Quality of dried seaweed *Kappaphycus alvarezii* with traditional drying methods from North Gorontalo

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**Abstract.** *Kappaphycus alvarezii* seaweed collected from farmers in North Gorontalo were dried under the sun for 4-5 days. The aim of this research was to compare the quality of dried *K. alvarezii* processed by 3 different methods, i.e. use of plastic sheets, use of bamboo shelf and dry hanging. During the drying period, temperature was monitored and sensory checking was carried out to assess physical appearance, texture, moisture, impurities and CAW (clean anhydrous weed) levels of dried seaweed. Drying using plastic sheets and bamboo shelf was carried out for 5 days @ 6-7 hours at temperature of 29.8°C. The quality of *K. alvarezii* dried on plastic sheets showed less clean appearance, rather dull specific type, dry texture was less uniform, the clay was not easily broken, moisture level was 4.96%, impurities was 7.23%, CAW was 87.52%. The quality of *K. alvarezii* dried on bamboo shelf had a slightly less clean appearance, specific type of less bright color, less uniform dry texture, clay was not easily broken, moisture level was 4.64%, impurities was 7.18%, CAW was 74.77%. The quality of *K. alvarezii* dried by dry hanging over 4 days @ 7 hours at temperature of 29.8°C, had less clean appearance, specific dull color, evenly dry texture, the clay was not easily broken, moisture was 8.25%, impurities was 7.21%, and CAW was 61.29%.

**Keywords:** bamboo shelf, free-hanging, quality of *K. alvarezii*, plastic sheets, sensory

1. Introduction

The seaweed production of North Gorontalo in 2010, especially *K. alvarezii* was 20,000 kg and continued increasing to 43,830 kg in 2014 [1]. The main production areas were Anggrek, Atinggola, Kwandang and Simalata sub-districts. The community cultivate *K. alvarezii* because of market demand; *K. alvarezii* was sold by the farmers for Rp. 5000/kg wet and Rp. 12,000/kg dry. Dried *K. alvarezii* seaweed was sold up to 6 tons/month directly by several companies from Makassar, Manado and Surabaya.

Our field observation in 5 villages in North Gorontalo, one of them in the village of Tihengo, found three drying methods applied by the farmers. In the first method, the farmers placed the seaweed on plastic sheets on the ground or sand. In the second method, the farmers placed the wet seaweed on bamboo shelves. In the the third method, the farmers simply hanged the seaweed bunches vertically on clothlines. The last method was not popular among the farmers because they wanted to keep the salt crystal to make an extra weight when they sold their dried seaweed.

Drying was conducted basically to reduce the water content in seaweed. The quality of seaweed is getting better with lower water content [2]. Improper drying process will result in several losses, namely the natural characteristics of the original material, such as texture, appearance and quality.
properties. Drying using plastic sheets or tarpaulin on the ground causes dirty seaweed, uneven dryness due to moist [3]. Drying using bamboo shelves causes even dryness with the desired water content due to air circulation through the gaps on the drying bed. Free hanging is better because salt content is low and dryness is more evenly distributed [4].

According to Indonesian National Standard 2690.1:2009 the normal value of organoleptic dried seaweed *K. alvarezii* is 7. The color of dried seaweed is one of important features that stimulating consumer attention, a very important in the success of food trades. Drying will reduce the moisture content. The normal value for clean anhydrous weed (CAW) in dried *K. alvarezii* is 50% while for impurities is 3%, and for the maximum moisture content is 30% [5]. Impurities are foreign objects that are not expected on dried seaweed.

Seaweed drying by the farmers in North Gorontalo was carried out for 3-4 days, depending on the weather condition. Cases of rejection of their products were reported from several places because the products did not the standard set by the collectors. So far, the quality of dried *K. alvarezii* produced by the farmers have not been assessed. The farmers claimed their dried seaweed was of good quality considering the amount of salt crystals attached to seaweed, the texture of seaweed, and level of dryness. To ensure fair trade in dried seaweed business, it is important to describe the quality of seaweed dried from different methods. The study aimed to compare the quality of dried *K. alvarezii* processed under direct the sunlight and laid over plastic sheet (tarpaulin), bamboo shelves and free hanging. The information from this study is important to the farmers in supporting their claims or for improving their practice to produce better quality of dried seaweed.

2. Material and Methods

This research used equipments for three types of drying methods (plastic sheets, bamboo shelves, free-hanging method), thermometers, coarse scales, petri dishes, scissors, stirring rods, measuring cups, desiccators, blenders, analytic scales, ovens, plastic spoons, goblets, clamp pliers, aluminum foil, porcelain cups, weigh paper, plate and filter. For each method, 30 kg of fresh seaweeds collected from main ingredients used, namely *K. alvarezii* seaweed from Tihengo village or Langge village. Before being dried, the fresh samples were washed by dipping it into sea water and shaken to drop the dirt attached to them.

The experiment applied three methods of seaweed sun-drying practiced by the farmers from North Gorontalo. The methods were drying the seaweed on plastic sheets, bamboo shelves and free hanging on clothlines (figure 1). The bamboo shelves had a dimension of 4 m (length) x 4 m (width) x 3.7 m (height).

![Figure 1](image)

*a* drying on plastic sheets; *b* drying on bamboo shelves; *c* free hanging on clothline

*K. alvarezii* was dried for 3-4 days, but if expected level of dryness had not been achieved, drying was continued. During drying, air temperature was monitored every hour and average temperature was calculated. After drying, seaweed samples were evaluated for moisture content, CAW and impurities with 3 replications. Texture testing and appearance were evaluated by 25 panelists with reference to
SNI 01-2346–2011, moisture content was evaluated with reference to SNI 01-2354.2-2006, CAW and impurities was evaluated with reference to SNI 8169-2015. The data were processed with Microsoft Excel (Microsoft Inc. USA) and descriptive analysis was conducted to determine and compare the quality of *K. alvarezii* dried in the three different methods.

3. Results and Discussion

There were some differences in the quality among the seaweeds produced by different drying methods (Table 1).

| Characteristics | Plastic sheets (5 days) | Bamboo shelves (5 days) | Free hanging (4 days) | Indonesian National Standard: 2690.2015 |
|-----------------|-------------------------|-------------------------|-----------------------|----------------------------------------|
| Appearance      | 5                       | 7                       | 5                     | 7                                      |
| Texture         | 7                       | 7                       | 8                     | 7                                      |
| Moisture (%)    | 4.96                    | 4.61                    | 8.25                  | Max. 30                                |
| Impurities (%)  | 7.23                    | 7.18                    | 7.21                  | Max. 3                                 |
| CAW (%)         | 87.52                   | 74.77                   | 61.29                 | Min. 50                                |

3.1. Appearance

Samples from both the first and second methods were not yet dried evenly after 4 days (i.e. 28 hours) so drying period was extended for an extra one day (8 hours). Samples from hanging-free method dried after 4 days. The appearance of the seaweed samples after 4-5 days of drying are shown in figure 2.

**Figure 2.** Appearance of *K. alvarezii* after drying on plastic sheet after 4 days (a), on plastic sheet after 5 days (b); after 4 days on bamboo rack (c); after 5 days on bamboo shelf (d); after 4 days on cloth line hanging (e).

The samples dried on a plastic sheet were less clean in its appearance, i.e. a rather dull color of a specific type. Drying with this method caused the seaweeds easily got contaminated by dirts from the
ground, as reported by [4]. As a comparison, the seaweed samples dried on drying cabinet over 12 hours and 24 hours were quite good in appearance, as reported by [6].

The samples dried on bamboo shelves were a little less clean, less bright color specific types, meaning that they met the standard quality. The use of bamboo racks for drying enabled the water to drip down and the distance between the bamboo shelves and the ground kept the seaweed away from dirt [7]. The samples dried with free-hanging method were less clean in appearance of a specific type of dull color. Such description was under the standard quality, i.e. clean with bright colors [4].

3.2. Texture
The samples from each drying method showed the texture of less uniform, clay was not easily broken and meets SNI quality requirements: 269: 2015. The use of plastic sheets implied a limited air circulation for the specimens at the bottom layer of the seaweed. To obtain a uniform texture, the drying period must be extended. According to [8], if drying by free-hanging method will be used, thickness and distance among bunches of the seaweed must be arranged to allow uniform exposure to sunlight and good air circulation. Compared to large-sized one, small-sized bunch of seaweed will have larger area exposed to the direct sunlight and require shorter time of drying period.

3.3. Moisture
Water content was different among the samples of dried seaweed processed in different drying methods. However, all samples met the quality described in SNI: 269: 2015. In this study, the low water content for both seaweed dried on plastic sheets and bamboo shelves was caused by extension of drying period and elevated air temperature up to 33°C. The gap between bamboos were also a factor causing lower water content. The advantage of drying with bamboo shelves methods over the other methods were an ability to produce uniform moisture content [7].

The moisture content of seaweed was very important to know as part of the handling in maintaining durability and quality. The water content of the sample s from free-hanging method was relatively high (8.25%) due to short drying times (4 days) compared to the samples dried on plastic sheets and bamboo shelves (5 days). Water content of *K. alvarezii* had a score up to 10.75% after 40 hours of exposure to sunlight and 15.75% after 24 hours drying with a cabinet dryer.

3.4. Impurities
From impurity point of view, the samples of dried seaweed from three drying methods did not meet the quality standards. The seaweed processed with open drying models were susceptible to dirt. [10] reported that conventional drying requires large space hence the seaweed can get dirty easily and then its quality is lower. The use of seaweed dryers can minimize the presence of dirt. The level of seaweed impurities by [11] used a cabinet type tool with aluminum surface was 4% and with plastic surface was 5%.

3.5. CAW
From CAW point of view, all dried seaweed from the three drying methods met the standard of at least 50%. According [12], products with a high value of CAW was good. According [8], the level of CAW seaweed carried out using para-para drying was influenced by the gaps among seaweed being dried. If seaweed overlapped each other, then the formation of crystals may occur due to low evaporation and allows dirt to easily stick.

4. Conclusion
The quality of dried *K. alvarezii* on plastic sheet had less clean appearance, less bright colors, uneven texture, and clay was not easily broken. The quality of dried *K. alvarezii* dried on bamboo shelves had a little less clean, less bright colors, less even textures, and clay was not easily broken. The quality of dried *K. alvarezii* from free-hanging method was less clean in appearance, less bright specific color, and the dried texture was less uniform, clay was not easily broken. The three drying models produced dried algae with water content and CAW that met quality standards, but not the standards.
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