CHAPTER I
INTRODUCTION

1.1 Introduction

Spirulina (*Arthrospira* spp.) is a photosynthetic, multicellular, filamentous cyanobacteria that has a long history of utilization. It has been traditionally consumed for centuries as human food by various cultures which call by different names, such as dihé in Africa and tecuitlatl in Mexico (Henrikson 1994; Abdulqader et al., 2000). Countless scientific studies highlight the fact that Spirulina is a rich source of nutrients and of high-value compounds, as it has a very high contents of macro- and micronutrients, essential amino acids, up to 62.7% protein content, 15.6% carbohydrates, 8.1% fat, 3.1% fiber, vitamins, minerals, and anti-oxidants (Aouir et al., 2017).

Nowadays, Spirulina is commercially produced worldwide and is mainly cultivated for nutritional biomass as human food and supplement, as well as for animal feed (Priyadarshani et al., 2012). High-value natural pigments such as phycocyanin, which is exclusively found in cyanobacterial cells, can be obtained from Spirulina. In the past few decades, Spirulina made its name in the food supplement market as one of the gold standards. Unfortunately, regardless of its manifold nutritional and health benefits and despite its great business potential, Spirulina has gradually lost its shine and is not in the global nutritional spotlight anymore. Based on the market research conducted by Siambiota Co., Ltd (unpublished study), the main reason for this loss of interest towards Spirulina over the past decades resides in an avoidable marketing mistake: manufacturers constantly advertise Spirulina as a single universal product. Spirulina can indeed be purchased under a variety of forms (i.e. tablets, powder, and capsules) but variations of the product itself (i.e. strains, cultivars, cultivation methods) have not been mention. In addition, the health benefits of Spirulina have been marketed with unclear directions and overclaimed. This gradually generalized Spirulina

products, creating a biased customer perception that Spirulina is one single agricultural product with indifferent yet arguable properties. This perception has been scientifically proven to be false, as the health benefits of Spirulina are indeed significant in different model organisms and between clinical trials (Marles et al., 2011), but they also vary greatly depending on Spirulina species, strains, and the way they have been cultured (Van Eykelenburg and Fuchs, 1980). As the trends of plant-based protein food and holistic nutritional supplements have recently come into fashion, it is believed that Spirulina may regain its position in the market again. However, in order to achieve and make a Spirulina-based sustainable business, its marketing has to be strategic, notably by showcasing the varieties of the Spirulina produced (i.e. species, strains, and the ways they are cultivated) with claimable benefits that are specific to a given variety. The validation of the Spirulina varieties is however a challenging task for manufacturers, but it is also a crucial step for the determination of varieties, customer recognition, and therefore for the successful strategic marketing of Spirulina. Unlike other agricultural products such as durians, mangoes, or rice of certain cultivars, ways of farming, and regions whose characteristics may be observed through ordinary senses such as visible appearance, scent, and taste, differences in the characteristics of Spirulina varieties can only be confirmed at a biomolecular/biofunctional level. Biochemical analysis equipment such as HPLC (High Performance Liquid Chromatography), Raman spectroscopy and gas analyzers may be used to characterize such biochemical differences. Although these methodologies can deliver accurate results, they are less practical for repeated use on an industrial scale due to their requirements for complicated sample preparation, the time spent to proceed with the analysis, demand for technical skills to operate and operational costs. Alternative methodologies, such as UV-Vis spectrophotometry and FTIR/UV-Vis spectroscopy (Fourier Transform Infrared Spectroscopy) are less time-consuming, less complicated, and much more cost-effective. These techniques allow for the optical responses of certain constitutional biomolecules, which are specific to broad scanned wavelengths, to be semi-quantitatively measured. The profile of the optical response over the range

of scanned wavelengths is therefore specific to a sample of a unique biochemical constitution. In other words, this profile can be used as a "fingerprint" of a biochemically distinct sample. A similar technique has been previously implemented in characterizing and identifying agricultural products such as yeast, grassland plant species, and also chicken (Rana et al., 2018; Shapaval et al., 2019; Katemala, S., 2022). In this particular study, our aim is to investigate the relationship between the biochemical profiles obtained from UV-Vis spectrophotometry and FTIR spectroscopy and link it to a single variety of Spirulina (i.e. strains and the ways they are cultivated), which will ultimately allow for the construction of the standard biochemical fingerprints of specific Spirulina products. Finally, we aim to test these fingerprints for their ability to determine strains and ways of cultivation of unknown Spirulina samples.

1.2 Research Objective

1. To create and validate standard biochemical profiles base on FTIR analysis for the classification of Spirulina strains

2. To characterize biochemical profile with FTIR specific to the species or standard culture.

1.3 Research hypothesis

The biochemical profile of Spirulina is generated from FTIR that can determine the difference of species and culture in terms of different condition factors. These biochemical profiles can be used to determine the species and culture, water quality, origin of species, and type of media used to grow Spirulina.

1.4 Scope of research

This research focuses on studying and determining the SB, C005H and C005L species (previously developed at SUT) and standard culture in terms of quality of water, duration of light, indoor and outdoor culture with the aim of creating biochemical profiles based FTIR analysis results. This method aims to be effective both for known and unknown samples.