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**Sea Kelp: Resolving Burkina Faso’s Hunger Crisis**

**Abstract**

This paper explores the hunger and malnutrition crisis in Burkina Faso and proposes harvesting sea kelp from the North Pacific Ocean for human feedstock as a solution.  The Northern Oceanic regions are the most abundant source of available sea kelp in the world; countries such as the United States (Alaska and Maine), France and Norway have more than doubled their sea kelp production per year (Marine Species Portal; Hermans 2023). However, the focus is on using sea kelp as industry feedstock rather than for human consumption. This paper builds on earlier research on high protein content in sea kelp and advocates for its use in human feedstock as a powder to solve nutrition issues in countries such as Burkina Faso.

**Background**

Burkina Faso is a poor country in West Africa, with a population of over 23 million (BBC, 2024; Worldometer, 2024). The average family from Burkina Faso has 6.13 children, approximately 4 more children than the global average of 2.37 (Our World in Data, 2022). Burkina Faso's population is growing at an alarming rate, exceeding the country's carrying capacity. Additionally, Burkina Faso has experienced many conflicts. In 2022 alone, there were two military coups (WPUSA, 2022).  The absence of an effective governmental structure has contributed to a cycle of violence, which has adversely affected food production and led to the suffering of the people. Nearly half of the population lives on less than $2 a day; 3.4 million people living in Burkina Faso are starving (Our World in Data, 2022). More than 10% of children under 5 in Burkina Faso face acute malnutrition, a condition in which a lack of protein impacts their growth (UNICEF, 2023).

With very little industrialization, 90% of the population is reliant on agriculture to make ends meet (Britannica, 2024). At the same time, the country's terrain and weather are not well-suited for an agrarian economy. Over the past four decades, Burkina Faso has experienced deforestation, desertification, and soil erosion, leaving much of the soil infertile (Britannica, 2024). In 2022, the West Africa region faced many natural calamities, like drought and intense floods that have destroyed habitats that the agricultural population was dependent on (WPUSA, 2022). The agricultural growth of local crops like cereal, fruits, and vegetables is unsustainable.  This has been a big impediment to the food supply in Burkina Faso, and therefore a call to action is required.

**Solution**

There are about 30 different species of sea kelp. Of late, there has been a surge of interest in tapping their vast potential as an industrial raw material used in the production of bioplastics to biofuels (Jones, 2023). Sea kelp-derived biopolymers have garnered attention as a potential substitute for conventional synthetic packaging materials (Lähteenmäki-Uutela et al., 2021).

This interest has led to a significant increase in the harvesting and production of sea kelp, as well as research into sustainable farming. World production of sea kelp is over 35 million tons, the majority of which is in the Pacific Northwest region (Jones, 2023). Large-scale companies are already participating in sea kelp extraction. Take Cascadia, the largest Canadian sea kelp cultivator. They explain their farming process: "kelp trimmings are taken from local wild plants in the autumn, and their spores are spread onto twine wrapped around pipes in a nursery composed of a couple of tanks in adapted shipping containers. After about a month, when the babies are still smaller than a pinky fingernail, they are transported out to ocean farms, where the twine is rewrapped around long lines anchored a few meters below the surface. Here they grow until early spring" (Cascadia, 2021). This type of farming is very sustainable for the Canadian environment; Cascadia only leaves 10% of the sea kelp in the water as the base source for next year’s crop.

As sustainable farming and production of sea kelp rises, the prices will naturally decrease. This represents a key opportunity to expand the use of sea kelp beyond industrial raw materials and to explore its potential to fight the hunger crisis. Sea kelp is a nutritional powerhouse. They are rich in protein (up to 47%) and contain bioactive compounds such as peptides, glycoproteins, lectins, mycosporine-like amino acids, and phycobiliproteins (Pliego-Cortésa et al., 2020; Pandey, Chauhan, & Semwal, 2020). It offers 20 distinct vitamins, minerals, and antioxidants including vitamin K, vitamin A, vitamin B12, iron, and magnesium. The food packs dietary fibers, omega-3 fatty acids, and essential amino acids (Pliego-Cortésa et al., 2020). Sea kelp has significant potential for human nutrition needs. However, in the food industry today, it is mostly used as a flavoring and gelling agent.

The current push for mainstream human consumption of sea kelp is driven by a few visionary culinary activists like Phil Mansergh and Øistein Nilsen. Phil Mansergh is popularizing it through his “The Kelp Shack” eatery in Cape Town, South Africa, and Øistein Nilsen is introducing kelp-based cuisine to cruise-goers as the culinary director for Hutigruten Norway (Japhe, 2023). Delicacies like kelp ravioli and burgers are popularizing kelp in mainstream cuisine, but the emphasis is on fresh sea kelp harvested from the oceans straight to the kitchen table.

For sea kelp to be a viable solution for tackling hunger, harvesting it and converting it into human consumable form must be sustainable in the long term, and economically viable in the short term. In the tropics, kelp grows at much deeper depths making it more expensive to harvest (Santelices, 2007). Hence, the big challenge is the distance between hunger trouble spots like Burkina Faso in Africa and the North Pacific Ocean where the sea kelp will be most cost-effectively harvested.

Fresh kelp with a high moisture content of almost 95% - is easily perishable (Djaeni & Sari, 2015). Additionally, that moisture does not add nutritional value, but instead adds an excessive weight and volume load, which makes transportation costly. Therefore, sea kelp cannot be transported in its raw form. It must be converted to a form that is shelf-stable and lightweight for effective transportation, while still preserving all nutrients. This is achieved by drying the sea kelp.

Historically, the process of drying sea kelp and using it as a human protein source has been met with skepticism. Sea kelp has poor protein digestibility in its raw, unprocessed form. Its complex cell wall poses a physical barrier inhibiting digestion in the gastrointestinal tract. Hence the protein digestibility of kelp is much less than that of animal proteins. This greatly emphasizes the need for protein extraction techniques to improve their digestibility. Unfortunately, heat-drying the kelp to lower transportation costs can negatively impact digestibility. According to a recent study heat above 200° C “can negatively affect protein digestibility and accessibility due to racemization of amino acids" (Connor et al., 2020). However, with proper and controlled drying techniques, heat can increase protein accessibility. It was shown that heat treatment in the range of 70-90° C can increase protein digestibility, as it resolves the tertiary structure and unmasks accession to proteins (Connor et al., 2020).  Additionally, pretreatment methods were shown to increase essential amino acid content in sea kelp, particularly tyrosine, essential in cognitive brain development in children (Kadosh et al., 2021). The use of the autoclave method, a pretreatment method combining both heat and pressure used on *P. Palmeta*, a species of kelp grown in the North Pacific, was shown to increase protein yields by 17.1%-24.3% (Connor et al., 2020).

Dried sea kelp per 100g has ~32g protein compared to chicken which has ~27g (USDA, 2019; USDA 2020). Dried sea kelp will most likely be a form of complete protein as some species, including kelp in the Gulf of Alaska, contain all essential amino acids (Pangestuti & Kim, 2017). But even if essential amino acids are lost during processing, sea kelp has an advantage on traditional forms of protein as in powdered form it can be blended into other plant-based products which can form a complete protein (Goriessen et al., 2018).

The process of drying seafood and shipping internationally is not that uncommon. One of the largest examples of such a supply chain happens to be from a cluster of West African countries where large quantities of fish are dried, smoked, and then exported on boat to the EU, UK, and US (Small starter). For international shipping, exporters can use what we learned about dried fish shipping. Sea kelp has an advantage compared to dried fish as it will be cheaper for Burkina Faso to buy due to being less of a commodity.

Some scientists have expressed concern about the practicality and environmental impact involved in drying sea kelp and converting it for human consumption. The process of drying remains expensive, time-consuming, and energy-intensive, emitting carbon into the environment (Badmus et al., 2019; Godin, 2020). In the past, with smaller processing facilities these issues were major hurdles. Yet, more high-tech processing plants for sea kelp dehydration are being established in various areas of North America, in hopes of achieving economies of scale. Take Ocean's Balance, one of America's largest dried sea kelp distributors. Each carbon-friendly industrial dryer can dry 30,000 tons of sea kelp in just a day. Ocean Balance report this new technology being a game-changer (Oceans Balance). As a result, this method of processing can be done practically in Western countries like Canada or the United States of America.

The other impediment to effective sea kelp harvesting is the regulatory complexity. Given the potential for the impact on oceans, regulations are necessary. However, the current regulations are outdated and do not consider the advances in sea kelp harvesting techniques over recent years. Carlos Duarte, a researcher professor in biological oceanography, comments that sea kelp "is not an industry in most western nations" (Godin, 2020). In Western countries, finding a permit for growing kelp is cumbersome. To get a permit in Washington State, you must go through nine different agencies, and the paperwork is so time-consuming that people give up (Brown, 2022). Laura Butler, a coordinator with the Washington State Department says, "There's a lot of people who are interested in seaweed farming, take a look at that [permitting] flowchart, and decide there's just no functional way" (Brown, 2022). We must advocate for streamlined regulations, for governments to recognize the problems and implement policy solutions.

While concerns about the over-farming of sea kelp damaging local ecosystems exist, the techniques used in commercial farming have been tested over the years and have had no apparent effect on the environment (NOAA Fisheries). The reason why is apparent; the industry requires no pesticides, or fertilizers, requires minimal land, and is low-tech. (Jones, 2023). Companies like Cascadia in Canada are leading by example by engaging in responsible and sustainable farming. A study concluded that substituting 10% of human food with sea kelp by 2050 could save 110 million hectares of land (Nature Sustainability).

Along with the culinary experts who are driving the popularity of sea kelp in raw form, we need to encourage and publicize the incorporation of the extracted sea kelp protein in food products and recipes. Food influencers’ reach on social media platforms especially to younger generations should be leveraged to encourage and publicize the incorporation of extracted sea kelp in food products and recipes. For broader adoption, the recipes in local ethnic cuisine should be adapted. Ragoût d’igname is a yam stew cooked in tomato sauce, which in poorer parts of the country is eaten as a vegetarian meal lacking protein (Tunuka Media, 2020). The strong spices from the ginger and garlic in the dish can pair well with the blended and dried sea kelp powder. Another common food is Babinda, a Burkinabe stew made from leafy greens and fermented locust beans (Persson, 2022). The use of dried sea kelp powder can help enhance the flavors in the stew, especially the flavor profile provided by the fermented locust beans. Pairing umami with spice-rich stews brings out earthy notes which can bring unique flavors to traditional dishes. (SpicesInc, n.d). If we are successful in this adaptation, we can enhance the amount of protein in local cuisine. Other food trends emphasizing sustainability, like veganism, can be synergistic in that effort. Sea kelp is halal, and since the majority of Burkina Faso has a Muslim population, this solution addresses one of the most critical cultural barriers for adoption.

Successful integration of sea kelp in cuisine will require collaboration with grassroots organizations involved in food security. Organizations like APROSSA focus on food security initiatives in Burkina Faso. Currently, APROSSA organizes a cereal market that brings together small farmers and larger organizations that are willing to trade with them (APROSSA, n.d).  APROSSA could potentially adapt some of its existing programs to include education on the integration of sea kelp protein into local cuisine and diet.

Along with helping directly address the malnutrition problem in countries like Burkina Faso, sea kelp farming can help such countries by acting as a cheap, environmentally friendly fertilizer for the farming population, who can focus their limited arable land on the production of crops that are complementary to what sea kelp provides. With an increased food supply, we reduce scarcity of food, water, and land. This is more likely to prevent future humanitarian conflicts and consequently Burkina Faso could have more people working in the tertiary sector providing the country with economic resiliency.

The movement to resolve the hunger crisis in Burkina Faso begins with the West. It’s not a technological question of if sea kelp farming can be scaled; it’s a question of the companies, governments and the people to support the industry’s growth. We must urge governments to change their policies and obtain private sector investment to get this solution off the ground. When the sea kelp industry scales, the return on investment economically, as well as addressing the hunger crisis will be worth it (Godin, 2020).

**Conclusion**

The paper finds that the research and processes have reached a point where sea kelp, sustainably harvested in an economically viable way in the North Pacific Ocean - can help address the food scarcity challenges in distant locations like Burkina Faso. Sea kelp farming for human consumption can address one of the most critical challenges facing humanity - food insecurity - which is driving political instability and mass human migration. Further research is needed improving the drying technology to further reduce costs and incorporation of dried kelp in human consumable form. We also need a strong involvement of policymakers, investors, and influencers in developed countries to make the solution feasible on a large scale in Burkina Faso.

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