Characteristics of Izu-Akazawa Deep Seawater by Aquaphotomics

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Summary

In order to investigate the characteristics of the Izu-Akazawa deep seawater (DSW) pumped from a depth of 800 m (5 km offshore) in Ito City, Shizuoka Prefecture, Japan, the water molecular structure was analyzed by aquaphotomics. Surface seawater (SSW) from the same location was prepared as a comparative control. PCA was performed for 1300-1600 nm, which is the first overtone of water, and water spectrum patterns (WASP) were compared as aquagrams. As a result, it was suggested that there were differences in each structure between DSW and SSW by PCA. In addition, it was found that DSW had the less hydrogen bonded water structure which were assigned to 1368 nm and 1424.5 nm, and SSW had strongly hydrogen bonded water structure. Furthermore, the results of aquagram on the ability of collagen synthesis by the medium including 0.5% DSW or SSW with vitamin C (Nomura et al., 2011) suggested that 0.5% DSW remained the less hydrogen bonded water structure even when the medium was added, but the characteristics of the water structure of 0.5% SSW was changed by adding medium.

Introduction

DSW is seawater at a depth of more than 200 m where it has a low temperature. It is completely dark, clean and plentiful in nutritive salt, and the conditions are stable for long periods of time (Fig. 1). In addition, DSW has been utilized in various industrial fields, such as ocean thermal energy conversion, cosmetics, drinking water, fishery, and agriculture, using the above characteristics.

We have been investigating the effect of DSW on beauty and health. It was discovered that DSW accelerated collagen synthesis of NHDF cultured using a 0.5% DSW medium with vitamin C, and it was suggested that the effect was caused by various kinds of minerals in the DSW. The purpose of this research is to understand the characteristics of the water molecular structures in DSW and SSW, and to elucidate the collagen synthesis accelerating effect of DSW by means of NIRS and aquaphotomics, which is a new method to observe water functionalities comprehensively.

Methods

The following samples were prepared for the measurement.

1) DSW (depth of 800 m, sampling day: July 30, 2018) pumped in Akazawa, Ito City, Shizuoka Prefecture, Japan
2) SSW (depth of 0 m, sampling day: July 30, 2018)
3) evaluation medium (two mediums prepared by adding 0.5% DSW and 0.5% SSW, which included 0.5% fetal bovine serum and 20 μg/mL vitamin C)

The medium adding 0.5% DSW regarding the collagen synthesis accelerating effect was reported by our study (Fig. 2). Near-infrared spectra were acquired with 1 mm optical path length and wavelength range of 400-2499.5 nm (0.5 nm step) using a spectrometer XDS Rapid Liquid™ Analyzer (FOSS). A spectral analysis was performed with Pirouette 4.5 (Infometrix) and PCA was used to investigate the characteristics of DSW and SSW. The effective wavelengths for understanding water characteristics were found in loadings. In addition, characteristics of each sample were compared by the aquagram.

Results and discussion

DSW (100%) and SSW (100%) were classified clearly by PCA. From loadings, DSW had the less hydrogen bonded water structure which were assigned to 1368 nm ($(OH)^-$-$(H_2O)_{1, 2, 4}$, water solvation shell) and 1424.5 nm (H-OH bend, OH ··· O). On the other hand, SSW had strongly hydrogen bonded water structure. Moreover the aquagram showed the same trend as the loading (Fig. 3).

From these results on aquagram of the diluted DSW and SSW, DSW had more water molecular structures assigned to 1408 nm (free molecule) than SSW (Fig. 4). As shown to Fig. 5, when both seawater were diluted from

1.00% to 0.01%, DSW had become similar to Milli-Q water (MQ), whereas SSW was different from MQ, because that had strongly hydrogen bonded water structures than MQ yet.

The results of the aquagram on the medium including 0.5% DSW, 0.5% SSW and MQ which were including vitamin C, 0.5% DSW remained the less hydrogen bonded structure even when the medium was added, and also 0.5% SSW had strongly hydrogen bonded structure (Fig.6).

Therefore, it was suggested that the characteristics of the water molecule structures of 0.5% DSW remained in the medium. Investigation of the significance of the above wavelength region in collagen synthesis on NHDF planned as a future subject of study.

1) Nomura et al. (2011) Deep Ocean Water Research, 12(1), 11–17.

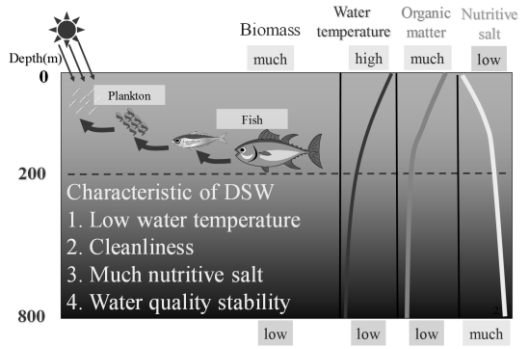

Fig.1 Characteristics of Deep seawater

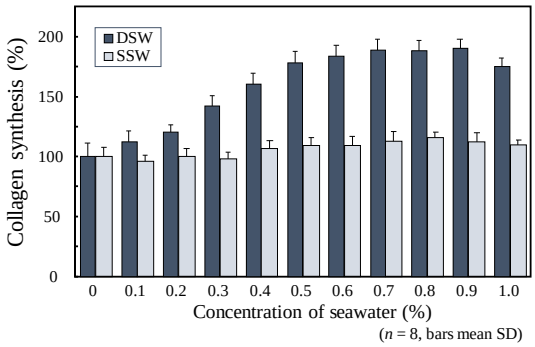

Fig.2 DSW accelerate collagen synthesis of human fibroblast

1) Nomura et al. (2011) Deep Ocean Water Research, 12(1), 11–17.

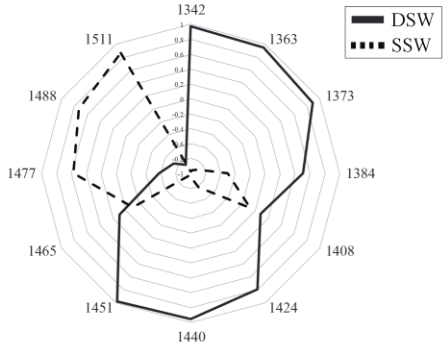

Fig.3 Aquagram of DSW and SSW (100%)

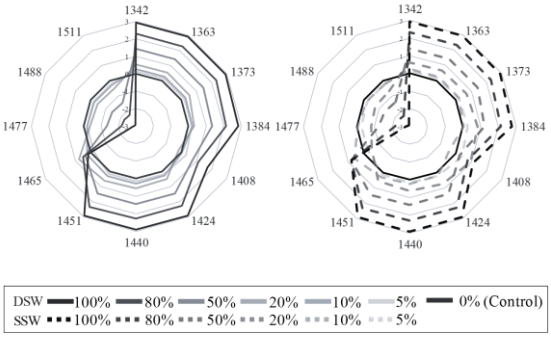

Fig.4 Aquagram of DSW and SSW (5-100%)

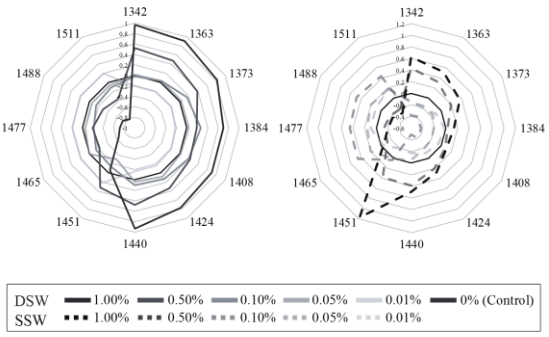

Fig.5 Aquagram of DSW and SSW (0.01-1.00%)

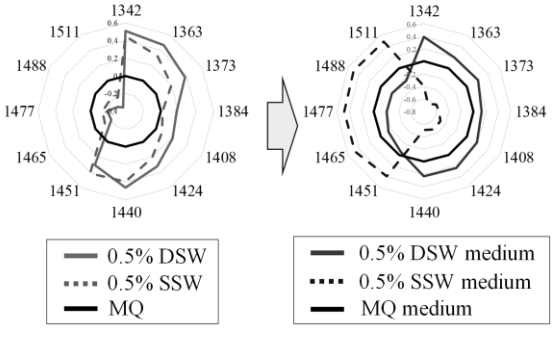

Fig. 6 Aquagram of DSW, SSW and those medium