POST HARVEST TREATMENT AND QUALITY CONTROL OF EUCHEUMA SEAWEEDS

by

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Introduction

Since about 1950 Eucheuma seaweeds have been used commercially for the production of carrageenan extracts. In the early years, these seaweeds were natural or wild crops but starting about 1974 when the markets for these species expanded rapidly, increasing volumes of cultivated Eucheumas were developed. As we approach 1990 most commercial Eucheumas are cultivated, particularly "cottonii", the species Eucheuma alvarezii, recently renamed Kappaphycus alvarezii by Doty.

Much attention has been focused on marine agronomy, including selection of fast growing species and strains, various methods of farming to utilize a wide range of environmental conditions, and preservations of the plants in their ocean habitat. However, in order to produce a top quality finished product for export, it is equally important to take good care of the plants after they have been harvested. Failure to maintain quality, seriously impacts seaweed farmers, exporters, and users.

In the early years, Eucheuma volumes of wild harvests were relatively low and played only a minor role in carrageenan applications. Consequently, even significant degradation of the seaweed after harvesting had only a minor impact on the carrageenan business. However, as we approach 1990, Eucheumas represent a major and still rapidly growing percentage of the carrageenan business and semi-refined flour products. In addition, some of the newer applications responsible for the growth of Eucheuma markets are based on higher and consistent quality seaweed.

Therefore, to protect current markets and to continue to expand the markets for Eucheuma seaweeds, it is essential to develop and strictly enforce good post-harvest practices. Also, those who do not follow these guidelines may find themselves with an inferior product carrying a lower market value. In addition, it makes no sense to grow seaweed with the greatest of care in the water, only to see those efforts go to waste after harvesting.

This presentation outlines the key parameters of post-harvest care to ensure the optimum qualities for Eucheuma for use as raw materials for carrageenan extraction or semi-refined flours. Specific attention is also focused on stability during shipping and storage.

Post-harvest Treatment

Post-harvest treatment covers the steps between taking fresh seaweed from the ocean at 85% moisture and processing to export quality dried seaweed at 35% moisture. This sounds

simple, but the steps of drying, cleaning, storing, transporting, re-cleaning, baling, storing, and transporting provides many opportunities to reduce or destroy the product quality. Each of these steps will now be discussed in more detail, and the key issues emphasized.

Initial Drying

The rules for good drying of Eucheuma are very straightforward in theory. They should be dried as rapidly as possible, kept clean, and not allowed to come in contact with fresh water. However, in practice these criteria can cause numerous problems. Solar drying is the most popular and low cost option, taking two days under ideal conditions. The wet (85% moisture) to dry (35% moisture) ration for E. cottonii is about 7:1 or a yield of 15%, and 6:1 and 17% respectively for E. spinosum. As measurement of moisture is difficult in remote regions and requires a high degree of precision for duplicate data, it is often useful to use wet dry yield as a good indication of seaweed moisture.

The methods for most rapid drying will have air circulating below the seaweed, for example on net racks raised above the ground. This extra circulation and reduced drying time can be very valuable when problems have been encountered as explained later.

If the seaweeds are spread on the ground, mats must be used to prevent contamination such as sand, dust, dirt, etc., which will stick to the seaweed, and raise the foreign material content above specification. Once on the seaweed, these contaminations are difficult to remove.

Under all drying methods and conditions, the thickness of the layer of plants should be adjusted to the current conditions. If drying is taking more than three days, spread the seaweed thinner over more mats or racks. "Steaming" Eucheuma, particularly E. spinosum, degrades the carrageenan very rapidly.

Contact with fresh water, particularly rain, should be avoided, as this extends the drying time and reduces the salt content, both of which causes the seaweed or carrageenan to degrade and reduce storage stability at 35% moisture.

Consequently, whenever possible, Eucheuma should be covered during rain. This is not always possible or practical. If seaweeds are exposed to rain, the supplier should accelerate the drying process as much as possible by spreading them thinner and turning them over frequently. If seriously exposed, the Eucheumas should be dried to a lower moisture content such as 20% to compensate for the loss of salt and storage stability.

For certain Eucheuma markets, the seaweeds are washed in fresh water and dried. This bleaches them. This is acceptable for only a few applications, but this washing process does not add value for the carrageenan manufacture, and in most cases reduces the carrageenan quality. These products would to be dried to 15 to 20% moisture to be stable on storage.

Effectively dried Eucheuma comprises salt covered thalli which are neither slimy nor foul-smelling, but remain flexible enough for efficient baling.

The market standard of 35% moisture for dried Eucheuma is not an arbitrary number but has been derived after considerable field research combined with detailed analytical work on the seaweeds and their carrageenan extracts.

This FMC research has shown that Eucheumas are unstable above 35% moisture and undergo degradation during storage. At above 40% moisture, the carrageenan in the seaweeds

may not survive transportation to the factory, arriving with functionalities too low for some applications.

Between 25% and 35% moisture, Eucheumas are relatively stable for periods in excess of 12 months, and the thalli are ideally flexible for efficient baling. Between 15 and 25% moisture, Eucheumas are extremely stable, but the thalli are too brittle, and resist pressure or snap baling.

Eucheumas below 15% moisture remain stable, but can cause processing problems during carrageenan extraction.

Cleaning

Cleaning seaweeds is essential during both cultivation and post-harvest treatment. In the water, cleaning optimizes growth rates and reduces yield losses to produce obvious positive advantages. Cleaning after harvest maintains a high quality product which is sometimes not considered favorable by the farmer or exporter, but is definitely noticed by the carrageenan manufacture. Producers of high quality clean seaweeds are preferentially treated by buyers, both on price and volume.

Cleaning should remove non-Eucheuma seaweeds, plastics, stones, wood, and most important, any sand sticking to the thalli. Sand causes severe problems during carrageenan extraction due to its abrasive properties.

Eucheuma cottonii and E. spinosum must never be mixed, and any accidental contamination of one by the other should be immediately reversed.

Storage

Storage of seaweeds is necessary at various stages of post-harvest treatment as most individual steps are batch operations. The basic objectives is to keep storage time as short as possible, moving the seaweeds rapidly through the system.

Eucheumas should never be stored wet, especially in piles. All wet seaweed should be dried without delay. Farmers should dry their harvest to at least 35% moisture before storage because unbaled Eucheumas tend to pick up moisture during storage. All storage should be in clean, cool, dry, and well ventilated places.

Baling

Baling is carried out for two major reasons. First, bales are much easier to handle than the loose Eucheuma product, and second, it is essential to reduce shipping costs as much as possible, a key for locations such as the South Pacific Islands.

The target for baling efficiencies is a minimum of 20 mt per 6 m container. To achieve this, bales are recommended to be at least 100 kg net weight with a volume of 43 cm by 43 cm by 73 cm which will allow 200 bales per container.

Balers can be screw type (manual or mechanical) or hydraulic. Because of the importance of bale density on economics, investing in a hydraulic system is advised, particularly if large volumes of Eucheumas are being processed in one location.

Exports Specifications

Key specifications are:

- Moisture - Maximum 35%
- Contamination - Maximum 5%
- Bale Density - Minimum 20 mt per 20' container

Of major importance to the exporter is "yield" or "shrinkage". This is the difference between the weight received from the farmer and the weight exported, normally the contamination of re-drying and cleaning. A scale of payment from the exporter to the farmer is recommended to reward farmers who consistently sell Eucheumas with low shrinkage levels.

Quality Control by Manufacture

It is important that the seaweed farmer and exporter know the criteria used by carrageenan manufacturers to judge the quality of Eucheuma shipments. This section details these tests and their implications on the business.

Moisture

Samples for moisture are taken by core sampling ten bales from each shipment and mixing. One hundred grams are dried in an electric oven with fan at 90 °C for 16 hours. Changing equipment, temperature, or time will produce a different moisture result.

FMC purchases Eucheumas based on 35% moisture by this test. If exporters want to carry out meaningful moisture testing on their shipments, it is strongly recommended that they install the same equipment. As it is impossible to always dry exactly to 35% moisture, FMC encourages exporters to over-dry 35% moisture and pays extra for the additional Eucheuma content. There is no economic penalty for shipping drier than specification to FMC. On the other hand, FMC pays less for seaweeds with moistures above 35%.

Moisture content data strongly influence storage and process plans, with wet shipments having to be used up immediately, normally at some inconvenience.

Contamination

Non-Eucheuma seaweeds, sand, salt, plastics, etc., are determined by hand separation and washing/drying.

Eucheuma Content

The pure Eucheuma content is calculated by difference using moisture and contamination data.

Carrageenan Yield and Quality

Each shipment of Eucheuma is tested for carrageenan yield and quality extraction and functionality measurements such as viscosity, gel, strength, etc. Abnormal data are followed up with more detailed analysis. FMC has an extensive database on Eucheuma seaweeds which can fingerprint a number of field problems. For example :

- Age of plants at harvest whether too young or too old

- Drying efficiencies including contact with fresh water

- Storage efficiencies

- Mixing a wide range of qualities

These data are used by FMC to try to improve farming practices and supplier operations. This enhances the quality and value of Eucheuma seaweeds in the marketplace.

Competitive Product

In summary, several criteria are viewed as being essential to produce a top quality dried Eucheuma seaweed. These are listed below.

Quality:
- 30 to 35% moisture;
- Quick drying;
- Protection from rain;
- Rapid transmit.

Costs:
- Good farming practices for optimum growth rate;
- Reasonable shrinkages;
- Baling efficiencies.

One additional factor of great importance to carrageenan manufactures is "consistency". It is normal for process operations to prefer to receive the same reliable quality raw materials on an ongoing basis, but is critical for carrageenan manufacturing as even routine adjustments are quite complicated.

Fiji Quality

The current quality of Fiji Eucheuma cottonii is excellent, with good post-harvest practices in effect.