

# *From Ocean to Plate: How Drying Methods Affect the Quality of Edible Seaweeds*

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## **ABSTRACT**

Edible seaweeds are gaining increasing attention as sustainable and nutrient-rich marine food resources. However, their high moisture content makes them highly perishable, necessitating effective preservation techniques such as drying. This article examines the impact of various drying methods, including sun drying, hot air drying, freeze drying, microwave and infrared drying, on the quality of edible seaweeds. Drying not only extends shelf life but also influences physico-chemical properties, nutrient retention and functional attributes. While traditional methods are cost-effective, advanced techniques such as freeze-drying offer superior preservation of bioactive compounds and lipid stability. The study highlights the importance of selecting appropriate drying methods to ensure optimal quality and utilization of seaweeds in food applications.

## **INTRODUCTION**

**E**dible seaweeds are increasingly recognized as sustainable marine food resources due to their high nutritional value and functional properties. They are rich in dietary fibre, essential minerals, proteins,

and bioactive compounds that contribute to human health and disease prevention. Based on their pigmentation and biochemical composition, seaweeds are classified into brown, red and green groups. However, fresh

seaweeds contain high moisture levels ranging from 75-90%, which makes them highly perishable. This high moisture promotes microbial growth, enzymatic degradation, and rapid quality deterioration. Therefore, processing methods such as drying are essential to enhance shelf life and usability (Holdt & Kraan, 2011; Gupta & Abu-Ghannam, 2011). Thus, drying becomes a critical step in converting fresh seaweeds into stable and usable food products. It not only preserves but also determines the final quality of the product.

### **IMPORTANCE OF DRYING IN SEAWEED PROCESSING**

Drying is one of the most important preservation techniques used to extend the shelf life of seaweeds by removing moisture and reducing water activity. Lower water activity inhibits microbial growth and slows down enzymatic and biochemical reactions responsible for spoilage. Similar to fish preservation systems, reducing moisture directly improves product stability by limiting microbial activity. Drying also reduces the weight and volume of seaweeds, making them easier to store and transport. Additionally, it allows seasonal seaweeds to be available throughout the year for consumption and industrial applications. Hence, drying plays both a preservative and economic role in seaweed processing (Fellows, 2009).

- Reduces moisture and water activity
- Inhibits microbial growth
- Slows enzymatic and biochemical reactions
- Extends shelf life
- Reduces storage and transport costs
- Enables year-round availability

### **DRYING TECHNIQUES USED FOR EDIBLE SEAWEEDS**

Various drying techniques are employed in seaweed processing, each differing in efficiency, cost, and impact on product quality. Traditional methods such as sun drying are widely practiced due to their simplicity and low cost, but they lack control over environmental conditions. Controlled drying methods such as hot air drying provide better consistency but may affect heat-sensitive nutrients. Freeze drying, on the other hand, removes moisture through sublimation under low temperatures and preserves most of the original quality. Advanced methods like microwave and infrared drying offer rapid drying with improved efficiency. Each technique presents a trade-off between cost, energy consumption, and quality retention (Chan *et al.*, 2015).

- Sun drying (low cost, less control)
- Hot air drying (controlled, widely used)
- Freeze drying (best quality retention)
- Microwave drying (rapid process)
- Infrared drying (efficient heat transfer)
- Trade-off between cost and quality

### **MECHANISMS OF QUALITY CHANGES DURING DRYING**

Drying induces several physical and chemical changes in seaweeds due to heat transfer and moisture diffusion. As water is removed, the cellular structure of seaweeds undergoes shrinkage and deformation. Exposure to heat can lead to protein denaturation and lipid oxidation, affecting nutritional quality. Oxygen exposure during drying may further accelerate degradation of sensitive compounds. Additionally, rapid drying can cause structural damage such as case hardening, where the surface dries faster than

the interior. These changes collectively influence texture, color, and functional properties. The extent of these effects depends on drying temperature, duration, and method used (Deng *et al.*, 2020).

- Moisture diffusion from internal tissues
- Heat-induced structural changes
- Protein denaturation
- Lipid oxidation
- Degradation of bioactive compounds
- Risk of case hardening

## EFFECT ON PHYSICO-CHEMICAL PROPERTIES

### Moisture Content and Water Activity

Drying significantly reduces the moisture content of seaweeds, which is essential for improving shelf stability. Moisture removal directly lowers water activity, thereby inhibiting microbial growth and enzymatic reactions. Different drying methods result in varying levels of residual moisture, affecting product safety and storage life. Freeze drying generally achieves the lowest moisture content due to sublimation under vacuum. In contrast, sun drying may leave higher residual moisture due to uncontrolled environmental conditions. Proper control of moisture and water activity is therefore critical in ensuring product quality (Gupta & Abu-Ghannam, 2011).

- Reduction in moisture content
- Lowering of water activity ( $a_w$ )
- Inhibition of microbial growth
- Improved shelf stability
- Freeze drying gives lowest moisture
- Sun drying may leave residual moisture

### Proximate Composition

Drying has a significant impact on the proximate composition of seaweeds, including protein, lipid, ash, and fibre content. While moisture removal may increase the apparent concentration of nutrients, high temperatures can cause degradation of sensitive components. Proteins may undergo denaturation, affecting their functional properties. Lipids, particularly unsaturated fatty acids, are highly prone to oxidation during thermal drying. Minerals generally remain stable, although minor variations may occur. The extent of these changes depends largely on the drying technique and temperature applied.

- Protein denaturation at high temperature
- Lipid oxidation during thermal drying
- Minerals remain relatively stable
- Fibre structure may be altered
- Apparent nutrient concentration increases
- Strong dependence on drying method

Thus, drying method selection plays a crucial role in determining nutrient retention. Controlled drying techniques are essential to maintain nutritional quality.

### Fatty Acid Profile and Lipid Stability

Seaweeds contain valuable polyunsaturated fatty acids (PUFAs), which are highly sensitive to heat and oxidation. Drying at high temperatures can lead to significant degradation of these fatty acids, especially omega-3 compounds such as EPA. Oxidative reactions during drying reduce both nutritional value and functional properties of lipids. Freeze drying, due to its low-temperature conditions, preserves fatty acid composition more effectively. Low-temperature drying methods also help in retaining lipid quality

compared to high-temperature drying. Therefore, lipid stability is strongly influenced by drying conditions.

- High sensitivity of PUFAs to heat
- Loss of omega-3 fatty acids
- Oxidation reduces nutritional value
- Freeze drying preserves lipids best
- Low-temperature drying is preferable
- High-temperature drying causes major losses

### CONCLUSION

Drying is a critical step in transforming seaweeds from highly perishable marine biomass into stable and valuable food products. The choice of drying method significantly affects the physico-chemical, nutritional, and functional properties of seaweeds. While traditional methods are economical, they often compromise quality, whereas advanced methods provide better retention of nutrients and bioactive compounds. Scientific evidence consistently shows that low-temperature and freeze-drying offer superior quality retention. Therefore, selecting appropriate drying techniques is

essential to maximize the potential of edible seaweeds.

### REFERENCES

- Chan, J. C., Cheung, P. C. K., & Ang, P. O. (2015). Comparative studies on the effect of drying methods on seaweeds. *Food Chemistry*.
- Deng, Y., Zhao, Y., & Tao, H. (2020). Effects of drying on food quality: A review. *Journal of Food Processing and Preservation*.
- Fellows, P. (2009). *Food Processing Technology: Principles and Practice*. Woodhead Publishing.
- Gupta, S., & Abu-Ghannam, N. (2011). Bioactive potential and possible health effects of edible brown seaweeds. *International Journal of Food Science & Technology*, 46, 189–199.
- Holdt, S. L., & Kraan, S. (2011). Bioactive compounds in seaweed: Functional food applications. *Journal of Applied Phycology*, 23, 543–597.
- Journal of Applied Phycology (2024). Studies on drying effects in *Fucus vesiculosus*.