CHAPTER 1
INTRODUCTION

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In the modern world, finding sustainable protein sources is more crucial than ever. There is an urgent need to look at alternatives because traditional protein sources are becoming scarcer, and the world's population is growing. This book explores into the forefront of this revolution, where algae, particularly spirulina, emerges as a promising solution. Current protein sources, which come primarily from crops and cattle, are struggling with issues of environmental effect and scalability. The increasing demand for protein worldwide, resulting from dietary changes and population expansion, is surpassing the supply of traditional sources. Furthermore, protein malnutrition is still a major problem in many regions of the world, which exacerbates economic hardships and health inequalities. Algae present a special chance as a wholesome and sustainable source of protein. When compared to traditional agriculture, they are much more efficient due to their quick rates of development and low land requirements.

Algae, including spirulina, have a variety of uses in the food business in addition to being a possible source of single-cell protein (Bratosin et al., 2021). Algae have practical advantages as food additives since they improve the nutritional value and sensory qualities of food items. The process of removing functional elements from algae opens up a world of possibilities, from producing bioactive chemicals with health-promoting qualities to improving the texture of food. In particular, spirulina has attracted notice due to its exceptional nutritional makeup.

Spirulina is a high-quality powder that is produced using an advanced technology and is high in protein and other necessary elements. Its use as a dietary supplement has demonstrated potential in reducing malnutrition and enhancing general health results.

Encapsulation techniques are essential for improving the stability and distribution of beneficial ingredients like spirulina in the food sector (Bortolini et al., 2022). Spirulina's bioactive chemicals can be encapsulated using a variety of techniques, such as spray drying or coacervation, which maintains the plant's effectiveness and bioavailability. In addition to shielding spirulina from environmental deterioration, encapsulation materials in which can range from lipids to natural polymers ensuring regulated release mechanisms that maximise nutritional advantages. Because of the benefits of encapsulation, spirulina can now be used as a viable ingredient in a wide variety of consumer goods by enhancing the sensory qualities and shelf life of food products.

Subsequently, agro-industrial operations generate a large amount of trash globally, which poses both environmental problems and potential for resource recovery. The idea of a biorefinery is examined in this synopsis as a viable way to valorise agro-industrial waste and turn it into useful products. Crop leftovers, byproducts of food processing, and biomass are among the significant amounts of waste produced by agro-industrial sectors like forestry, agriculture, and food processing (Ogbu & Okey, 2023). These wastes are frequently disposed of by burning or landfilling, which presents risks to the environment such soil contamination and greenhouse gas emissions. The ineffective handling of agro-industrial waste highlights the necessity for long-term fixes that can both reduce negative effects on the environment and maximise the value of these resources.

A viable method for turning agricultural and industrial waste into useful goods is the biorefinery. Biorefineries allow the conversion of organic residues into biofuels, bioactive chemicals, biosorbents, and biofertilisers by utilising biotechnological processes. Biofuels made from agricultural and industrial waste, such biodiesel and bioethanol, provide renewable energy substitutes for fossil fuels, lowering greenhouse gas

emissions and enhancing energy security. Bioactive chemicals that are isolated from waste streams give otherwise wasted materials new value in the pharmaceutical, nutraceutical, and cosmetic industries. Agro-waste-derived biosorbents are useful for cleaning up the environment since they may absorb contaminants from the air and water and make ecosystems healthier.

Probiotics have drawn a lot of interest in shrimp aquaculture because of their potential to increase sustainability and productivity. When given to shrimp, these advantageous microbes can have a good impact on a number of biological processes. Probiotics work in a variety of ways, including as immunological activation, antiviral, antibacterial, and antifungal properties (Wang et al., 2022). Additionally, they aid in the synthesis of substances known as inhibitory compounds, which have the ability to stifle harmful organisms and hence support a more robust microbial balance within the aquaculture environment. There are various benefits to using probiotics in shrimp aquaculture. First of all, they boost the immune system of the host, making it more capable of fending off infections. By lowering illness incidence and mortality in shrimp populations, immunological modulation enhances overall farm output and financial returns.

Additionally, probiotics aid in the synthesis of bioactive substances that have the ability to competitively keep harmful bacteria and fungus out of shrimp intestines and the surrounding environment. In addition to enhancing shrimp health, this competitive exclusion mechanism lowers the demand for antibiotics, allaying worries about antibiotic resistance. Probiotics support environmentally and financially viable sustainable shrimp farming methods by maximising nutrient absorption. Probiotics, in general, provide a proactive strategy for developing stronger and more robust shrimp populations, guaranteeing the aquaculture sector's long-term viability.

Food quality analysis is a vital field that protects food items' nutritional value, safety, and authenticity. It includes a range of techniques and tools designed to evaluate the various characteristics of food, from its chemical makeup to its microbiological safety. This study