RHEOLOGICAL PROPERTIES OF COLLAGEN GELS AFTER UV TREATMENT

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Introduction

Fish collagen is commonly applied in food and biomaterials production and can replace mammalian collagen; however, low denaturation temperature is usually its main disadvantage. Collagen extracted from the *Silver Carp* skin has attracted much attention in recent years due to its relatively high denaturation temperature [1]. As far as collagen in a solution is concerned, several properties can be measured. Rheological characteristics of collagen solutions and gels at different concentrations is one of them. Rheological properties of collagen are essential in several applications. In the case of cosmetic, biomedical and food applications, its rheological behaviour at different temperature values is essential in order to design a proper formulation and check its applicability under several conditions. Collagen gels are also used for studying cell–matrix mechanical interactions as well as developing tissue equivalents, the rheological properties of which are very important, too [2]. For several applications, collagen gels need to be sterilized and for this purpose the UV radiation can be used.
The aim of this work was to study the rheological behaviour of collagen obtained from the *Silver Carp* skin and the influence of UV irradiation on rheological properties of collagen gels.

Materials and Methods

Collagen was purchased from WellU sp. z.o.o, Gdynia, Poland. It was obtained by collagen isolation from the *Silver Carp* skin. The skin fragments were removed manually and washed with chilled tap water to get rid of the adhering tissues. In the next stage, the material was disinfected with 3% hydrogen peroxide water solution, residues of which were further rinsed off. The purified skin was placed in a lactic acid solution and left for 3 days to extract the collagenous proteins.
The collagen solution was dialyzed against distilled water for 2 days and then lyophilized. After lyophilisation, collagen gels were prepared in diluted 0.1M acetic acid at the concentrations of 5 mg/mL and 10 mg/mL. For prepared collagen gels, the rheological properties were measured. Collagen gels were irradiated with UV light and again the rheological properties were measured.
A rheological investigation was carried out on the prepared samples by means of a rotational viscometer, Bohlin Visco 88 (UK), equipped with a heating system and a solvent trap kit. Collagen solutions were irradiated using UV lamp ULTRAVIOL NBV 15, which emits mainly UVC with 254 nm wavelength. Collagen solutions were irradiated in a distance of 5 cm from the UV lamp.

Results and Discussion

FIG. 1 reports the viscosity curves of collagen solutions with concentration 5 mg/mL before and after UV irradiation with wavelength 254 nm.

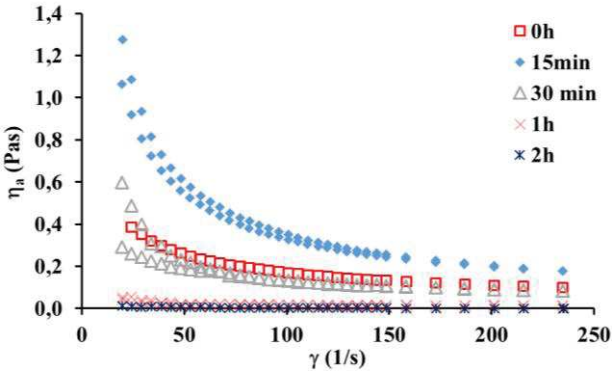

FIG. 1. Viscosity curves for 5 mg/mL collagen solution at 20°C before and after various time of UV-irradiation.

A collagen solution is characterized by the typical shear-thinning behaviour of polymer solutions observed in the decrease in the viscosity as the shear rate increases due to the progressive orientation and disentanglement of the chains. The apparent viscosity of the collagen solution is heightened with increasing concentrations. While the concentration of the collagen solution increases, the viscosity curves present a more pronounced shear-thinning behaviour. This is caused by an increase in collagen macromolecules interactions leading to the increase in the entanglement of the chains and more pronounced non-Newtonian behaviour.
After 15 min of UV irradiation an increase of viscosity was observed. Such an increase can be a result of physical crosslinking of collagen molecules by free radicals induced by UV light. However, after longer treatment than 15 min a decrease of viscosity was observed. After 1 hour of UV treatment collagen molecules lost its ability for gel formation. It may suggest that collagen molecules are fully denatured after 1 hour of UV treatment and collagen lost totally its native structure.

Conclusions

UV treatment of collagen gels obtained from the *Silver Carp* fish skin leads to the crosslinking reaction after short time of UV irradiation. After 1 hour of UV treatment collagen was fully denatured and lost its ability for gel formation.

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