

Biomaterials Journal

www.biomatj.com

Online ISSN: [2812-5045](https://doi.org/10.2812/5045)

Amalgamation of Astaxanthin and Spirulina may be a potential anti-carcinogenesis treatment strategy

Sadia Jahan¹, Rezwan Ahmed Mahedi^{2*}, Fahmida Zaman³, Sadia Afrin³, Anika Rodela⁴, Samina Shimu⁵, Shakil Ahmed⁵, Shahriar Shohan³

¹Lecturer, Department of Pharmacy, Comilla University

²Bangladesh Pharmacists' Forum, Comilla University

³Department of Pharmacy, Comilla University

⁴Department of Pharmacy, North South University

⁵Department of Pharmacy, Manarat International University

(Received 14 December 2021; Accepted 18 December 2021; Published 1 January 2022)

Abstract

Introduction. A projected 43.8 million individuals die within five years of a diagnosis of cancer worldwide. For years, surgery, chemotherapy, radiation, and chemotherapy were the only options. For decades, surgery, immunotherapy, radiation, and chemotherapy were the only options. Numerous case studies demonstrate that micro-algae offer considerable potential as a cancer-fighting strategy. Frequent use of Astaxanthin, a red-colored antioxidant, combined with Spirulina, nutrient-rich blue-green algae, may show potential in cancer treatment. **Objective.** The major focus is on the mixture of astaxanthin and spirulina, two natural chemicals with anti-cancer capabilities against many malignancies. However, the combination of ATX with SPU is still in its early stages. Thus, we showed the anticancer capabilities from prior research and paved the way for the combination of these two compounds. **Methodology.** Various publications have been reviewed for evidence of these two chemicals' anticancer capabilities against different types of cancer, as well as how these compounds function against tumor tissues. **Result.** Individually, the therapeutic impact of spirulina can prevent HCC conformational alterations. Astaxanthin, on the other hand, is implicated in the prevention of prostate cancer in naked mice. **Conclusion.** This review might provide ideas for future cancer research or study into the combined therapeutic impact of these two natural anti-cancer agents.

Keywords: Astaxanthin, GLOBOCAN, Algae, Spirulina, Carcinogenesis

1. Introduction

With the uncontrolled multiplication of aberrant cells that can develop in situ or even conquer afflicted tissues and reach the level of organs via circulatory and lymphatic systems, cancer ranks second in the globe [8]. GLOBOCAN forecasts that

now the fatality rate and deaths globally keep increasing each year to 18.1 million new cancer cases and 9.6 million deaths by 2018 and death (one in eight men and one in 11 women). Worldwide, an estimated 43.8 million people live within five years of cancer diagnosis (five-year pre-valence). For decades, surgery, chemotherapy, radiotherapy, and chemotherapy were the only means to an end. These

*Corresponding author e-mail: rezwanmahed747@gmail.com

Received 14 December 2021; accepted 18 December 2021; published 1 January 2022

©2022 Biomaterials Journal (Biomat.J.)

days, natural products are thriving in our society and almost half of the best-selling medicines are made or promoted in the environment. Many testing procedures such as preclinical, clinical stages I to III, and re-registration, include 547 FDA-approved products and products. They took mainly plant crops (47%), bacteria (30%), and fungi (23%) [11]. Among the natural ingredients, many have been shown to be particularly effective for biological purposes involved in the prevention or treatment of carcinomas such as astaxanthin (3,3'-dihydroxy- β , β' -carotene-4,4'-dione) and spirulina.

Astaxanthin was originally identified in lobsters in 1938, and also was utilized in aquaculture for coloring purposes until the 1970s. Powerful antioxidant qualities, biological and physiological activities, it was authorized as a nutritional supplement in 1991. In addition, astaxanthin is able to penetrate the cell membrane due to its polar-nonpolar-polar configuration. Astaxanthin's ionic rings contain hydroxyl (OH) and carbonyl (C = O), making it very polar, powerful, and antioxidant [6].

A. platensis, *A. maxima*, and *A. fusiformis* are some of the blue algae (cyanobacteria) that grow in saline water and are being used as a nutritional supplement called spirulina [4]. It grows natively and is commercially produced in tropics and subtropics regions of the United States, Asia, and Central Africa where there are alkaline water sources. A large amount of phytochemicals in Spirulina has been shown in several studies to be beneficial for health (B. Li, 2005). It is known as a high-protein food (55-70 percent). Inhibition of cancer cell growth and breakdown of the cancer cell cycle have been related to spirulina [2]. Notably, Spirulina includes all the necessary amino acids needed in humans and decreased levels of cysteine, methionine, and lysine, parallel to animal proteins [1]. In addition, the extract of Spirulina has been described as antibacterial [5] and anticancer agents.

Numerous case studies show that micro-algae hold great promise as a weapon in the battle against cancer. Regular intake with Astaxanthin, a red-colored antioxidant, with Spirulina, nutrient-rich, blue-green algae, maybe showed promise in cancer therapy [9]. These two drugs are working like super antioxidants. If we combined both of these drugs we expect that we get a satisfactory effect. It inhibits the proliferation of tumor cells, induces tumor cells, inhibits tumor cell metastasis, and promotes tumor cell apoptosis through the cell membrane surface

death receptor pathway. In this paper, we showed that a combination of this drug could serve as a promising anti-cancer therapeutic agent.

2. Objectives

Our main focus is the combination of astaxanthin and spirulina, two natural compounds, having anti-cancer properties against various cancers. But Combination of ATX and SPU is still unestablished. So, here we revealed the anticancer properties from previous studies, and make the path for the combination of these two products

3. Methodology

When it comes to seafood, such as sea bream and salmon crabs, Astaxanthin is a xanthophyll carotenoid. When it comes to the blue-green algae Spirulina, it's also described as Cyanobacteria. Mineral-rich alkaline lakes provide the perfect environment for this plant to thrive. In addition, both Astaxanthin and spirulina possess potent anti-inflammatory effects. Astaxanthin and spirulina have shown significant potential as chemotherapeutics in cancer, according to research. Spirulina is a cyanobacteria (blue-green algae) biomass that people and animals may ingest. *Arthrospira platensis*, *A. fusiformis*, and *A. maxima* are the three species. As a nutritional supplement or complete food, *Arthrospira* is grown globally.

As part of the research, spirulina was tested against advanced mouse hepatocellular cancer. 100 mg/kg intraperitoneal dose of diethylnitrosamine was used to develop Hepatocarcinoma, accompanied by 22 weekly injections of carbon-tetrachloride (0.5 mg/kg) for 22 weeks. As soon as hepatocellular carcinoma was detected, oral spirulina (250 to 500 milligram/kilogram BW) was administered. Researchers found that Spirulina prevented conformational changes in HCC. This was shown in improved survival rates, decreased levels of the tumor bio-marker AAFP, and a reduction in nodule count and size, too. An increase in antioxidant capacity, Bax and p53, as well as a decrease in lipid peroxidation markers (MDA) and neoangiogenesis markers [3], were also observed (VEGF) [6]. Like these studies, some research revealed that spirulina works well against some cancer biomarkers such as HepG-2, MCF-7, SGC-7901, A549, and HT-29 [15].

Some of in vitro study, it has an effective impact on rat brain tumor cells, and Hela cells [8].

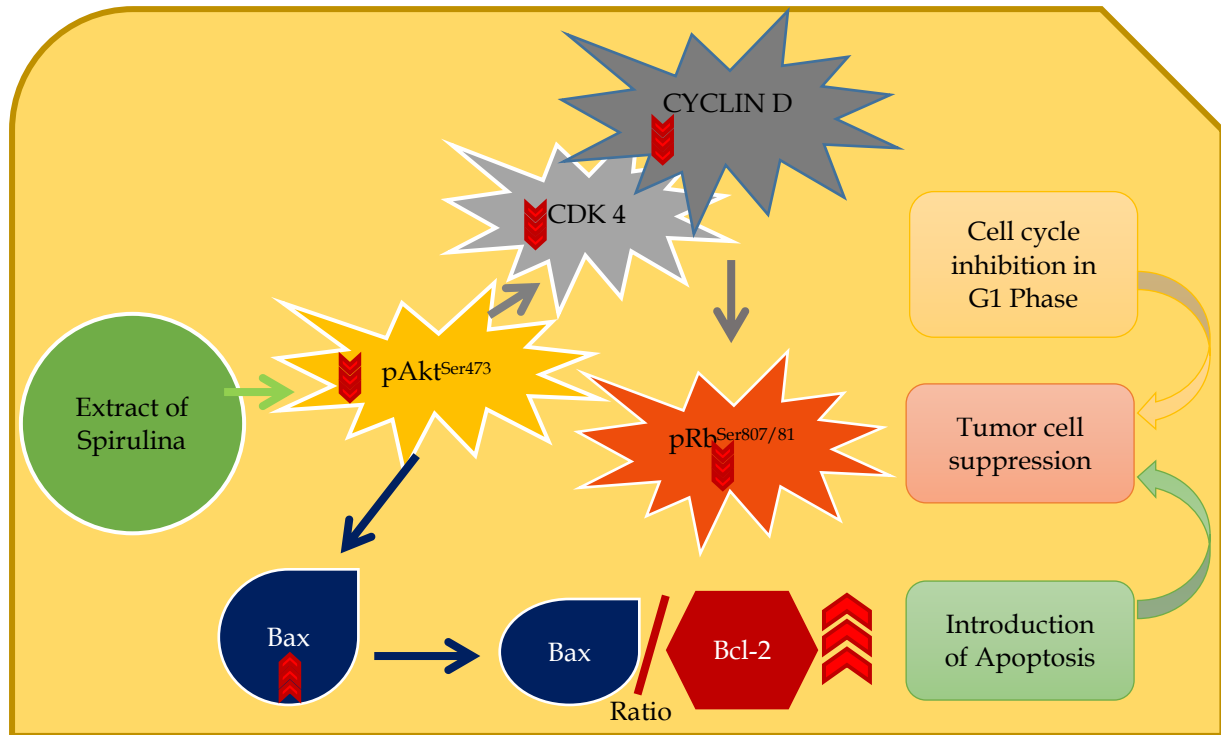


Figure 1: Molecular representation of spirulina against lung cancer.

Various kinds of cancer have been found to be inhibited by astaxanthin in vivo and in vitro. Astaxanthin has anti-proliferation, anti-apoptosis, and anti-invasion properties, according to several researchers [12]. These include signal transducer and transcription activator 3 (STAT3), nuclear factor kappa-light-chain-enhancer of activated B cells (NF- κ B), and peroxisome proliferator-activated receptor gamma (PPAR). For these reasons and more,

astaxanthin has tremendous potential as an anticancer agent. Only live creatures, such as bacteria, fungus, and unicellular green algae, are capable of ketching [13].

Table 1: Table 1: Impact of of ATX on cancers. (JAK: Janus kinase; STAT: Signal transducers and activators of transcription; NF- κ B: Nuclear factor kappa-light-chain-enhancer of activated B cells; ERK: Extracellular signal-regulated kinaes; JNK: c-Jun N-terminal

Cancer	Process	Bio-marker/T arget	Mechanisms
Breast Cancer	<i>In vitro</i>	-	Inhibits the growth of cells
Lung Cancer	<i>In vitro</i>	-	Inhibits the growth of cells
Oral Cancer	<i>In vivo</i>	NF- κ B, ERK, AKT (PKB), JAK-2/STAT-3	Angiogenesis and cell proliferation are inhibited by apoptosis.
Bladder Cancer	<i>In vivo</i>	-	Reduce cancer incidence and cell proliferation
Colon Cancer	Both	ERK, JNK, p38, AKT, NF- κ B	Apoptosis can be induced, and cell cycle progression can be stopped.
Hepatocellular Carcinoma	Both	STAT-3	Apoptosis is induced by mitochondria-mediated apoptosis.

Many researchers have analyzed the role of ATX on cancer cell growth. As part of a study, ATX was shown to inhibit the multiplication of the human hepatoma CBRH-7919 cell line, the rat breast SHZ-88 cell line, and the mouse lung Lewis cells in vitro, respectively. These cells showed a significant decrease in proliferation after 24 hours of exposure to ATX. CBRH-7919 [13], but on the other hand, was perhaps the most ATX-sensitive cell line, with an IC50 value of 39 micrograms. On K562 leukemia cells [16], ATX, as well as other carotenoids such as -carotene, capsanthin, and bixin, had a growth inhibitory impact.

4. Result

Chemotherapy is one of the most popular treatments used to cure cancer by killing or slowing the development of cancer cells. Cancer is one of the most serious diseases in the world. Chemotherapy has been replaced with cancer therapy based on Astaxanthin and Spirulina, which has two or more therapeutic agents. A single treatment may be more successful. Comparatively to monotherapy, the combination of anti-cancer medicines improves efficacy because it hits critical pathways in a generally synergistic or additive manner. When combined with other anti-cancer benefits such as decreasing tumor progression and metastatic spread and stopping mitotically active cells, this strategy has the potential to minimize drug resistance while still delivering therapeutic anti-cancer effects. The organs and tissues are also less likely to be damaged by these combinations.

5. Conclusion

These two natural products are containing some real anti-cancer effects. But, at present, we do not have any kind of combination of these two molecules for drug delivery. Our achievement will be complete if we establish the real combination of spirulina and astaxanthin, then we can go for further investigation for combination therapy for various cancer in vivo or in vitro methods.

6. Conclusions

These two natural products are containing some real anti-cancer effects. But, at present, we do not have

any kind of combination of these two molecules for drug delivery. Our achievement will be complete if we establish the real combination of spirulina and astaxanthin, then we can go for further investigation for combination therapy for various cancer in vivo or in vitro methods.

7. Conflicts of interest

There is no conflict of interest.

7. Formatting of funding sources

All of the authors do not receive any kind of financial support.

8. Acknowledgments

On the basis of this review paper, a poster presentation was presented at 3rd Indo Onco Summit 2021 – India, organized by Bioleague.

9. References

- [1] Parvin, M. H. A review on culture, production and use of Spirulina as food for humans and feeds for domestic animals and fish. *Aquaculture*, 33. (2008)
- [2] Zhou, M. L. Directed coevolution of betacarotene ketolase and Hydroxylase and its application in temperature regulated biosynthesis of astaxanthin, . *Journal of Agriculture Food Chemistry*, 1072–1080. (2019)
- [3] B. Li, X. Z. Effects of CD59 on antitumoral activities of phycocyanin from Spirulina platensis. *Biomedical Pharmacotherapy*, 551–560.(2005)
- [4] C. Xueding, C. Y. Astaxanthin prevents against lipopolysaccharide-induced acute lung injury and sepsis via inhibiting activation of MAPK/NF- κ B. *American Journal of Translation Research*, 1884–1894.(2019)
- [5] F.K. El-Baz, W. E.-S.-S. In vitro antiviral and antimicrobial activities of Spirulina platensis extract. *Journal of Applied Pharmacy Science*, 52–56.(2013)
- [6] L.M.A.J. Seabra, L. P. Astaxanthin structural and functional aspects. *RNutr*, Campinas, 1041–1050.(2010)
- [7] Mahmoud, Y. I., Shehata, A. M., Fares, N. H., & Mahmoud, A. A. Spirulina inhibits hepatocellular carcinoma through activating p53 and apoptosis and suppressing oxidative stress and angiogenesis. *Life Science*.(2021)
- [8] R. Hu, S. C.-L.-N. R.Regulation of NF-E2-related factor 2 signaling for cancer chemoprevention:

- antioxidant coupled with antiinflammatory. Redox Signal.(2010)
- [9] R. Koničková, K. V. R. Koničková, K. Vaňková, J. Vaníková, K. Váňová, L. Muchová, I. Anticancer effects of blue-green alga *Spirulina platensis*. Annual Hepatology, 273-283.(2014)
- [10] Ramazan Erenler, K. P. Chemical constituents and antiproliferative effects of cultured *Mougeotia nummuloides* and *Spirulina major* against cancerous cell lines. Zeitschrift für Naturforschung C, 87-92.(2016)
- [11] S. Fakhri, F. A. Astaxanthin, A mechanistic review on its biological activities and health benefits. Pharmacological Research, 1-20.(2018)
- [12] S. Rechter, T. K. Antiviral activity of *Arthrospira*-derived spirulan-like substances. Antiviral Research, 197-206.(2006)
- [13] Song XD, Z. J. Astaxanthin induces mitochondria-mediated apoptosis in rat hepatocellular carcinoma CBRH-7919 cells. Biological Pharmacy Bulletin, 839-44.(2011)
- [14] T. Hayashi, K. H. Calcium spirulan, an inhibitor of enveloped virus replication, from a blue-green alga *Spirulina platensis*. Journal of Natural Products, 83-87.(1996)
- [15] Wang, Z., & Zhang, X. Inhibitory effects of small molecular peptides from *Spirulina* (*Arthrospira*) *platensis* on cancer cell growth. Food Function, 781-788. (2016)
- [16] Zhang X, Z. W. Carotenoids inhibit proliferation and regulate expression of peroxisome proliferators-activated receptor gamma (PPAR γ) in K562 cancer cells. Archives of Biochemistry and Biophysics, 96-106.(2011)