



# The Cytotoxic Effects of Astaxanthin on Breast Cancer Cells

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## Abstract

**Background and Aim:** Astaxanthin, a potent antioxidant carotenoid has been found to be highly effective in mopping up free radicals as it possesses anti-oxidative properties. It also has anticancer effects because of antioxidative property. The aim of this study was to investigate the cytotoxic effects of astaxanthin on breast cancer (MCF7) cells *in vitro*.

**Methods:** In this experimental study, MCF7 cells were purchased from Pasteur institute (Tehran, Iran) and cultured on standard medium. The cells were divided in to control (untreated) group, and groups exposed to 0.5, 1, 5, 10, 20, 30, 40 and 50 µg/ml of astaxanthin. MTT assay was used to determine cytotoxic effects of the astaxanthin on MCF7 cells. Data were analyzed using one-way ANOVA.

**Results:** Exposure of MCF7 cells to 5, 10, 20, 30, 40 and 50 µg/cc of astaxanthin led to significant decrease in viability of MCF7 cells compared with control group. The viability of cancer cells decreased in a dose dependent pattern.

**Conclusion:** The results of this study indicated that astaxanthin has anticancer effects on breast cancer cells; however, lower concentrations of astaxanthin did not show cytotoxic effects on breast cancer cells.

**Keywords:** Astaxanthin, MCF7, Viability

## Introduction

Astaxanthin is a xanthophyll carotenoid, contained in *Haematococcus pluvialis*, *Chlorella zofingiensis*, *Chlorococcum*, and *Phaffia rhodozyma*. Astaxanthin, being a xanthophyll carotenoid is chemically identified as 3,3'-dihydroxy-β,β'-carotene-4,4'-dione. It is lipid soluble and distinguished from all other carotenoids and has a molecular mass of 596.84 g/mol with a formula of C<sub>40</sub>H<sub>52</sub>O<sub>4</sub>. It has conjugated double bonds at its center—giving it, its antioxidant effects. Astaxanthin, a potent antioxidant carotenoid has been found to be highly effective in mopping up free radicals as it possesses anti-oxidative, anti-inflammatory, anti-apoptotic, and other beneficial pharmacological properties. Many chemical reactions produce free radicals which are injurious to body cells, as they are the causes of many diseases, disabilities, and death. Antioxidants suppress

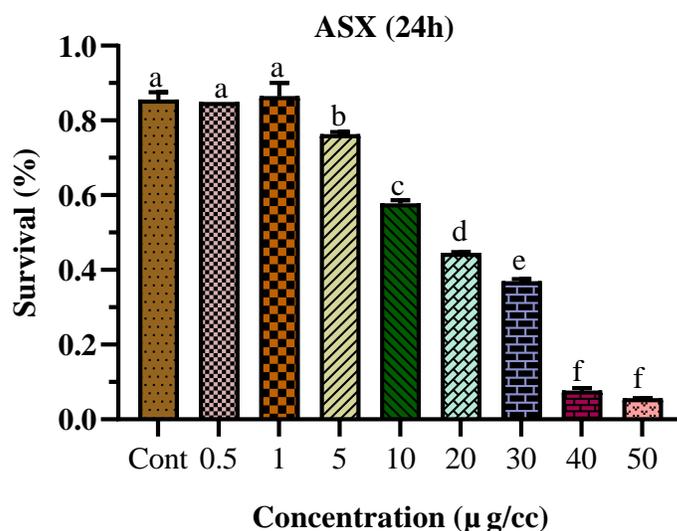
and mop up these circulating free radicals. [1-5] Sources of astaxanthin are yeasts, krill, trout, microalgae, shrimps, and crayfish. Astaxanthin is present in most red-colored aquatic organisms. Health benefits of astaxanthin include protection against eye-related macular degeneration (the most common cause of blindness) and inflammatory eye conditions. [6] Neuroprotective effects of astaxanthin have also been noted in recent studies. [7, 8] It has been reported that astaxanthin may have anticancer effects. [9] The aim of this study was to investigate the cytotoxic effects of astaxanthin on breast cancer (MCF7) cells *in vitro*.

## Materials and Methods

In this experimental study, MCF7 cells were purchased from Pasteur institute (Tehran, Iran) and cultured on standard medium. The cells were divided into control, and cells exposed to 0.5, 1, 5, 10, 20, 30, 40 and 50  $\mu\text{g}/\text{cc}$  of astaxanthin. MTT assay was used to determine cytotoxic effects of the astaxanthin on MCF7 cells. Data were analyzed using one-way ANOVA.

## Results

Exposure of MCF7 cells to 5, 10, 20, 30, 40 and 50  $\mu\text{g}/\text{cc}$  of astaxanthin for 24 hours resulted in significant decrease in viability of MCF7 cells compared with control group. The viability of cancer cells decreased in a dose dependent pattern. (Figure 1).



**Fig. 1.** Viability (survival%) of MCF7 cells exposed to 5, 10, 20, 30, 40 and 50  $\mu\text{g}/\text{cc}$  of astaxanthin for 24 hours (ASX24). b, c, d, e and f indicate significant difference compared with control (Cont) group. a indicate non-significant difference compared to control group.

## Discussion

Astaxanthin is a red pigment common to several aquatic organisms including algae, salmon, trout, and shrimp, the most common source of astaxanthin used in dietary supplements is from *Haematococcus* algae. [1] In the present study, we evaluated the cytotoxic effects of astaxanthin



on breast cancer (MCF7) cells in vitro. Our findings indicated that astaxanthin has cytotoxic effects on breast cancer cells. In line with our finding, previous studies have demonstrated cytotoxic and apoptotic effects of astaxanthin on cancer cells. [9] Pro-apoptotic and anti-cancerous effects of astaxanthin on intestinal human colon adenocarcinoma cell line have been recently reported. [10] The findings also suggest that astaxanthin can be involved in treatment of ovarian cancer. [11] In vitro antitumor potential of astaxanthin against cancer cells via mitochondrial mediated apoptosis has been demonstrated in recent studies. [12] Astaxanthin anti-proliferative effects on breast cancer cells have been suggested in a study carried out to evaluate the effects of carbendazim and astaxanthin co-treatment on the proliferation of MCF-7 breast cancer cells. [13] It has also been found that application of astaxanthin significantly reduced proliferation rates and inhibited breast cancer cell migration compared to control normal breast epithelial cells. [14] The combination of carotenoids and doxorubicin (DOX) selectively can alter oxidative stress-mediated apoptosis in breast cancer cells. [15] Several researches have deciphered that astaxanthin exerts its anti-proliferative via different molecules and pathways including signal transducer and activator of transcription 3 (STAT3), nuclear factor kappa-light-chain-enhancer of activated B cells (NF- $\kappa$ B) and peroxisome proliferator-activated receptor gamma (PPAR $\gamma$ ). [9]

### Conclusion

The results of this study indicated that astaxanthin has anticancer effects on breast cancer cells; however, lower concentrations of astaxanthin did not show cytotoxic effects on breast cancer cells.

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