2022 8th International Conference
on Energy Efficiency and Agricultural Engineering
EE&AE 2022

30th June - 2nd July 2022, Ruse, Bulgaria

Investigation of emulsion stability in Soybean protein isolates – Soybean oil – Water system

Vanya Gandova, Ivalina Petrova

Technical University Sofia, branch Plovdiv, 4002 Plovdiv, Bulgaria
ivalinapetrova.com@abv.bg

ABSTRACT

The objective of this study is to investigate emulsion stability between soybean oil-water-soybean protein isolate (SI) system. The protein added as stabilizing emulsion, with different quantity 1 and 3 percent. Thermodynamic parameters Gibbs free energy, enthalpy and entropy for each emulsion were calculated. The samples of emulsions prepared with different pH interval. Microscopic observations and turbidity of all emulsions were prepared and used for determined stability of presented emulsions.

RESULTS AND DISCUSSION

The above results were further supported by the variation of Gibbs free energy of formation (ΔG). From the results listed in Table 1, can be conclude that all process in emulsions were spontaneous (ΔG < 0). The Gibbs energy is criterion for emulsion stability. When the ΔG increases in negative value the emulsions increase their stability. According the calculations all samples exhibited exothermic process. Change of enthalpy (ΔH) calculated in all samples was negative too. Change of entropy (ΔS) exhibit very small values, because food emulsions are very unstable and don't have possibilities to determine the direction (phase separation) of the process. The equilibrium constant K determined of emulsions was presented in Table 1 too. The K was between 3.88 to 9.71. This conclusion is important, because the Van't Hoff equation include lnK. The values less 1 (K < 1) after logarithm had negative values, but in this case all K > 1. According the calculations at sample 4, K = 9.71 and ΔG show the most value -5.635 kJ mol^{-1}. This emulsion with chemical composition presented in Table 1 was the most stable.

Figure 1 shows dependence between ΔG and pH. All samples were prepared with pH between 5.8-6.2. Emulsions prepared with pH around 5.95 - 6 were more stable. Figure 7 presented constructed phase diagrams of oil-water-SI on emulsion sample 4. Two types of emulsions were observed after first day investigation. On the one side can see W/O emulsion in the left region. On the other side O/W emulsion occupied phase diagram. The formation of W/O emulsion or O/W emulsion depends on the composition of the protein and it solubility in the water [13]. The results obtained in this work also showed that areas of W/O increased as the increase value of the protein. The investigation of emulsion systems had purpose to slow down phase separation in emulsions and decrease W/O emulsion part. Food emulsions was used for a long time in the food industry.

Table 1. Thermodynamic parameters obtained in emulsions with 4 % and 6 % SI at 298.2 K

Emulsion N	ΔG kJ mol^{-1}	ΔH kJ mol^{-1}	ΔS kJ K^{-1} mol^{-1}	K
1	-4.218	-19.174	-0.050	5.48
2	-4.842	-19.445	-0.049	7.05
3	-4.229	-19.179	-0.050	5.51
4	-5.635	-19.789	-0.047	9.71
5	-4.185	-19.159	-0.054	5.41
6	-3.358	-18.800	-0.054	3.88
7	-4.185	-19.159	-0.053	4.76
8	-4.282	-19.201	-0.049	5.63

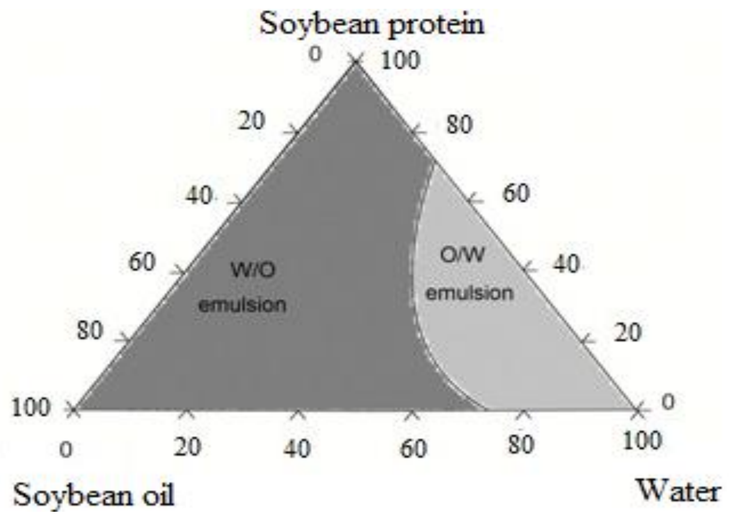

Fig. 1. Ternary phase diagram of Soybean oil/Water/Soybean protein isolate of sample 4

CONCLUSIONS

In this study emulsions with soybean oil, water and 1 and 3 percent soybean protein isolate were studied. Microscopic observation and thermodynamic calculations were provided. pH in each emulsion was measured in determined interval. Gibbs energy calculated as dependence of oil percent, protein present and pH. Turbidity of emulsions was measured to storage emulsions for 15 days. The results obtained from these work suggest that the emulsions prepared with 50 oil percent and 3 percent SI are more stable.