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Comparative Study on the Absorption Rate of Nano-Micellar Biphasic Astaxanthin Versus Synthetic Astaxanthin in Healthy Adults

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Abstract: This study compared the absorption rates of nano-micellar biphasic astaxanthin and synthetic astaxanthin in a group of eighteen healthy adults. Participants were randomly assigned to receive either nano-micellar biphasic astaxanthin with an average particle size of 96 nm or synthetic astaxanthin, at a daily intake of 8 mg of astaxanthin for seven consecutive days. Blood samples were collected on days 1, 3, and 7 to measure plasma astaxanthin concentrations for assessing absorption rates. The results revealed significantly higher blood drug concentrations of nano-micellar biphasic astaxanthin compared to synthetic astaxanthin, with Cmax and AUC values markedly higher than those of synthetic astaxanthin. Specifically, the Cmax of the nano-micellar biphasic astaxanthin group was 12.12 times that of the synthetic astaxanthin group, and the AUC was 11.90 times that of the synthetic astaxanthin group. The enhanced absorption of nano-micellar biphasic astaxanthin indicates strengthened antioxidant effects and potential health benefits. These findings support the use of Biowell nano-micellar biphasic astaxanthin in dietary supplements, offering promise for improved cardiovascular health, immune function, and reduced oxidative stress.

1. Introduction

Astaxanthin is a powerful antioxidant with numerous health benefits, including anti-inflammatory properties, cardiovascular support, and immune system enhancement[1]. It is commonly found in two forms in dietary supplements: synthetic astaxanthin and natural left-handed (3S, 3'S) astaxanthin derived from microalgae such as Haematococcus pluvialis. While both forms are used to promote health, their bioavailability can significantly differ, impacting their overall effectiveness[2].

Synthetic astaxanthin, typically produced from petrochemical sources, is often a mixture of stereoisomers, including the less biologically active right-handed (3R, 3'R) and meso (3R, 3'S) forms. Natural astaxanthin, on the other hand, predominantly contains the (3S, 3'S) stereoisomer, which has been shown to have superior bioavailability and efficacy in various health applications[3].

Despite the advantages of natural astaxanthin, one of the persistent challenges has been its low absorption rate. Traditional formulations of astaxanthin are lipophilic, meaning they are fat-soluble and not readily absorbed in the aqueous environment of the gastrointestinal tract. This limits the

amount of astaxanthin that can cross cell membranes and exert its beneficial effects within the body[4].

In order to overcome these limitations, Biowell, a brand of Eternal Grace Pte. Ltd., has developed a groundbreaking nano-micellar biphasic astaxanthin using the Ultra-Absor™ technology. This innovative approach involves encapsulating astaxanthin sourced from natural Haematococcus pluvialis found in the Atacama Desert in nano-sized micelles, which enhances its solubility and stability in both aqueous and lipid environments. The astaxanthin is extracted using a customized, light-protected multi-stage kinetic extraction process to ensure its purity and potency before being encapsulated in nano-micelles. The unique nano-micellar formulation allows for efficient transport of astaxanthin across cell membranes, leading to a significant increase in its absorption and utilization within the body[5].

The nano-micellar biphasic technology represents a significant advancement in the delivery of astaxanthin, breaking through the absorption barriers that have traditionally limited its bioavailability[6-7]. By improving the solubility and stability of astaxanthin, Biowell's formulation ensures that a greater proportion of this potent antioxidant reaches systemic circulation, thereby enhancing its health-promoting effects. This study aims to quantitatively compare the absorption rate of Biowell nano-micellar biphasic astaxanthin with that of regular astaxanthin in healthy adults, providing scientific evidence to support its superior bioavailability.

2. Methods

2.1. Participant Selection Criteria

Inclusion criteria included ages 18-65, good health with no major medical history. Exclusion criteria included allergies to astaxanthin or related compounds, pregnant or nursing women, and individuals who had recently participated in other clinical trials.

2.2. Product characterization

The mean particle size, polydispersity index (PDI), and zeta potential of Biowell nano-micellar biphasic astaxanthin was evaluated at 25° C by the DLS method using a Malvern Zetasizer Ultra (Malvern Instruments Ltd, Worcestershire, UK). The samples were diluted 10-fold with Milli Q water and then utilized to determine the size distribution and zeta potential. All measurements were carried out in triplicate.

2.3. Test Process

This study employed a double-blind, randomized controlled design, involving 18 healthy adult volunteers who were randomly assigned to two groups: the experimental group (receiving Biowell nano-micellar biphasic astaxanthin prepared using the Ultra-Absor™ technology, Group A) and the control group (receiving synthetic astaxanthin, Group B). The nano-micellar biphasic astaxanthin from Eternal Grace Pte. Ltd.'s Biowell brand, utilizing the Ultra-Absor™ preparation method, was administered to Group A participants. All subjects consumed 8 mg of astaxanthin daily for a duration of 7 days. Blood samples were collected on days 1, 3, and 7 to assess plasma astaxanthin concentrations[8].

2.4. Data Collection and Analysis

Blood samples were collected at 0 hours (before ingestion), 2 hours, 4 hours, 6 hours, 8 hours, and 24 hours on days 1, 3, and 7. Plasma astaxanthin concentrations were measured using liquid

chromatography-mass spectrometry (LC-MS/MS)[9].

The primary endpoint was the peak plasma concentration (Cmax), and the secondary endpoint was the area under the plasma concentration-time curve (AUC). Statistical analysis was performed using independent samples t-tests to compare plasma astaxanthin concentrations between the two groups at each time point. Analysis of variance (ANOVA) was used to compare Cmax and AUC between the groups, with a significance level set at 0.05.

3. Results

Based on table 1, it is evident that the average particle size of Biowell nano-micellar biphasic astaxanthin is 96 nm, with a Polydispersity index <0.3. The absolute value of its Zeta potential is close to 28, confirming that this product meets the size requirements for nanoparticles and exhibits good uniformity and stability in dispersion.

Table 1: Particle size distribution and zeta potential of Biowell nano-micellar biphasic astaxanthin

	Mean particle size (nm)	Polydispersity index	Zeta potential (mV)
Biowell nano-micellar biphasic astaxanthin	96 ±3.5	0.28 ±0.2	-28 ±0.8

Based on table 2 and figure 1, it is evident that following the intake of Biowell nano-micellar biphasic astaxanthin, the plasma levels of astaxanthin in the experimental group were significantly higher at 2, 4, 6, 8, and 24 hours compared to the control group that ingested synthetic astaxanthin. This observation indicates a notable increase in astaxanthin concentration in the plasma of the experimental group after consumption of Biowell nano-micellar biphasic astaxanthin.

Table 2: Plasma Astaxanthin Concentration Data at Each Time Point (μg/mL)

Time Point (hours)	Experimental Group (Group A)	Control Group (Group B)	P value
0	0.0 ±0.0	0.0 ±0.0	-
2	8.3 ±1.1	0.7 ±0.2	0.015
4	12.6 ±2.0	1.04 ±0.3	0.011
6	11.3 ±1.7	0.8 ±0.3	0.023
8	10.1 ±1.4	0.8 ±0.2	0.034
24	4.1 ±0.5	0.4 ±0.1	0.031

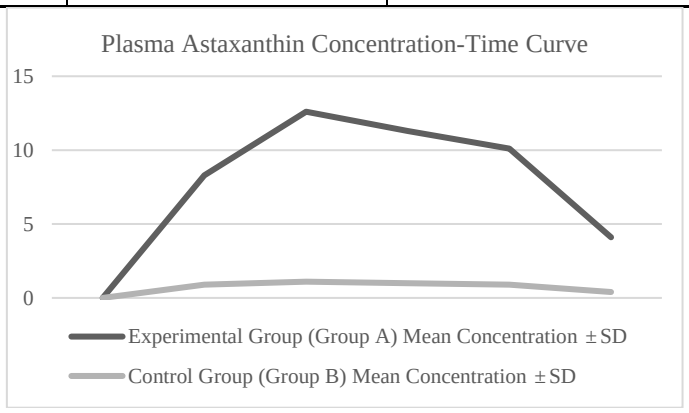

Figure 1: Plasma Astaxanthin Concentration-Time Curve

As shown in table 3, at all measured time points, Group A's Cmax and AUC were significantly higher than those of Group B ($p < 0.05$). Group A's Cmax was 12.12 times that of Group B, and AUC was 11.90 times that of Group B.

Table 3: Comparison of plasma astaxanthin Cmax and AUC between experimental group and control group.

	Experimental Group (Group A)	Control Group (Group B)	P value
Mean Cmax (μg/mL)	12.60 ±2.00	1.04 ±0.30	0.021
Mean AUC (μg·h/mL)	1285 ±145	108 ±17	0.004

4. Discussion

This study provides the first evidence that Biowell nano-micellar biphasic astaxanthin, with an average particle size of 96 nm, has higher absorption rates in healthy adults compared to synthetic astaxanthin. The nano-micellar biphasic technology likely aids in forming astaxanthin nanoparticles, enhancing its solubility and bioavailability, thereby improving absorption efficiency. The higher Cmax and AUC values indicate that Biowell nano-micellar biphasic astaxanthin is absorbed more effectively compared to synthetic astaxanthin, remaining in the bloodstream for a longer duration. This enhanced absorption can translate into increased antioxidant benefits and greater efficacy in promoting overall health[10-11].

The results also suggest that the nano-micellar biphasic formulation could be particularly beneficial for individuals seeking to maximize the health benefits of astaxanthin without needing to increase the dosage. This has important implications for the formulation of dietary supplements and could lead to the development of more effective antioxidant products.

5. Conclusion

The absorption rate of Biowell nano-micellar biphasic astaxanthin with an average particle size of 96 nm is 12 times higher than that of synthetic astaxanthin in healthy adults. This finding provides strong scientific evidence for the application of nano-micellar biphasic astaxanthin in dietary supplements and health products. The significantly improved absorption rate suggests that this novel formulation could enhance the therapeutic effects of astaxanthin, making it a valuable addition to the market of health supplements[12].

The enhanced absorption rate and bioavailability of Biowell nano-micellar biphasic astaxanthin could potentially lead to better health outcomes, including improved cardiovascular health, enhanced immune function, and reduced oxidative stress. Future research should focus on long-term effects and optimal dosing strategies to maximize these benefits.

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