Remote areas with little pollution will provide a seaweed of better quality. Selecting an appropriate site, is a key factor to success. Influencing parameters are the following:

- **Water quality parameters:** Sufficient supply of nutrients, water salinity at 28–34 part per thousand (ppt), water temperature between 26–32 °C, pH level between 7–8.5, water movement (for *E. cottonii* slow to moderate water flow levels; *E. spinosum* moderate to strong water flow levels)
- **Climate:** Availability of sunlight, no storms, no strong winds
- **Oceanography and environmental aspects:** Substrates (for *E. cottonii* grows on sandy-corally to rocky substrates; *E. spinosum* can be cultivated on sandy-morally to rocky substrates), no big waves, free from pollution, away from big shipping lines

2.3.1 SEAWEED CULTIVATION METHODS

Different cultivation methods for *agarophytes* (*gracilaria*) and *carrageenophytes* (*E. cottonii* and *E. spinosum*) exist. The method which is used by the Indonesian seaweed farmer depends on costs for material involved, climate and tradition of use.

*Gracilaria* can be cultivated on lines, ropes or nets, in ponds or tanks, in open waters on the bottom of bays, reef flats or estuaries. The cultivation of *Gracilaria* in ponds, together with shrimp or other fish is quite successful in Indonesia. It is known as the mixed farming method. The impurities released from the fish, are used as nutrients by the seaweed.

For *E. cottonii* and *E. spinosum*, three different methods can be employed: Off-Bottom method, floating raft method and long-line method.

<table>
<thead>
<tr>
<th>CULTIVATION METHOD</th>
<th>OFF-BOTTOM METHOD</th>
<th>FLOATING RAFT METHOD</th>
<th>LONG-LINE METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental factors</td>
<td>Suitable method for sandy bottom of sea water or muddy sand water, shallow and clean water</td>
<td>Suitable method for cultivation areas with waves in deeper areas</td>
<td>Suitable method for calm areas</td>
</tr>
<tr>
<td>Description of method</td>
<td>Wooden stakes are driven into the sea bottom in a straight row. Between the stakes, ropes and seedlings are attached.</td>
<td>A raft made out of bamboo contains several ropes on which seedlings can be attached. The raft is secured with a sack of sand etc. Suitable method for cultivation areas with waves in deeper areas</td>
<td>A long rope is suspended by floaters such as empty plastic bottles. On that rope the seedlings can be attached.</td>
</tr>
</tbody>
</table>

In Indonesia, the long-line method is widely used due to its lower material costs and the ease of implementation. Seedlings can be attached to the ropes in different ways. Most commonly plastic strings – also known as tie-ties – are used. Small parts of them stay in the raw material and may not be detected before seaweed processing. Blue or black specks (depending on the original color of the plastic string) can be easily seen in a white powder. Taken into account, that the obtained processed seaweed product is intended for human consumption, it goes without saying that the food product should be plastic-free. Instead of tie-ties, other farming technologies such as the Made Loop method exists. For this easy to apply method the seedlings are attached to lines instead of plastic strings. To mitigate supply chain risks, purchasers should request from their suppliers that the raw material comes from tie-tie free farms.
2.3.2 SEAWEED REPRODUCTION METHODS

Basically, there are two different methods how to reproduce seaweed. In the vegetative reproduction process, one seaweed seedling is simply grown to an appropriate size for harvesting and then cut into small pieces. These pieces will be used as new seedlings for the next cultivation period. This type of reproduction method is the most common among Indonesian seaweed farmers.

The other method is known as generative process. The life cycle of red algae is divided in an alternation of generations, also known as metagenesis. In one generation, sporophytes can reproduce themselves by releasing spores which grow in the generative process described above. In the next generation, it is the gametophyte who becomes fertile, releases sperm and eggs that together form new sporotypes.

It takes approximately 45 days from seedling to harvest to obtain a high-quality raw material which gives a good gel strength. With new reproduction methods such as tissue-culture, this time can be reduced to 30 days.

2.4 Global seaweed production

The steady growth of the Indonesian seaweed production is a leading global trend. Seaweed production data are available from the Food and Agriculture Organization of the United Nations (FAO, 2012). Generally, accurate data for FAO figures are not collected from farm areas but based on best estimates of national fisheries and aquaculture organizations. Indonesian data are provided to FAO primarily through the Ministry of Marine Affairs and Fisheries (MMAF), which is known in Bahasa Indonesia as Kementerian Kelautan dan Perikanan (KKP).

2.4.1 GLOBAL SEAWEED PRODUCTION VOLUMES

FAO data from 2012 indicated that global seaweed production increased from over 3.7 million tons in 1990 to more than 19 million tons in 2010, with an average annual growth rate of the production volume of 7.4 % in the 2000s and 9.5 % in the 1990s. During that period the rate of growth in tropical regions, especially in Indonesia, tended to be higher than the rate observed in temperate regions (table 4). The estimated total value of farmed seaweed worldwide was estimated at US$ 4.4 billion for 2008 and at US$ 5.7 billion in 2010.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical</td>
<td>0.3</td>
<td>0.7</td>
<td>1.0</td>
<td>3.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Temperate</td>
<td>3.0</td>
<td>5.4</td>
<td>5.3</td>
<td>8.1</td>
<td>8.4</td>
</tr>
<tr>
<td>Unknown</td>
<td>0.3</td>
<td>0.8</td>
<td>2.9</td>
<td>2.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Global totals</td>
<td>3.7</td>
<td>6.9</td>
<td>9.3</td>
<td>13.5</td>
<td>19.0</td>
</tr>
</tbody>
</table>

Source: The State of World Fisheries and Aquacultures 2012, FAO

2.4.2 GLOBAL SEAWEED PRODUCTION SPECIES

The global production volume relies only on a number of species. As shown in table 5, global seaweed production is dominated by fewer than ten genera of seaweeds. According to FAO 98.9 % of world production in 2010 came two groups of tropical genera, three groups of temperate genera, and a mixture of tropical and temperate algae of various types not clearly identified in trade data.

Production of tropical seaweeds was mainly of the genera *Eucheuma*, *Gracilaria* and *Kappaphycus* whereas temperate seaweeds were mainly of the genera *Laminaria*, *Porphyra Saccharina* and *Undaria*. Almost all tropical seaweed production was of red algae (phylum Rhodophyta) whereas, except for *Porphyra*, the production of temperate regions was dominated by the “brown” algae (phylum Phaeophyta). The “unidentified and other” category was dominated by unclassified exports from China but also included a wide range of tropical and temperate macroalgae from all phyla of algae including the coralline algae and also the genera *Ascophyllum*, *Caulerpa*, *Gelidium*, *Sargassum* and *Ulva*. The category also included microalgae such as *Chlorella*, *Spirulina*, *Haematococcus* and several others. Indonesia was a significant contributor to the “unidentified” category.
Table 5: Global seaweed production by genus as millions of tons of fresh seaweeds

<table>
<thead>
<tr>
<th>GENERA</th>
<th>PHYLUM</th>
<th>TRADE NAME(S)</th>
<th>1990</th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucheuma &amp; Kappaphycus</td>
<td>Red</td>
<td>Spinosum &amp; Cottonii</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>2.4</td>
<td>5.6</td>
</tr>
<tr>
<td>Gracilaria</td>
<td>Red</td>
<td>Gracilaria</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Saccharina/ Laminaria</td>
<td>Brown</td>
<td>Japanese Kelp</td>
<td>2.0</td>
<td>3.9</td>
<td>4.1</td>
<td>4.4</td>
<td>5.2</td>
</tr>
<tr>
<td>Porphyra</td>
<td>Red</td>
<td>Nori/Laver</td>
<td>0.5</td>
<td>0.9</td>
<td>0.9</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Undaria</td>
<td>Brown</td>
<td>Wakame</td>
<td>0.4</td>
<td>0.5</td>
<td>0.3</td>
<td>2.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Unidentified</td>
<td>All</td>
<td>Other</td>
<td>0.3</td>
<td>0.8</td>
<td>2.9</td>
<td>2.0</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Source: The State of World Fisheries and Aquacultures 2012, FAO

2.4.3 MAJOR PRODUCING COUNTRIES

Indonesia is increasing its lead in tropical seaweed production. In terms of production volume Indonesia comes second place, behind China, among 31 countries and territories with algae production reported by FAO in 2010. In due course it is expected that Indonesian seaweed production will surpass that of China because China’s coastline suitable for seaweed farming is substantially occupied while much Indonesian coastline remains relatively under-developed.

Eight countries accounted for 99.6% of global seaweed production (table 6). Indonesia was the major producer of cultivated tropical seaweeds with 2010 production amounting to about 65% of the global total. Since 2010 Indonesia has increased this margin substantially and is now estimated to be over 73% of the global total. Based on Indonesian government sources even the most conservative estimates place 2014 production levels at more than 1.5 times levels observed during 2010.

Table 6: Millions of tons of fresh (live) seaweeds produced by major source countries during 2010

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>REGION</th>
<th>TONS</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>Temperate</td>
<td>11.1</td>
<td>58.4</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Tropical</td>
<td>3.9</td>
<td>20.6</td>
</tr>
<tr>
<td>Philippines</td>
<td>Tropical</td>
<td>1.8</td>
<td>9.5</td>
</tr>
<tr>
<td>RO Korea</td>
<td>Temperate</td>
<td>0.9</td>
<td>4.7</td>
</tr>
<tr>
<td>DPR Korea</td>
<td>Temperate</td>
<td>0.4</td>
<td>2.3</td>
</tr>
<tr>
<td>Japan</td>
<td>Temperate</td>
<td>0.4</td>
<td>2.3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Tropical</td>
<td>0.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Tropical</td>
<td>0.1</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Source: The State of World Fisheries and Aquacultures 2012, FAO

Indonesian production share has risen partly due to increased volumes of cultivated seaweeds and partly because of force majeure incidents in the Philippines where typhoon damage and armed conflicts have had negative impacts. This situation has forced the Philippines’ seaweed industry to become increasingly dependent on Indonesian raw material. During 2014, the Seaweed Industry Association of the Philippines (SIAP) made formal approaches to Asosiasi Rumput Laut Indonesia (ARLI) and to Indonesian government ministries to ensure availability of the equivalent of 500,000 fresh tons per annum of Kappaphycus spp. (cottonii) seaweeds as raw material to Philippines-based processors.
2.5 **Seaweed cultivation in Indonesia**

### 2.5.1 COMPARITIVE ADVANTAGES

Indonesia’s comparative advantages for tropical seaweed cultivation include the archipelago’s equatorial location; a relatively benign climate; vast areas of coastal reefs among about 17,500 islands; distribution of large populations along seashores; and minimal peace and order problems. Tropical seaweeds generally grow best between ten degrees of latitude north and south of the equator and virtually all Indonesian seacoast is within this zone. The Coral Triangle is home to more than 70% of tropical seashores and Indonesia accounts for about 65% of that total (table 7). Globally, Indonesia possesses almost half of tropical seashore area suitable for coastal aquaculture development.

Because of its equatorial location Indonesia is free of typhoons so the main *force majeure* risk is the occasional tsunamis that can impact all regions around the Pacific “ring of fire”. A 1992 tsunami in East Indonesia is the only one to have impacted seaweed farming significantly as of 2014.

Various sources estimate that the population of Indonesia is about 350 million people as of 2014 and about half of this population is close to seashores. Among seaweed growing areas there is a plentiful supply of actual and potential farmers in western and central regions but populations are sparse in potential farming areas of eastern regions such as Maluku, Papua and Nusa Tenggara Timor. In East Indonesia there are instances of communities being established by trans-migrants for the purpose of farming. Such movements can play a role in the expansion of seaweed production. In all seaweed growing regions as of 2014 there were no areas with severe peace and order problems that jeopardized farm production or prevented international business people from visiting production sites.

### Table 7

<table>
<thead>
<tr>
<th>A REGION</th>
<th>PERCENTAGE</th>
<th>B CT COUNTRY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral Triangle</td>
<td>71</td>
<td>Indonesia</td>
<td>65</td>
</tr>
<tr>
<td>Latin America</td>
<td>14</td>
<td>Philippines</td>
<td>15</td>
</tr>
<tr>
<td>West Africa</td>
<td>5</td>
<td>Solomon Islands</td>
<td>7</td>
</tr>
<tr>
<td>East Africa</td>
<td>4</td>
<td>Malaysia</td>
<td>6</td>
</tr>
<tr>
<td>Indian Ocean</td>
<td>3</td>
<td>Papua New Guinea</td>
<td>6</td>
</tr>
<tr>
<td>Pacific Oceania</td>
<td>3</td>
<td>Timor Leste</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Calculated from data in World Fact Book.

### 2.5.2 SEAWEED PRODUCTION AREAS IN INDONESIA

Seaweed farming is generally distributed among lesser-populated island groups of central and east Indonesia. These are regions where aquaculture in general and seaweed farming in particular is a welcome source of family income. Most Indonesian seaweed production is from eastern regions of the archipelago. The center of production is the large island of Sulawesi where all six provinces produce seaweed crops. Within the past five years the East coast of Kalimantan (Borneo) has also become a major and growing source. In regions extending from Madura through Bali and Nusa Tenggara Barat to Nusa Tenggara Timor have been seaweed producers since the dawn of the industry. The far eastern regions of Maluku and Papua are proving to be fertile regions for seaweed growth. All regions have substantial scope for expansion and the far-eastern regions are in their infancy as producing areas.

### 2.5.3 SEAWEED PRODUCTION POTENTIAL IN INDONESIA

In 2015, the population accounts for 7.3 Billion people. According to the United Nations report, “World Population Prospects: The 2015 Revision”, the world population of 7.3 billion is expected to reach 8.5 billion by 2030, 9.7 billion in 2050 and 11.2 billion in 2100. These projections indicate that all possible resources to meet the increasing demand of food and energy need to be explored. Seaweed represents an important raw material for the food industry. It can also serve as a source of biomass for energy production. Macroalgae are only using sunlight and nutrients from the sea. In the meanwhile they incorporate CO₂. It is a sustainable source. In addition, seaweed is labour-intensive to farm. According to the United Nations report, during 2015–2050 half of the world’s population growth is expected to be concentrated in nine countries: Indonesia being one of them.
2.5.4 SEAWEED CROPS IN INDONESIA

All seaweed production from Indonesia is based on genera that are indigenous to the archipelago but cultivars move freely among regions of Southeast Asia so it is impossible to definitively trace their origins. Most cultivars have been selected by farmers from natural populations but some are have passed through tissue culture laboratories of research institutions on their way to commercial development.

The predominant Indonesian seaweed crops are *Kappaphycus alvarezii* (cottonii of the trade) and *Kappaphycus striatus* (sacol of the trade). Virtually all production is sun-dried; then sold as raw material for the production of kappa carrageenan. At least 50% of *Kappaphycus* crops are exported to China; about 20% are processed by domestic processors and the balance is sold to carrageenan manufacturers in the Philippines and other countries. Carrageenan is similar in characteristics between the species but some processors differentiate between them. During early years of seaweed farming in Indonesia *K. alvarezii* cultivars of various origins dominated production volume but the *K. striatus* cultivar known as "sacol" is increasingly spreading throughout the archipelago. This spread is attributed to apparent resistance of the sacol cultivar to seasonal temperature impacts. The production of *Eucheuma denticulatum* (spinosum of the trade) accounts for at least 200,000 tons of fresh production per annum. It serves mainly as a source of iota carrageenan but an appreciable quantity is subjected to solar “bleaching” and sold for direct consumption as sea vegetables; mainly to China. Most spinosum is exported as raw, dried seaweeds (RDS) but production of semi-refined iota carrageenan by domestic processors is a growing trend.

The production of farmed *Gracilaria* species is mainly from ponds where it is often grown along with prawns and/or milkfish. Most of the crop is processed into agar by domestic processors. Crop production is estimated to be at least 500,000 wet tons per annum. Increased utilization of available pond areas would permit a major production increase. There are also opportunities to farm *Gracilaria* species in the sea.

Projects are underway in Indonesia to extend cultivation to genera of carrageenan, agar and other seaweeds in addition to the ones already developed. *Sargassum*, a “brown” seaweed that is harvested from wild populations, is being considered for farming. Also there is expanding cultivation of seaweeds as sea vegetables including *Caulerpa* and there are projects developing the production of several genera of microalgae. Indonesia is on track to satisfy much of the world’s growing need for algal biomass.

2.6 Quality, traceability and standards of seaweed in Indonesia

Seaweed quality varies widely among sources and it can range from the excellent to the unacceptable. Quality received by buyers is a reflection of their purchasing strategy. Full traceability to seaweed sources is feasible in Indonesia for any buyer who seeks it. All quality problems have solutions that can be readily implemented. Traceability and information flow in Indonesia are facilitated by assistance through government agencies and trade organizations as well as through internet information sites (e.g. jasuda.net) and wireless communication systems. A high proportion of value chain players, including farmers, have mobile phones that they use to trade information nationally and with neighboring seaweed producing countries.

In addition to quality standards established between buyers and sellers, Indonesian producers are applying both international and national standards. The "Standar Nasional Indonesia" (SNI) was developed to cover all products and processes related to production of seaweed and seaweed products. The SNI are harmonized with international standards that are applied to export products including CCRF, CITES, ISO, HACCP and SPS agreements.

2.7 Social and economic dimensions of seaweed farming in Indonesia

Almost all Indonesian seaweed production takes place in coastal villages that effectively control adjacent nearshore waters. Seaweeds have proven to be lucrative cash crops for regions where cash can be hard to come by. Most seaweed enterprises are community-based family businesses that are clustered into producer groups. On average, individual household income from part-time seaweed farming is about 500 US$ per month based on production of about 5 wet tons of seaweed per month. This income is above the national average and it can be increased by those who wish to expand production on a full-time basis. This cash income directly benefits an estimated 70,000 families across Indonesia and indirectly benefits entire communities through multiplier effects.
INDONESIA – SEAWEED PRODUCTION AREAS
SEAWEED PROCESSING IN INDONESIA

The most important processed seaweed products in Indonesia are the hydrocolloids agar and carrageenan. The following chapter gives an overview about the raw material which is used for the production, the processing technologies of agar and carrageenan and their applications.
3.1 Agar

3.1.1 RAW MATERIAL FOR AGAR PRODUCTION
Agar is a natural hydrocolloid extracted from seaweeds all belonging to the *Rhodophyceae* class (red algae). Two genera, *Gelidium* and *Gracilaria*, account for most of the raw material used for the extraction of agar.

Extraction of *Gelidium* species gives the higher quality agar measured as gel strength. However, nearly all *Gelidium* used for commercial agar extraction still comes from natural resources in the wild, resulting in a certain limitation of supply. *Gelidium* is a small, slow growing plant and while efforts to cultivate it in tanks and ponds have been biologically successful, it has so far not been proved to be economical feasible.

In the past, *Gracilaria* species were once considered unsuitable for agar production because the quality of the agar was considered inferior due to lower gel strength. But in the 1950s, it was found that pre-treatment of the seaweed with alkali before extraction although lowering the yield gave a good quality agar with higher gel strength. This allowed expansion of the agar industry, previously limited by the supply of *Gelidium* available, and led to the harvesting of a variety of wild species of *Gracilaria* in countries such as Indonesia.

Cultivation methods were then developed, both in ponds and in the open waters of protected bays. Today the supply of *Gracilaria* in Indonesia is mainly cultivated. The country has become one of the largest and best positioned supplier of agar to the food industry worldwide.

3.1.2 CURRENT PROCESSING TECHNOLOGIES OF AGAR
The basic principle in all processes for the production of agar is simply an extraction of the agar from the seaweed after it has been cleaned and washed. This step is necessary to remove any foreign material such as sand, salts, sticks and any debris which may appear naturally with the seaweed.

The agar is extracted by heating in water for several hours. During this process the agar dissolves in the water. The mixture is then filtered to remove the residual seaweed. The hot filtrate is cooled and forms a gel which contains about one percent agar. The gel is broken into pieces and washed to remove all soluble salts, and, if necessary, it can be bleached to reduce the color. After this step, water is removed from the gel, either by a freeze-thaw process or nowadays more likely by squeezing it under pressure. Remaining water can then be removed by drying. The final step is to mill the agar to a suitable and uniform particle size.

There are some differences in the treatment of the seaweed prior to extraction, depending on the type of seaweed. With *Gelidium* the process is simply washing with plain water or sometimes with a little acid to facilitate extraction. Whereas *Gracilaria* must be treated with alkali before extraction to obtain the optimal gel strength. For the alkali treatment, the seaweed is heated in 2–5 percent sodium hydroxide at 85–90 °C typically for one hour. After the removal of the alkali, the seaweed is washed with water, and sometimes with weak acid to neutralize any residual alkali.

For the hot-water extraction, *Gelidium* is more resistant. The extraction of this type of seaweed takes often place under pressure (105–110 °C for 2–4 hours) as this is faster and gives higher yields. *Gracilaria* is usually just extracted with water at 95–100 °C for 2–4 hours. The hot extract is given a coarse filtration to remove the seaweed residue, filter aid is added and the extract is passed through a filter press equipped with a fine filter cloth to ensure removal of any insoluble products.

3.1.3 APPLICATIONS OF AGAR
The name “agar” or “agar-agar” originates in Indonesia. The widespread use of agar is caused by its ability to form gels, and the unique properties of these gels. Agar dissolves in boiling water and when cooled it forms a gel between 32 and 43 °C, depending on the seaweed source of the agar. In contrast to gelatin gels, that melt around 37 °C, agar gels do not melt until heated to 85 °C or higher. In food applications, this means there is no requirement to keep them refrigerated in hot climates. This large difference between the temperature at which a gel is formed and the temperature at which it melts is unusual, and unique to agar. Many of its applications take advantage of this difference.

About 90 % of the agar produced is intended for food applications, with the remaining 10 % being used for bacteriological and other biotechnology applications. Agar has a preferential status all over the world: It is derived from a vegetable source, easy to use without any knowledge in chemistry needed and most importantly, agar has never received any negative comments. In addition, agar is tasteless and does not interfere with the flavors of foodstuffs, in contrast to some other gelling agents.
In the baked goods industry, the ability of agar gels to withstand high temperatures means agar can be used as a stabilizer and thickener in pie fillings, icings and meringues. Cakes, buns, etc., are often pre-packaged in various kinds of modern wrapping materials which often stick to the product, especially in hot weather. By reducing the quantity of water and adding some agar, a more stable, smoother, non-stick icing for the product is obtained. For the same reasons, one of the larger application for agar in North America is on donuts. Nowadays, agar from *Gracilaria* are often preferred in confectionery with a very high sugar content, such as fruit candies.

In Asian countries, agar is a traditional and popular component of jellies. Probably, this has its origin in the early practice of simply boiling seaweed, straining it, adding flavors to the liquid before it cooled and formed a jelly. It is believed that this was the way agar was invented as a gelling agent already several hundred years ago. A popular Japanese sweet dish is *mitsumame*. It consists simply of cubes of agar gel containing fruit and added colors. It can be canned and sterilized without the cubes melting.

Agar is also used in gelled meat and fish products, and is preferred to gelatin because of its higher melting temperature and gel strength. It also improves the texture of dairy products like cream cheese and is often used in yoghurt, especially in North America.

Unlike starch, agar is not readily digested and therefore adds little calorific value to food. In addition, it is described as a high fiber additive. Agar is often used in vegetarian foods such as meat substitutes.

In the pharmaceutical industry, agar is used as a growth substrate to obtain clones or copies of particular plants in nurseries. Bacteriological agar is used in testing for the presence of bacteria. It is specially purified to ensure that it does not contain anything that might modify bacterial growth. The highest quality agar and its derivative agarose is used for biotechnological applications of DNA research and gel electrophoresis and diagnostic purposes.

### 3.2 Carrageenan

#### 3.2.1 RAW MATERIAL FOR CARRAGEenan PRODUCTION

The original source of carrageenan was the red seaweed *Chondrus crispus* collected from natural resources along the west coasts in Europe and the east coast provinces of Canada. As the carrageenan industry expanded, the demand for raw material began to strain the supply from natural resources, although *Chondrus* had been supplemented by species of *Gigartina* from Spain and especially Chile.

The introduction of cultivation of species of *Eucheuma* in the Philippines during the 1970s provided the carrageenan industry with a much enhanced supply of raw material. A further advantage of this cultivated material was that one species contained almost exclusively a particular type of carrageenan (kappa-carrageenan) while a second species contained predominantly a second type (iota-carrageenan), each type having its own particular applications. *Chondrus* and *Gigartina* contains a mixture of two types (kappa and lambda) that could not be separated during commercial extraction. Today most of the raw material comes from the two *Eucheuma* species originally cultivated in the Philippines, but their cultivation has now spread to some other warm-water countries especially Indonesia where the natural conditions are most favorable.

#### 3.2.2 CURRENT PROCESSING TECHNOLOGIES OF CARRAGEenan

According to the production process, there is a differentiation between refined and semi-refined carrageenan. Refined carrageenan is the original carrageenan. For many years it was the only carrageenan permitted in food products.

The main difference between refined carrageenan (RC) and semi-refined carrageenan (SRC) is that SRC contains the cellulose that was in the original seaweed while in refined carrageenan this has been removed by filtration during the processing. Refined carrageenan will therefore give a clear solution, while PNG gives a cloudy solution limiting the applications of SRC. For both products the seaweed is washed to remove sand, salts and other foreign matter.

**Production of refined carrageenan**

After the seaweed has been cleaned, for refined carrageenan it is then heated with water containing an alkali for several hours. This step is necessary to extract the carrageenan and at the same time increasing gel strength in the final product. The seaweed that does not dissolve is removed by centrifugation or a coarse filtration, or a combination. The solution is then filtered again in a pressure filter using a filter aid in order to ensure complete removal of any insoluble particles.

Then the dissolved carrageenan has to be recovered. There are two methods for isolating it. Traditionally, an alcohol-precipitation method is generally used as carrageenan is insoluble in high-alcohol concentrations. This method has the advantage that it can be used for all types of carrageenan.
Another method similar to the method used for making agar was later applied also to the refined carrageenan production. Therefore, some agar processors in Indonesia are now using their equipment and similar techniques to produce refined kappa carrageenan as well. This gelling method is most suitable for kappa carrageenan. The gel is mainly dehydrated by squeezing as for agar. But it could also be recovered with a freeze-thaw process.

The gel method relies on the ability of kappa carrageenan to form a gel with potassium salts. The gel may be formed in various ways. The most common method is to force water out of the gel by applying pressure to it, using similar equipment to that used for agar. After squeezing for several hours the sheets of gel are chopped, dried in a hot air dryer and milled to an appropriate particle size. Inevitably, with the gel method the product contains some potassium chloride.

**Production of semi-refined carrageenan**

Also for the production of semi-refined carrageenan, the seaweed needs to be washed before further processing. For the production of SRC the carrageenan is never actually extracted from the seaweed. The principle is rather to wash everything out of the seaweed that will dissolve in alkali and water and leave the carrageenan and other insoluble matter behind. This insoluble residue, consisting largely of carrageenan and cellulose, is then dried and sold as SRC. Because the carrageenan does not need to be recovered from the solution, the process is much shorter and cheaper.

In the production of SRC the washed and cleaned seaweed is heated in an alkaline solution of potassium hydroxide for about two hours in order to increase the gel strength of the carrageenan in the seaweed and at the same time dissolve any soluble protein, carbohydrate and salts without dissolving the carrageenan. After the alkali treatment and water washing, the product is chopped and dried in a closed dryer which will keep the bacterial count low enough to make a human-food grade product.

Alkaline treated Eucheuma cottonii seaweed not produced according to the requirements for food applications is normally referred to as ATC. Often it is simply sold as chips (ATCC) which are typically used for the extraction of refined carrageenan, for canned pet food or non-food applications.

### 3.2.3 APPLICATIONS OF CARRAGEENAN

Carrageenan is one of the most diversified food additives due to the broad range of gelling and emulsifying properties – ranging from a soft elastic to a very brittle gel – and the ability to substitute to a large degree both gelatin and agar.

In Europe, both refined and SRC are permitted in human food:

- Refined carrageenan (RC) is labeled “carrageenan” and E-407
- Semi-refined carrageenan (SRC) is labeled “processed Eucheuma seaweed” or “PES”, and E-407a

Some years ago, the FDA declared SRC suitable for the use in human food in the USA and to be labelled as “carrageenan” with the same status as that of the refined carrageenan product.

Carrageenan is used in processed foods for stabilization, thickening and gelation driven by the consumers’ need for convenience, appealing food textures, advances in food processing, and new food products. It is used worldwide to enhance ice creams eliminating formation of ice crystals, chocolate milk, custards, cheeses, jellies, confectionary products, meat and for clarification of beer and wine.

Carrageenan has a high reactivity with a range of materials including and most importantly milk proteins so it can be efficient at low concentrations in dairy products to prevent fractionation of milk constituents. A major application is in chocolate milk where carrageenan is able to keep the cocoa particles in suspension.

Today, processed meat and poultry products offer the largest application for carrageenan worldwide with its many properties such as water binding and retention, fat substitution, control of syneresis and dehydration and enhancement of juiciness. Improved slice ability is especially important in high-speed slicers.

Kappa carrageenan obtained from the seaweed *E. cottonii* needs potassium salt to gel. It then results in brittle gels. Kappa carrageenan is soluble in hot water and shows synergistic effect with other food additives like locust bean gum, guar gum and xanthan.

Iota carrageenan gels most strongly with calcium salts, resulting in elastic gels with no syneresis. The gels furthermore freeze-thaw stable. Iota carrageenan is obtained from the seaweed *E. spinosum*.

Carrageenan is also widely used in the canned pet food industry and in some non-food applications such as toothpaste and air fresher gels.
History of seaweed processing and future outlook

Seaweed farming and processing technologies developed elsewhere during the 1970s and 1980s. They were commercially applied in Indonesia about a decade later during the 1980s and 1990s. This occurred as wireless communication technology and developing transport links enabled value chain development across the thousands of islands that span three time zones in the Indonesian archipelago. Indonesia emerged as the major producer of tropical seaweeds by the mid-2000s.

Both international and domestic companies are involved in producing and processing Indonesian seaweed crops. There are opportunities for global value chain players to participate in Indonesian seaweed production development at several value chain levels.

As of 2014 most *Gracilaria* was made into agar by national processors and was sold into domestic markets but most *Kappaphycus* and *Eucheuma* was exported as raw-dried seaweeds. Processors based in Indonesian are capable of making refined and semi-refined kappa carrageenan and semi-refined iota carrageenan and can do so with competitive production costs. At least one major end user discovered decades ago that SRC from Indonesian processors is cost effective but most solution providers retain legacy links to processors outside Indonesia even though they are processing Indonesian-sourced seaweed. Indonesian processors are therefore striving to penetrate such global markets for their carrageenan and agar building block products.

Currently, the list of the Indonesian Seaweed Industry Association (ASTRULI) comprises of 16 seaweed processors. However, the country has listed a total of 37 national seaweed processing industries. They are distributed among 11 provinces.

Indonesia is evolving from follower to leader: Hosting of the 21st International Seaweed Symposium (ISS) in Bali during April, 2013 marked the evolving transition of Indonesia from industry follower to innovation leader.

The transition is being catalyzed by public and trade organizations including government ministries, international assistance organizations and research consortia in Indonesia; and innovative enterprises building strategic business alliances among domestic and international value chain stakeholders.

Initiatives include development of more productive agronomy practices; implementation of diversified, ecosystem approaches to aquaculture within coastal communities; and innovative new processes and products.

At the farm level step-change innovation is possible as more efficient farming methods are combined with advanced post-harvest treatment. Lower-labor farming methods not only reduce production cost but also open up large areas for farm development by enabling planting in deeper waters.

Processing that commences with live seaweeds at the farm level greatly enhances seaweed value by enabling effective recovery of seaweed solids and seaweed juice that feed into multi-stream, zero-effluent (MUZE) processing systems. Systems such as these make it feasible to develop remote, unpopulated areas using a ‘plantation’ approach to seaweed aquaculture systems. In populated regions developing technologies enable the implementation of ‘nucleus-plasma’ systems, such as those successfully operated at large scale in Indonesian poultry and prawn production.

International involvement in such developments is already beginning in Indonesia. There is ample opportunity for European companies to get involved as a development partner as Indonesia evolves from technology follower to technology leader.
The following chapter gives an overview about selected carrageenan and agar suppliers from Indonesia which are included in the Swiss Import Promotion Programme (SIPPO).
INDONESIA – SEAWEED PROCESSING COMPANIES

4.1 Agarindo Bogotama
Gracilaria Processing Plant
Product: Agar
Java, Jakarta

4.2 Algalindo Perdana
Cottonii Processing Plant
Product: refined and semi-refined carrageenan
Java, Surabaya

4.3 Cahaya Cemerlang
Cottonii Processing Plant
Product: refined and semi-refined carrageenan
Sulawesi, Makassar

4.4 Hydrocolloid Indonesia
Cottonii Processing Plant
Product: Semi-refined carrageenan
Java, Jakarta

4.5 Gumindo Perkasa
Cottonii Processing Plant
Product: Semi-refined carrageenan
Java, Jakarta

4.6 Surya Indoalgas
Gracilaria Processing Plant
Product: Agar
Java, Surabaya

4.7 Wahyu Putra
Cottonii Processing Plant
Product: semi-refined carrageenan
Sulawesi, Makassar
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Java, Surabaya

4.7 Wahyu Putra
Cottonii Processing Plant
Product: semi-refined carrageenan
Sulawesi, Makassar

4.5 Agar Swallow
Gracilaria Processing Plant
Java, Jakarta

4.6 Phoenix Food
Cottonii Processing Plant
Lombok

4.7 Galic Artabahari
Cottonii Processing Plant
Java, Bekasi
PT. Agarindo Bogatama

Facts & Figures
Agarindo Bogatama, founded in 1988, is a privately owned Indonesian company manufacturing agar powder. Currently, Agarindo Bogatama is the world’s largest manufacturer of agar with its head office, laboratories and factory located in the Jakarta region. The products are sold to bakeries, liquid desserts, confectioneries, the meat and dairy industry.

Products & Services
The production capacity of Agarindo can be increased from 1,800 MT to 2,500 MT annually. The company cultures its own seaweed raw material at marine farms located in the eastern part of Indonesia. Most of the agar powder is produced using cultivated gracilaria seaweed as well as wild harvested gelidium spp and pterocladia spp. Agarindo Bogatama also offers processed edible seaweed. The products of the company meet the specifications of the U. S. Food Chemical Codex (FCC) as well as the directive of the European Economic Community (EEC). Agarindo Bogatama is kosher and halal certified.

Mission & Vision
Agarindo Bogatama provides high-quality products to customers worldwide. All of the company products contain 100% agar powder.
PT. Agar Swallow

Facts & Figures
PT. Agar Swallow is an Indonesian company engaged in the processing of seaweed (gracilaria) type into edible seaweed flour for more than twenty five years. As a leader in the retail market for agar, the company has a strong focus on quality, hygiene and integrity to provide customer satisfaction.

Products & Services
Agar Swallow has a capacity of producing more than 60 tons of agar per month in a factory located close to Jakarta. Agar Swallow has adopted closed method production processes with strict hygiene measurements in place to obtain high quality agar product. The company produces edible seaweed with high gel elasticity and a textured solidity. The product doesn’t contain preservatives, nor does the company use food hardening agents.

Mission & Vision
Agar Swallow uses the latest technology and modern equipment for the processing of good quality seaweed. Trained and educated workers take care of the production in cooperation with a team of specialists in the research and development and quality assurance team. This shows the holistic approach of the company. Agar Swallow’s mission is to make agar a healthy food product which forms part of the daily life of consumers around the world.

www.agarswallow.com
4.3

PT. Algalindo Perdana

Facts & Figures
Algalindo Perdana PT. with brand name Seatech Carrageenan is one of the leading Indonesian manufacturers of carrageenan and konjac. The company utilizes sophisticated alcohol processing facilities with a modern alcohol recovery system. Algalindo Perdana is HACCP certified by TUV Nord.

Products & Services
PT. Algalindo Perdana with brand name Seatech Carrageenan is engaged in manufacturing refined and semi-refined carrageenan and konjac as well as blending and compounding binders, thickeners, stabilizers, emulsifiers, clarifying and gelling agent for the manufacture of processed meat, dessert jellies, ice creams, beverages, confectioneries, dairy products, sauces, farinaceous products, pet food, cosmetics, toiletries and other applications. Algalindo develops and customizes blends of carrageenan and konjac for specific textural and rheological properties desired by the food manufacturer.

Mission & Vision
Processing only the finest eucheuma seaweeds and amorphophallos yam, Algalindo ensures high-quality products.
PT. Cahaya Cemerlang

Facts & Figures
Cahaya Cemerlang with brand name CC Carrageenan is an Indonesian based manufacturer of Kappa and Iota ATC (alkali treated seaweed chips) as well as semi-refined and refined carrageenan. The company started its business exporting seaweed in 1969.

Products & Services
Carrageenan is widely used for food applications such as binders, stabilizers, emulsifiers, thickeners, texture enhancers, clarifying and gelling agents for water as well as dessert jelly, pet food and non-food applications.

CC Carrageenan has designed, built and runs the production facility with the highest quality and safety standards in the industry. The company provides allergen-free products.

Mission & Vision
With production facilities located near the source of raw material in Indonesia and combined with an extensive knowledge and long experience in manufacturing, CC Carrageenan guarantees a reliable supply of quality products at competitive prices.

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PRODUCTS
Refined and semi-refined Kappa and Iota carrageenan, seaweed chips

CERTIFICATION
ISO 22000, HACCP, Halal

www.cahayacarrageenan.com
PT. Galic Artabahari

Facts & Figures
PT. Galic Artabahari is located in the industrial area of Bekasi, an area outside the East of Jakarta. The site has separate buildings for the production of the food grade and the pet food or industrial grade carrageenan. In December 1999, the company has received ISO 9002 certification from Sucofindo International Certification Services. The manufacturing process and products have HALAL certification from Majelis Ulama Indonesia.

Products & Services
The main line of production is the extraction of Carrageenan of KAPPA and IOTA types, extracted from the red seaweed of Eucheuma cottonii and Eucheuma spinosum. Galic Carrageenan products are marketed in the Indonesian market and into Europe, South America, North America, Asia and Australia. The company already sells SRC applied in meat processing products to several local companies in Indonesia.

Vision & Mission
Processing innovations and developing effective and functional blends for the food and non-food industries, is PT. Galic Artabahari’s mission to become a leading manufacturer of carrageenan. The company also supports seaweed farmers to develop and cultivate high quality seaweed raw material which will increase the commercial value of their products.
PT. Hydrocolloid Indonesia

Facts & Figures
PT. Hydrocolloid Indonesia is a leading manufacturer of seaweed products formed by business people with deep experience in the food and beverage industry.

Products & Services
PT. Hydrocolloid guarantees that only the best and most cost-effective semi-refined carrageenan building blocks for blenders, formulators, solution providers and further processors are provided. The products range from food-grade Kappa to Iota semi-refined carrageenan. They are tailored to customer needs, with specialty in 200-mesh SRC. The factory of PT. Hydrocolloid Indonesia is equipped with high state-of-the-art processing machinery and lab equipment. Strict quality assurance is adhered to guarantee consistent product quality. To secure the production, strong relationships with seaweed suppliers from farming sites throughout Indonesia were established and quality standards set.

Mission & Vision
PT. Hydrocolloid Indonesia is paying special attention to environmental issues by equipping the factory with a waste treatment facility. Hydrocolloid Indonesia – Your food grade semi-refined carrageenan manufacturing partner in Indonesia.
PT. Gumindo Perkasa Industri

Facts & Figures
Gumindo Perkasa Industri (IndogumTM) was established in 1997 and has satisfied customers in the food and beverage industries all over the world for over a decade. Indogum offers proven superior, quality controlled and pure, semi-refined-carrageenan products, as well as special customer blends. The company is halal and kosher certified.

Products & Services
Only the best carrageenan Eucheuma cottonii and Eucheuma spinosum seaweeds are processed during a full 24 hour circle manufacturing plant, with three shifts running. Indogum ensures that stringent farming guidelines and selection criteria are adhered to at all times. The company provides 100 % non GMO food grade quality.

Mission & Vision
The knowledge gained from extensive experience in serving customer needs, as well as constant research and development, enables Indogum to maintain the best quality products and develop innovative new products, whilst exploring new applications.
Phoenix Food

Facts and Figures
Phoenix Food is a company located on Lombok island in Indonesia. The company has export experience to Hong Kong and China.

Products and Services
The company is involved in the processing of carrageenan powder and semi-refined carrageenan since 1993. In addition, Phoenix Food produces snacks such as candies, taffy and other products based on seaweed. The brand of the company is known in Lombok as a specialty and has been recognized by national and international visitors.

Mission and Vision
Phoenix Food aims to be the leading agroindustry company in processing seaweeds products from Indonesia's natural resources, by building an integrated processing business.
PT. Surya Indoalgas

Facts & Figures
Surya Indoalgas was founded in 1990 to produce agar powder from Gracilaria seaweed. The company is located on a 3.8 ha processing facility in Surabaya, East Java. Surya Indoalgas has exported its products to customers in Asia, Europe and South America.

Products & Services
Surya Indoalgas is a top quality agar powder manufacturer from Indonesia. The company has the capability of producing 250 MT agar powder – starting from GS-700 up to GS-900 – per year, with capacity to nearly double its output when needed.

Surya Indoalgas employs only the latest technology in all seaweed production processes, from using Japanese state-of-the-art machinery to employing a highly skilled and dedicated workforce. The company is HACCP, ISO 9001:2008, halal and kosher certified.

Mission & Vision
Surya Indoalgas’ mission is to provide healthy food from seaweed. The company has a clear commitment to delivering high-quality products on time. Customers can expect stable product quality, reliable service and technical support. In addition, Surya Indoalgas places great importance on environmental issues. The company operates a waste water treatment facility, assuring that waste water from seaweed processing is discharged in compliance with government regulation.
Facts & Figures
Located in Makassar, South Sulawesi, the main hub for seaweed supply in Central and East Indonesia, PT Wahyu Putra Bimasakti specialises in the production of high quality semi-refined carrageenan, with an annual capacity of 1,000 MT.

Products & Services
The company offers semi-refined Kappa and Iota carrageenan, tailored food additives blends based on semi-refined carrageenan for different applications, alkali treated seaweed chips and seaweed (Eucheuma cottonii, Eucheuma spinosum and Gracilaria). The production is in line with international standards in order to provide products of outstanding quality to customers of the food and beverage industry such as meat, dairy, bakery, condiments and beer as well as to the non-food industry, such as feed, textile, dental and spa.

Mission & Vision
By maintaining a close relationship with raw material suppliers, Wahyu Putra guarantees reliable supply and high quality products according to customers’ requirements.
The following chapter gives an overview about some of the main stakeholders and organisations in Indonesia which are supporting the Indonesian seaweed industry.
5.1 Ministry of Marine Affairs and Fisheries (MMAF)

As the world’s archipelagic country, the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) places seaweed as one of the priority products for development, due to its sustainability and potential for supporting the local economy through extensive employment. Seaweed is a natural raw material that is environmentally friendly, labour-intensive to farm and utilises strict quality assurance systems to produce high-quality hydrocolloids such as agar and carrageenan. Due to its added value and the resulting economic and social benefits for Indonesian society, processing of seaweed within the country is encouraged.

The Directorate of Foreign Market Development (DFMD) is a unit under the Directorate General of Fisheries Product Processing and Marketing within the Ministry of Marine Affairs and Fisheries, Republic of Indonesia. DFMD encourages both public and private initiatives to boost foreign exchange earnings from aquatic resources.

DFMD has a wide range of activities among others:
- to promote Indonesian aquatic products having high quality standards which are suitable for international markets
- to link Indonesian exporters with both international agencies for import promotion and foreign buyers, or related associations
- to disseminate current foreign market trend to Indonesian exporters
- to support sustainable business of Indonesian exporters

5.2 Indonesian Seaweed Industry Association (Astruli)

The Indonesian Seaweed Industry Association (ASTRULI) is a forum for the Indonesian processing industry and the manufacturers of seaweed derivatives. It’s role and responsibility is to encourage the development of the seaweed industry in a sustainable and competitive environment in Indonesia.

ASTRULI was established in order to communicate, coordinate and distribute information among members and stakeholders. It’s values are based on the principles "harvest, process and market effectively and efficiently". The organization aims to position Indonesia as a one-spot location for processed seaweed products and to achieve a competitive advantage for the country in the global market.

Through the development and strengthening of the role of the Indonesian processing industry and the utilization of formulation technology to produce processed seaweed product, ASTRULI also assists the Indonesian government in job creation (pro-job), economic growth (pro-economic growth) and welfare improvement (pro-poor).

ASTRULI’s mission includes the following tasks:
- to nurture and develop Indonesia’s seaweed industry and encouraging it’s players to be professional, competitive and value-added
- to promote a business behavior among Indonesian seaweed processors which is based on morals, business ethics and norms
- to contribute actively in building a strong and competitive Indonesian export economy and to ensure a healthy business climate for the Indonesian seaweed industry
- to assist the Indonesian government in achieving recognition for the importance of the Indonesian seaweed industry
Indonesian Association of Seaweed (Arli)

The Indonesian Association of Seaweed (ARLI) promotes the cultivation of seaweed in Indonesia. Through its wide network, the association helps Indonesian seaweed farmers to market the raw material seaweed more widely and generate a higher quality and quantity.

In parallel, ARLI supports the development of domestic seaweed processors.

ARLI encourages seaweed cultivation throughout Indonesia and boosts the national seaweed industry with a strong vision, mission, and a profound knowledge about seaweed. The association is promoting community development among farmers and ensures technical trainings for farmers take place in cooperation with other stakeholders.

ARLI members that export and process seaweed, are required to have a Fisheries Business Licenses (IUP) from the local Marine Affairs and Fisheries Agency, Feasibility Processing Certificate (SKP) and certificate of Hazard Analysis at Critical Control Point (HACCP) issued by the Ministry of Marine Affairs and Fisheries, Republic of Indonesia.

Due to the strong commitment in regards to traceability, ARLI was involved in 2012 for the issuance of the Decree of the Minister of Marine Affairs and Fisheries regarding the Certificate Of Local Origin (COLO).

ARLI is focusing its activities especially on sustainability issues and gives Indonesian seaweed farmers an united voice when it comes to the challenges for coastal seaweed farming communities such as:

- access to national and international markets and price stability/fair trade
- access to knowledge and information on seaweed farming technologies which are appropriate to the different seaweed farming regions
- the need for sufficient cultivar biomass for seasonal replanting and robust cottonii cultivars that have similar growth characteristics to spinosum cultivars, especially throughout all the seasons of the year
- the need for finance to cover the purchases of biomass for replanting
- prevention or control of seasonal maladies such as “ice-ice” malaise
Switzerland's State Secretariat for Economic Affairs SECO has recognized the key role of trade for Indonesia. Among the instruments it deploys within its economic and development cooperation with the country, trade-related cooperation, including social and environmental aspects, takes on a major importance. The overall aim is to boost trade as a trigger for growth and sustainable development.

Specifically, SECO runs programmes for promoting imports, including processed seaweed products, to Switzerland and the EU. In this endeavour, SECO has set up the Swiss Import Promotion Programme (SIPPO) which connects European importers with suitable suppliers of high-quality products from partner countries.

European purchasers benefit from contacts to selected agar and carrageenan suppliers at leading trade fairs in Europe. In addition, trade missions to Indonesia are a good opportunity to network and form business partnerships within Indonesia's seaweed sector. Importers of processed seaweed products can experience a first-hand insight into the Indonesian business environment, including tailor-made 1:1 company visits with Indonesian suppliers of carrageenan and agar. In addition, delegation members will visit seaweed farms in order to learn more about the supply chain.

The Swiss Import Promotion Programme’s principal goals are:

- to establish qualified trade contacts between the Swiss and European import economy and SMEs from partner countries
- to promote innovative products with high potential on the Swiss and European markets
- to keep the Swiss and European import economy informed of new market sources
- to enhance the competitiveness of Swiss and European importers through better sourcing opportunities
- to strengthen trade institutions and business sector organisations in partner countries in the trade promotion process in order to facilitate trade for importing companies

The programme is implemented by Swisscontact from 2017–2020.

More information about the SIPPO Programme can be found under www.swisscontact.org.

In addition, to the SIPPO Programme, the State Secretariat for Economic Affairs SECO finances various other trade-related technical assistance projects in Indonesia. In this context, SECO’s 5-year SMART-Fish Programme seeks to strengthen the trade capacities of selected value chains such as seaweed, while ensuring the preservation of biodiversity through promoting the sustainable use of these fisheries resources. The programme focuses on assisting the Indonesian seaweed industry in selected locations such as East Java and South Sulawesi.

The SMART-Fish principal goals for seaweed value chains are:

- to increase the competitiveness of the Indonesian processed seaweed industry by improving product quality and productivity
- to establish product traceability from seaweed farmer to agar and carrageenan processor
- to acquire knowledge and technology for seaweed processors for further value addition, such as the production of refined carrageenan

The programme is implemented by the Ministry of Marine Affairs and Fisheries (MMAF) and the United Nations Industrial Development Organization (UNIDO) until 2019.

More information about the programme can be found under www.smart-fish-indonesia.org.
LIST OF ASTRULI MEMBERS

The following chapter gives an overview about the current list of members of the Indonesian Seaweed Industry Association (ASTRULI).
<table>
<thead>
<tr>
<th>COMPANY NAME</th>
<th>PRODUCT</th>
<th>WEBSITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV. Agar Sari Jaya</td>
<td>Agar powder</td>
<td></td>
</tr>
<tr>
<td>PT. Agar Sehat Makmur Lestari</td>
<td>Agar Agar</td>
<td><a href="http://www.agarsehat.biz">www.agarsehat.biz</a></td>
</tr>
<tr>
<td>PT. Agar Swallow</td>
<td>Agar powder</td>
<td><a href="http://www.agarswallow.com">www.agarswallow.com</a></td>
</tr>
<tr>
<td>PT. Agarindo Bogatama</td>
<td>Agar powder</td>
<td><a href="http://www.agarindo-bogatama.co.id">www.agarindo-bogatama.co.id</a></td>
</tr>
<tr>
<td>PT. Algalindo Perdana</td>
<td>Semi-Refined Carrageenan, Refined Carrageenan</td>
<td><a href="http://www.algaiindo.com">www.algaiindo.com</a></td>
</tr>
<tr>
<td>PT. Amarta Carrageenan Indonesia</td>
<td>Semi-Refined Carrageenan</td>
<td></td>
</tr>
<tr>
<td>PT. Cahaya Cemerlang</td>
<td>Semi-Refined and Refined Carrageenan</td>
<td><a href="http://www.cahayacarrageenan.com">www.cahayacarrageenan.com</a></td>
</tr>
<tr>
<td>PT. Centram Pasuruan</td>
<td>Refined Carrageenan</td>
<td><a href="http://www.mfct.jp">www.mfct.jp</a></td>
</tr>
<tr>
<td>PT. Gracindo Nusantara</td>
<td>Alkali Treated Gracilaria</td>
<td></td>
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<tr>
<td>PT. Galic Arta Bahari</td>
<td>Semi-Refined Carrageenan</td>
<td><a href="http://www.ptgab.com">www.ptgab.com</a></td>
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<td>PT. Gumindo Perkasa Industri</td>
<td>Semi Refined Carrageenan - Food grade</td>
<td><a href="http://www.indogum.com">www.indogum.com</a></td>
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<tr>
<td>PT. Hydrocolloid Indonesia</td>
<td>Semi-Refined Carrageenan - Food grade</td>
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</tr>
<tr>
<td>PT. Indoflora Cipta Mandiri</td>
<td>Agar powder</td>
<td></td>
</tr>
<tr>
<td>PT. Indonusa Algaemas Prima</td>
<td>Alkali Treated Cottoni</td>
<td><a href="http://www.algaemas.com">www.algaemas.com</a></td>
</tr>
<tr>
<td>PT. Java Biocolloid</td>
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</tr>
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<td>PT. Srigunting Pratama</td>
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<td></td>
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<td>PT. Surya Indo Algas</td>
<td>Agar powder</td>
<td><a href="http://www.indoalgas.co.id">www.indoalgas.co.id</a></td>
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<td>PT. Wahyu Putra Bimasakti</td>
<td>Semi-Refined Carrageenan, seaweed chips, seaweed</td>
<td><a href="http://www.seaweed.co.id">www.seaweed.co.id</a></td>
</tr>
</tbody>
</table>
### LIST OF TABLES

| Table 1 | Hydrocolloids and names of raw material |
| Table 2 | Hydrocolloids and its characteristics |
| Table 3 | The cultivation methods for *E. cottonii* and *E. spinosum* |
| Table 4 | Millions of tons of fresh (live) seaweeds produced by region |
| Table 5 | Global seaweed production by genus as millions of tons of fresh seaweeds |
| Table 6 | Millions of tons of fresh (live) seaweeds produced by major source countries during 2010 |
| Table 7 | A: Global seacoast, B: Coral Triangle |
LIST OF ABBREVIATIONS

ARLI  Asosiasi Rumput Laut Indonesia/Indonesian Association of Seaweed
ASTRULI Asosiasi Industri Rumput Laut Indonesia/Indonesian Seaweed Industry Association
ATC   Alkali-treated cottonii
E. cottonii Eucheuma cottonii
E. spinosum Eucheuma spinosum
FAO   Food and Agriculture Organization of the United Nations
FDA   Declared SRC suitable for US Food and Drug Administration
HACCP Hazard Analysis and Critical Control Points
MMAF  Indonesian Ministry of Marine Affairs and Fisheries
MSC   Marine Steward Council
PES   Processed Eucheuma seaweed
RC    Refined carrageenan
SECO  State Secretariat for Economic Affairs
S-GE  Switzerland Global Enterprise
SIPPO Swiss Import Promotion Programme
SME   Small to medium-sized enterprise
SRC   Semi-refined carrageenan
UNIDO United Nations Industrial Development Organization
REFERENCES


