Rheological properties of hydrocolloid extracted from Wild sage seed (*Salvia macrosiphon*)

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Wild sage seed is a novel source of hydrocolloid which has a good commercialized potential. The rheological characterization of hydrocolloid solutions under different concentration (1, 1.25, 1.5, 1.75 and 2%w/v) and temperature (15, 25, 35 and 45°C) were modeled by several models such Bingham, Power law, Casson and Vocadlo. R^2 and RMSE analysis showed good agreement for all four models applied in this study. The hydrocolloid exhibited non-Newtonian, pseudoplastic behavior at all temperatures and concentrations.The power law model was chosen as the best model and used to evaluate the temperature and concentration effect. Effect of concentration and temperature on the flow behaviour indices, n, was insignificant. An increase in concentration increased the consistency coefficients; *k* and increasing temperature decreased the consistency coefficient. The temperature effect was described using Arrhenius equation and as the gum concentration increased the activation energy (E_a) decreased.

Keywords: Emulsion, globular proteins, interfacial rheology, drop deformation, relaxation, Word Template Style: "ISFRS Keywords"

1 INTRODUCTION

Wild sage seeds (WSS), *Salvia macrosiphon*, contain a high amount of hydrocolloid with a potential as a thickening agent in edible and non-edible formulation [1]. The optimum condition of WSS hydrocolloid extraction was investigated by Bostan et al, 2008 [2], but there is not any information about the rheological behavior of WSS hydrocolloid solutions. The rheological behavior of hydrocolloids is of special importance when they are used to modify textural attributes and also rheological data are required for calculation in any process involving fluid flow (e.g. pump sizing, extraction, filtration, extrusion, purification) and play an important role in the analyses of flow conditions in food processes such as pasteurization, evaporation, drying and aseptic processing [3].
Thus, the objective of this study was to characterize the time independent rheological properties of hydrocolloids extract from the seeds of Wild sage as influenced by concentration and temperature.

2 MATERIALS AND METHODS

2.1 Materials

The wild sage seeds were obtained from a local market in Mashhad, Iran. The seeds were cleaned manually**.** All chemicals used were reagent grade unless otherwise specified.

2.2 Gum extraction

Wild sage seed hydrocolloid was prepared according to method presented by Bostan et al, 2008, [2]. In brief, wild sage seeds were dispersed in preheated distilled water at water to seed ratio of 51:1. The pH was monitored continuously and adjusted at 5.5 using 0.1 mol/L HCl at a constant temperature of 25± 1.0 °C. Extraction was carried out in three stages. Separation of the gum from the swelled seeds was done by passing the seeds through a laboratory extractor. Crude gum was collected and residual seeds immersed in remaining of water in two stages, according to water to seed ratio proposed for each run, and again was passed through the extractor. The collected crude gum from the different stages was mixed, filtered and dried overnight in oven at 70°C. The dried gum was then grounded, filtered and used for analysis.

2.3 Rheological measurement

Rheological measurements were carried out using a rotational viscometer (Bohlin Model Visco 88, Bohlin Instruments, UK) equipped with a C30 measuring spindle and a heating circulator (Julabo, Model F12-MC, Julabo Labortechnik, Germany). The prepared samples were loaded into the cup and subjected to a programmed logarithmic shear rate ramp increasing from 14 to 300 s^{-1} during 3 min. Shear stress–shear rate data of WSS hydrocolloid solutions were fitted with various rheological models (Newtonian, power law, Herschel Bulkley, Bingham, Casson and vocadlo) and the models adequacy checked (R^2 and RMSE).

2.4 *Evaluation of temperature dependency of gum solutions*

Gum solutions were prepared at concentrations of 1,1.25, 1.5, 1.75 and 2% (w/v) by dispersing the required amount of gum in deionized water (Milli-Q,

Millipore, Bedford, USA), under slow stirring at room temperature, and stored overnight at 4 °C for complete hydration prior to assessment. Prepared samples were loaded into the cup and maintained for 10 min at measurement temperatures of 15, 25, 35 or 45 °C. The temperature dependency of consistency coefficient (indicator of the viscous nature of the sample) was assessed by fitting the Arrhenius model (Eq.1).

$$k = k_0 \cdot e^{(E_a/RT)} \quad (1)$$

where k_0 is the proportionality constant (or consistency coefficient at a reference temperature, Pa s^n), E_a the activation energy (J/mol), R the universal law gas constant (J/mol K), and T the absolute temperature (°K).

3 RESULTS AND DISCUSSION

WSS hydrocolloid solutions showed non-newtonian, shear-thinning behavior over the entire tested temperature and concentration conditions [Figs. 1 and 2].

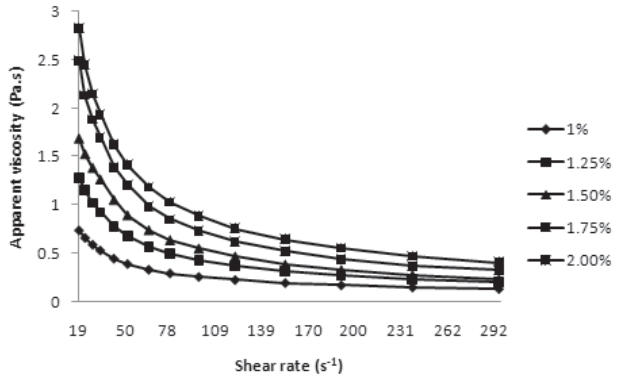

Figure 1: Apparent viscosity as a function of concentration at temperature of 25°C.

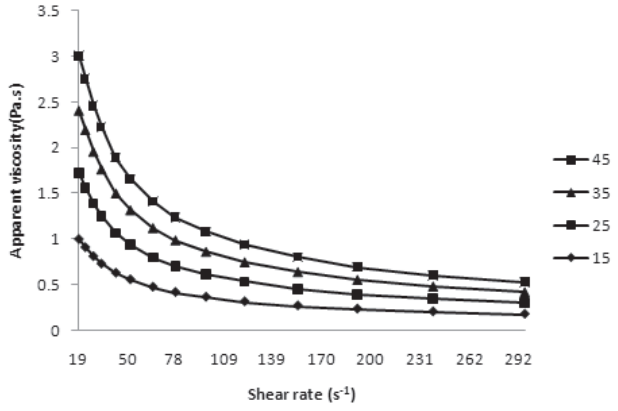

Figure 2: Apparent viscosity as a function of temperature at 1%(w/v) concentration.

All rheological models used in this study well fitted to experimental flow curves [Tab. 1].

Table 1:Power law, Bingham, Casson and Vocadlo models validity parameters.

Model	R^2	*RMSE*
Power law	0.99	0.63 – 9.61
Bingham	0.71 – 0.95	5.4 – 8.75
Casson	0.96 – 0.98	1.43 – 2.54
Vocadlo	0.97 – 0.99	0.92 – 6.88

The power law model was chosen as the best model and used to evaluate the temperature and concentration effect. Effect of concentration and temperature on the flow behaviour indices, n, was insignificant. An increase in concentration increased the consistency coefficients; *k* and increasing temperature decreased the consistency coefficient. The Arrhenius parameters reported for different concentration in table 2. As the gum concentration increased the activation energy (E_a) decreased.

Table 2: Temperature dependency of activation energy for WSS hydrocolloid

Concentrartion (w/v%)	*Shear rate at 50 s^{-1}*	
	E_a	R^2
1	1.3	0.83
1.25	0.69	0.81
1.5	0.39	0.72
1.75	0.30	0.81
2	0.24	0.84

4 REFERENCES

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