Algal Research 29 (2018) 343–353

Contents lists available at ScienceDirect

Algal Research

journal homepage: www.elsevier.com/locate/algal

Starch-based flocculant outperformed aluminium sulfate hydrate and polyaluminium chloride through effective bridging for harvesting acicular microalga *Ankistrodesmus*

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A R T I C L E I N F O

Keywords:
Microalgae harvesting
Coagulation-flocculation
Self-flocculation
pH-induced
Starch
Bridging mechanism

A B S T R A C T

Microalgae represent a diversified pool of resources famed for valuable raw materials which are favoured over terrestrial crops in certain applications. Even so, limited green microalgae strains have been explored and studied till date. Thus, the highlight of this study is to comparatively evaluate the performance of pH-induced settling, use of chemical coagulants and starches as natural coagulants for efficient harvesting of acicular-shaped *Ankistrodesmus*. Biomass recoveries were determined through conventional jar tests and small scale coagulation-flocculation studies. Increased acidity at pH 3 and enhanced basicity above pH 11.5 have facilitated self-flocculation of cells leading to rapid settling. Despite that, potential reduction in chlorophyll contents and contamination from resulting precipitation of hydroxides evident from field-emission scanning electron microscopy micrographs may limit further applications of harvested biomass. By adding 12 mg/L of alum or 4.8 mg/L of polyaluminium chloride, up to 36.6% and 40% of the initial biomass was harvested respectively at pH 6. Their poor performances were deduced to be the effect of buoyancy due to the long, curved needle-like structure with tapered ends of *Ankistrodesmus*. Remarkably, the use of 120 mg/L of autoclaved rice starch has enhanced the biomass recovery to at least 80%; improvement of 2 fold from those achieved using chemical coagulants. The bridging mechanism induced by the use of starches coupled with the effect of slow mixing has been found to be paramount for enhancing the floc formation process through effective linking of neighbouring cells. Subsequently, an extended blanket of *Ankistrodesmus* cells was formed which facilitated its heightened settling upon treatment with starches.

1. Introduction

Despite > 30,000 of known microalgae species, only selected few are commercially significant due to their high-value products such as pigments and proteins [1]. As such, microalgae symbolize a vast pool of unexploited natural raw materials esteemed for various commercial and industrial applications specifically for biofuel, pharmaceutical and animal feed. *Ankistrodesmus* sp. is a green microalga belonging to the family Selenastraceae and is characterized by the long needle-like structure with a curved body with tapered ends. While microalgae such as *Chlorella* and *Spirulina* are recognised for their protein and nutritional values and *Dunaliella salina* as a source for photosynthetic pigments, the green algae of *Ankistrodesmus spiralis* is known to produce organic metabolites such as mycosporine-like amino acids; a UV screening compound [1]. Additionally, the lipid and fatty acids present in *Ankistrodesmus* would be ideal for the production of biofuels [2]. Even though the microalgae oil yield varies according to the respective strains, they are generally more superior compared to other conventional vegetable oil crops [3]. Yet, the harvesting of microalgae has been challenging given their small size, low density and low solid concentrations [4]; demanding for a suitable harvesting method. Chemical methods such as coagulation-flocculation are fast, reliable and

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https://doi.org/10.1016/j.algal.2017.11.001
Received 14 February 2017; Received in revised form 1 November 2017; Accepted 3 November 2017
Available online 15 November 2017