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Applications of *Arthrospira platensis* as an Alternative Source of Food, Maintaining Nutritional Security and Awareness Creation; there by Reducing Problems of Malnutrition in the Society

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ABSTRACT

An increase in population has led to explorations of alternative sources of food, nutrition and energy. This search and the maintenance of nutritional security are essential dimensions of sustainable communal growth and development. This study revises evidences for alternative food production from *Arthrospira platensis*. The use of *Arthrospira platensis* for food is increasingly relevant as its components (proteins, lipids, minerals and vitamins) have substantial potential to be competitive with the same components from other food sources, and *Arthrospira platensis*-based food production is relatively low in price and holds medicinal properties.

Keywords: Cyanobacteria, Antioxidant, Single cell protein, *Arthrospira platensis*, Malnutrition

1. INTRODUCTION

Arthrospira platensis is a microscopic blue-green algae or cyanobacteria from the Cyanophyceae family. It normally grows in aquatic ecosystems, alkaline and suitable nutrient media, as well as in appropriate warmer media [1]. Like other edible algae, *Arthrospira platensis* can be considered as a source of a healthy food with good nutritional value - in an adequate quantity as single cells proteins (SCP) and there by provides energy for all life process. Furthermore, it comprises about 70% (w/w) of proteins, all other indispensable

nutrients required for body growth and development like ions, magnesium, zinc, vitamin A, and make a significant contribution to overcome challenges and problems of malnutrition and hunger in human beings and other animate being. The growth and production of *Arthrospira platensis* for food and the corresponding compositions of biomass produced (the living matter in a given culture media) depends upon a number of factors; of which nutrient availability, proper media alkalinity, temperature and sun light are predominantly mentioned. In the regions of an *Arthrospira platensis* growing, yields are approximately equivalent to 9 tons of proteins per hectare, when compared to 1 tone/hectare for barley and other protein rich cereals.

The use of micro-algae (*Arthrospira platensis*) as alternative method for human or animal feed production process, particularly regarding protein, provides several advantages over plants and animals food sources: it requires small cultivation unit area; it is not dependent on season to grow; it synthesizes protein from inorganic nitrogen, and it grows fast and double its biomass number within hours [2]. Additionally, since *Arthrospira platensis* can be grown and cultivated in an extreme condition (i.e., salinity and in media of high pH value), it is likely considered as a highly hygienic source of food, because several pathogenic microbial are unable to survive in such harsh conditions. Several previous research work has revealed that *Arthrospira platensis* is safe for human food and feed or it does not exhibit any negative implications upon its consumption by humans in their diet, i.e. there is no toxicities, neither chronic or acute [3].

Unbalanced diet and hunger, which is one of the main problems suffering developing countries is characterized by the increase in number of population and their growth rate relatively, when compared to agricultural production capacity, a situation has led to find an alternative source of food, high food requirement, the increase in food price and high infants mortality rate. Globally, on average, about twelve million children under five years are dying every year due to unbalanced diet and hunger. Above all, the most annihilating disease is kwashiorkor, caused by lack of sufficient proteins, vitamins and oligo-elements. In a situation where natural resources are running out, especially in agricultural arena, it requires an immediate action for awareness creation, searching for an alternative source of food supply and proper utilization of the resources, in order to insure efficient strategies for preservation and sustainable resource management system.

Introduction of different techniques as the rational management of the land and water resources for the growing food production system provides an opportunity for yield improvement, while insuring preservation of natural ecosystems and among these techniques, the growth of *Arthrospira platensis* appears as one of the principal solutions, since it requires small space to grow, and is economically seems to be feasible as long as the production capacity and production yield improvement are concerned [39-41].

2. NUTRITIONAL VALUES OF *ARTHROSPIRA PLATENSIS*

Arthrospira platensis, which is a filamentous blue-green microalgae or cyanobacteria, a major source of protein (60-70 g/100 g) with highest biological value and it is a rich source of vitamins, mainly vitamin B12 and pro-vitamin A, minerals, especially iron, and gamma-linolenic acid (GLA), essential fatty acids, is a precursor for prostaglandins. Furthermore, it has been shown by different authors that in its compositions, an *Arthrospira platensis*

contains molecules such as xanthophyll's pigments-tocopherol, phycocyanin, β -carotene and phenolic compounds, which are being an agent for the antioxidant activities of these microalgae.

In terms of nutritional compositions, *Arthrospira platensis* comprises macro- and micronutrients including high quality protein, iron, gamma-linolenic acid, vitamins, minerals, sulfated polysaccharides and phycocyanin and hence, it provides an opportunity and the possibility of being used as an alternative, clean and functional food. It has proven to help specific body functions, giving a health promoting properties and reduce the risk of disease in addition to its nutritional functions. Moreover, *Arthrospira platensis* has also shown to have good acceptance for human consumption due to the presence its organoleptic properties, which make it a possible view for protein rich source of food or a nutrition accessory for both humans and animals and it has also not exhibited neither acute nor chronic toxicities [3,4-9].

Under-nutrition is the consequence of inadequate food or diet consumption, resulting in a poor nutritional status characterized by lower body weight and/or height and this value is particularly evident for those children under five years old. In such circumstances, being frequently vulnerable to protein deficiency, constitutes a public health problem across the world, but particularly in developing countries. In the process of developing an adequate and protein rich sources of food to overcome challenges and problems associated with malnutrition, careful attention has been addressed to microalgae – *Arthrospira platensis*, and not only these but also it plays a great role as a single cell protein (SCP), i.e., crude or refined sources of protein which arises from microorganisms such as bacteria, yeasts, fungi or algae, it becomes a suitable and valuable ingredient to several chemical processing industries (e.g., fuel, cosmetic, therapeutic), including the feed, food and nutritional ones [10-13].

2. 1. Biochemical Compositions of *Arthrospira platensis*

Arthrospira platensis – is a microalga with its appropriate compositions (protein, vitamins, lipids, and minerals) could be considered as a suitable and an alternative source of food supplement. A number of previous research work concerning to antioxidant actions, anticancer, palatability, lack of toxicity and ease of digestion, immune stimulant, and anti-inflammatory, anti-viral, among others has been carried out so as to verify the possible advantages of *Arthrospira platensis* and some of its basic properties have been disclosed accordingly [14-16].

As a source of good nutrition, the supplements of *Arthrospira platensis* might be consumed for several reasons, i.e. to boost or compensate an insufficient energy, macronutrient (carbohydrates, lipids, and proteins) or micronutrient (vitamins and minerals), to strengthen or empowerment of body cells and to prevent disease and uncomfortableness [17]. This microalga (*Arthrospira platensis*) is mainly composed of the following major nutrients. These are:

2. 1. 1. Protein content

Arthrospira platensis do possess exceptionally high protein content (on an average 60-70% of its dry biomass weight), of which 90% is capable of being converted into assimilable condition (able to be absorbed and incorporated into body tissue). It contains all the essential amino acids in fairly high amounts, but the amount of the sulfur amino acids is low [18]. Based on available scientific evidence, *Arthrospira platensis* may be considered as a

promising source of protein for human nutrition especially in the situation of protein deficiency. In general, the biological values of microalgae in terms of their protein contents varies based upon their species type [19].

2. 1. 2. Vitamins

The indispensable vitamins including: Vitamin B - group, Vitamin E and Vitamin B12 that are available in *Arthrospira platensis* encourage the metabolic activities of body tissues and among these, Vitamin B12 is the most prominent and most complicated vitamin and it comprises all of the biologically active cobalamin [20]. Furthermore, due to its constituents of very large amount of vitamin B12, the consumption of *Arthrospira platensis* in diet provides great opportunities for vegetarians, because vitamin B12 is usually incorporated only in animal-based source of food [21]. *Arthrospira platensis* can also be considered as a promising source of β -carotene, comprising approximately 700-1700 mg/kg, and when consumed and absorbed properly, it will be converted into vitamin A and therefore, these microalgae have sufficient potential to insure the human requirements of vitamin A dosage in their daily diet i.e. about 1 mg/day [22].

2. 1. 3. Minerals

The mineral contents of *Arthrospira platensis* are usually depending upon the conditions of its growing culture media i.e. it depends upon: the amount of inorganic chemicals and nutrients added to the culture media, media alkalinity, and temperature. The most important inorganic nutrients in *Arthrospira platensis* include: iron (Fe), calcium (Ca) and phosphorous (P). Hence, proper consumption of sufficient and substantial amount of *Arthrospira platensis* in diet helps to prevent the risk and disease caused by iron deficiency - microcytic and hypochromic anemia as hemoglobin is not present in an adequate quantities in red blood cell (RBC) – a mature blood cell that carry oxygen to the bodily tissues [23].

2. 1. 4. Lipids

Arthrospira platensis comprises a lipid fraction of just about 5-10% of its dry biomass weight. The most crucial thing with this regard is that lipids constitute such fraction are mainly of greatest importance and indispensable to human beings. Hence, *Arthrospira platensis* is conceived as a good source of gamma-linolenic, linolenic and oleic acids. The gamma-linolenic acid, which is one the constituents of total fatty acids (TFA) has received much attention, because there are no several valuable food sources that contain such substantial amounts of gamma-linolenic acid; in fact, *Arthrospira platensis* is considered as the vegetable source with the highest quantity of lipid, representing around 20% of its total fatty acid (TFA) content [24]. The importance of this gamma-linolenic acid depends upon the concept that it is a precursor of prostaglandins, and consequently, as they are mediators in inflammation and immune processes, they take part in the course of situations such as cardiovascular disease, diabetes, arthritis, and cellular aging [25].

2. 2. Medicinal Values of *Arthrospira platensis*

Arthrospira platensis provides a number of significant and remarkable health benefits to malnourished children, especially those who are under five years old. It does possess an

abundant supply of desirable qualities of beta-carotene that can overcome an eye problems (eye diseases) caused by the deficiency of Vitamin-A, and it also offers the daily dietary requirement of β -carotene which can assist to prevent eye diseases and blindness. The protein constituents of *Arthrospira platensis* and its Vitamin-B complex provides a major nutritional betterment in adults and children's diet. It is the only food source incorporating significant amounts of essential amino acids, gamma-linoleic-acid (GLA) and essential fatty acids, which aids to determine the entire hormonal system. *Arthrospira platensis* do not possess cellulose in its cell walls, because it is composed of soft muco-polysaccharides structure and this facilitates the ease of its digestibility approximately (85 to 95% digestible) and assimilation in the body tissue. This ease of its digestibility is particularly crucial for these people suffering from abnormal absorption of nutrients from the digestive tract. Besides, the *Arthrospira platensis* helps to treat people who are suffered from kwashiorkor - disease due to deficiency of protein in the diet and if it's given to undernourished infants and children, it is much more efficient and effective than other sources of protein, such as milk powders, because milk's lactic acid can be difficult for intestinal absorption and assimilation processes. Previous research has revealed that the effects of this microalgae (*Arthrospira platensis*), as it plays a great role in significant therapeutic applications: an anti-cancer effect [26], a hypolipoproteinemia effect [27], and a protective effect against obesity and diabetes [28]. These benefits help to consider an *Arthrospira platensis* as an alternative raw material or ingredient for the production process of healthy food and diet with highest nutritional and medicinal values.

3. THE PROSPECTS OF ARTHROSPIRA PLATENSIS

The use of microalgae or cyanobacteria is getting an increasing concern due to its flexibility and large potential to produce and develop various types of reagents, chemicals and biologically active compounds, like proteins, lipids, vitamins, carotenoids, pigments and polysaccharides [15]. *Arthrospira platensis* has been taken into account and analyzed for its constituents as a single cell protein (SCP) [30], polyunsaturated fatty acids (gamma-linolenic-acid), vitamins, minerals, and proteins [31], antioxidant activity, and therapeutic properties [32]. A number of cultivation technologies and methodologies, such as; open surface or open ponds [33], tubular photo bioreactors [34], inclined glass panels [35] have been studied and attempted for effective and efficient production of this microalgae - *Arthrospira platensis* for the desired purpose. Consequently, this microalgae has received an increasing interest since it represents one of the most promising sources of compounds with highest chemical and biological activities, which might be used as functional ingredients in the balanced diet. Its appropriate chemical compositions, like, presence of antioxidants, vitamins, balanced fatty acid, minerals, good quality proteins, and its interesting properties provide great opportunities for production and proper utilization of this potential microalgae as a source of food with highest protein content and good nutritional value [36]. Furthermore, the production of *Arthrospira platensis* has also been regarded and received a remarkable considerations recently, according to [23], this microalgae can be an alternative and promising source of proteins, vitamins and minerals in the diet for the present and future generations [37]. Due to its small space requirement for cultivation and with its high reproduction rate, it is

approximated that the cultivation unit area available for its growth can produce about 125 times more protein than that of the same unit area provided for corn [38].

4. CONCLUSION

In conclusion, the cultivation and production of an *Arthrospira platensis* provides great opportunities as an alternative and promising source of food and feeds for all human beings and animate being, especially, due to its simple and low cost production methods, its moderate requirements for growth, its highest and qualified conservation value of ecosystems, its high nutritional and medicinal values, its high energy boosting potential in body tissue, as well as its safety and security in relation to consumption i.e. no toxicities [36].

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