# Ethyl cellulose oleogels from cold pressed beechnut (*Fagus sylvatica*) seed kernel oil- structural and oxidative properties as influenced by glycerol monostearate and cinnamon essential oil

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## INTRODUCTION

Ethyl cellulose (EC), is approved as food additive and is capable alone of forming oleogels, fat replacing systems in which edible liquid oil can be structured due to its entrapment in a network formed by the gelling agent.

EC requires a high gelation temperature (>150 $^0$C), which causes oxidation, especially when cold pressed oils, such as beechnut (BK) or sunflower (SF) seed kernel oils (O) are involved.

However, this issue might be solved if co-structuring and antioxidant agents are added
. Cinnamon essential oil (EO) was reported to exhibit antioxidant potential, while glycerol monostearate to improve the structure of EC oleogels.

The influence of 1% EO and 2% GM on the 16% EC (10cp) oleogels was assessed in therms of structural and oxidative properties.

## MATERIALS/ METHODS

### COLD PRESSED OILS OBTAINING:

A single screw press (CA59G, Komet, Germany), was employed for pressing the unroasted beechnut (BKO) and sunflower seed kernel's oil (SFO).

### OLEOGELS PREPARATION:

Conducted according to Haj Eisa, Aya, et al.2020, with modifications: oleogels were produced on a magnetic stirrer (IKA® C-MAG HS7, IKA, Staufen, Germany, 450 rot./min.) by inducing gelation at 150 °C , for 10 min., followed by storage in containers with lids at 4°C.

### SAMPLES COMPOSITION AND CODIFICATION

| CODIFICATION | EC | OIL | EO | GM |
|---|---|---|---|---|
| EC_BKO | 16 | 84 | - | - |
| EC_EO_BKO | 16 | 83 | 1 | - |
| EC_EO_MG_BKO | 16 | 82 | 1 | 2 |
| EC_SFO | 16 | 84 | - | - |
| EC_EO_SFO | 16 | 83 | 1 | - |
| EC_EO_MG_SFO | 16 | 82 | 1 | 2 |

### METHODS

1. Textural analysis: TPA test (Brookfield CT3, Brookfield Engineering Labs, Middleboro, MA, USA) probe TA4/1000, deformation target 40%.

2. Small amplitude rheological tests: determined using an Anton Paar MCR 302 (Anton Paar, Graz, Austria):amplitude sweep test were carried out at 1 Hz and 0.01-100%, and frequency sweeps (0.01-100 Hz), with PP50 probe, at 4°C.

3. The FTIR spectra of oleogels were acquired with Agilent Cary 630 FTIR (Agilent Technologies, Chelmsford, MA, USA) scanned in 4000–600 cm $^{-1}$ wavenumber range.

4. PV value was assessed according to the Cd8-53 (AOCS, 1998) method while p-AV was assessed according to Cd18-90 (AOCS, 1998) method.

5. Analyses were carried out at least in duplicate and results were statistically analyzed with Minitab 9.

## RESULTS

Table 1. Textural attributes of beechnut seed kernel oil oleogels

| SAMPLE/PARAMETER | HARDNESS[N] | ADHESIVENESS [mJ] | COHESIVENESS[-] |
|---|---|---|---|
| EC_BKO | 0.93±0.35 | 1.1±0.0 | 0.22±0.03 |
| EC EO_BKO | 0.70±0.18 | 1.15±0.03 | 0.22±0.03 |
| EC EO GM_BKO | 3.72±0.47 | 5.35±1.09 | 0.34±0.00 |

Table 2. Textural attributes of sunflower seed kernel oil oleogels

| SAMPLE/PARAMETER | HARDNESS[N] | ADHESIVENESS [mJ] | COHESIVENESS[-] |
|---|---|---|---|
| EC_SFO | 2.35±0.20 | 0.9±0.0 | 0.16±0.03 |
| EC EO_SFO | 10.43±0.44 | 1.95±0.03 | 0.09±0.01 |
| EC EO GM SFO | 5.92±0.41 | 8.5±1.6 | 0.34±0.00 |

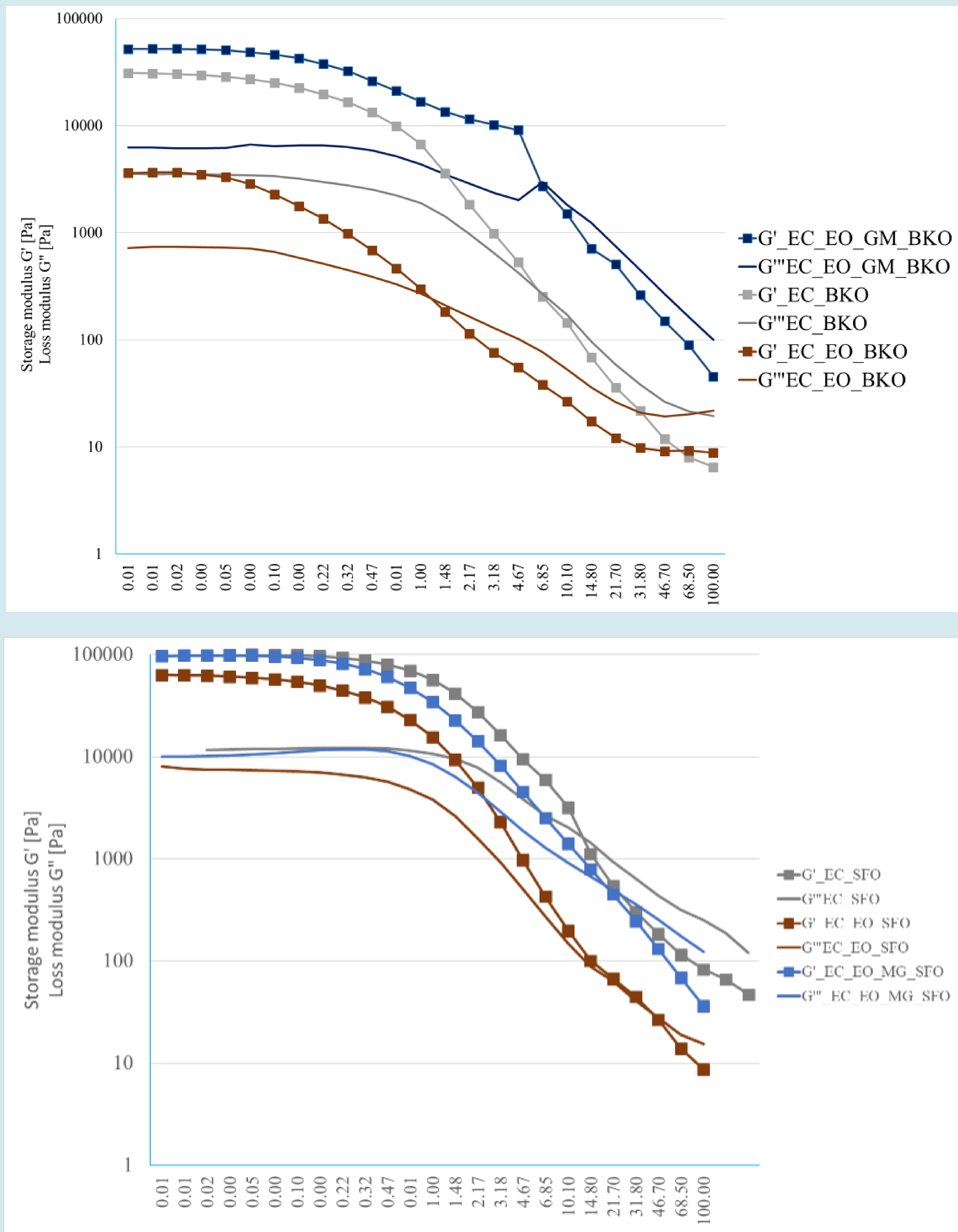


Fig. 1 Storage and Loss modulus of BKO and SFO ethyl celullose oleogels as affected by addition of 1% cinnamon essential oil and 2% glycerol monostearate.

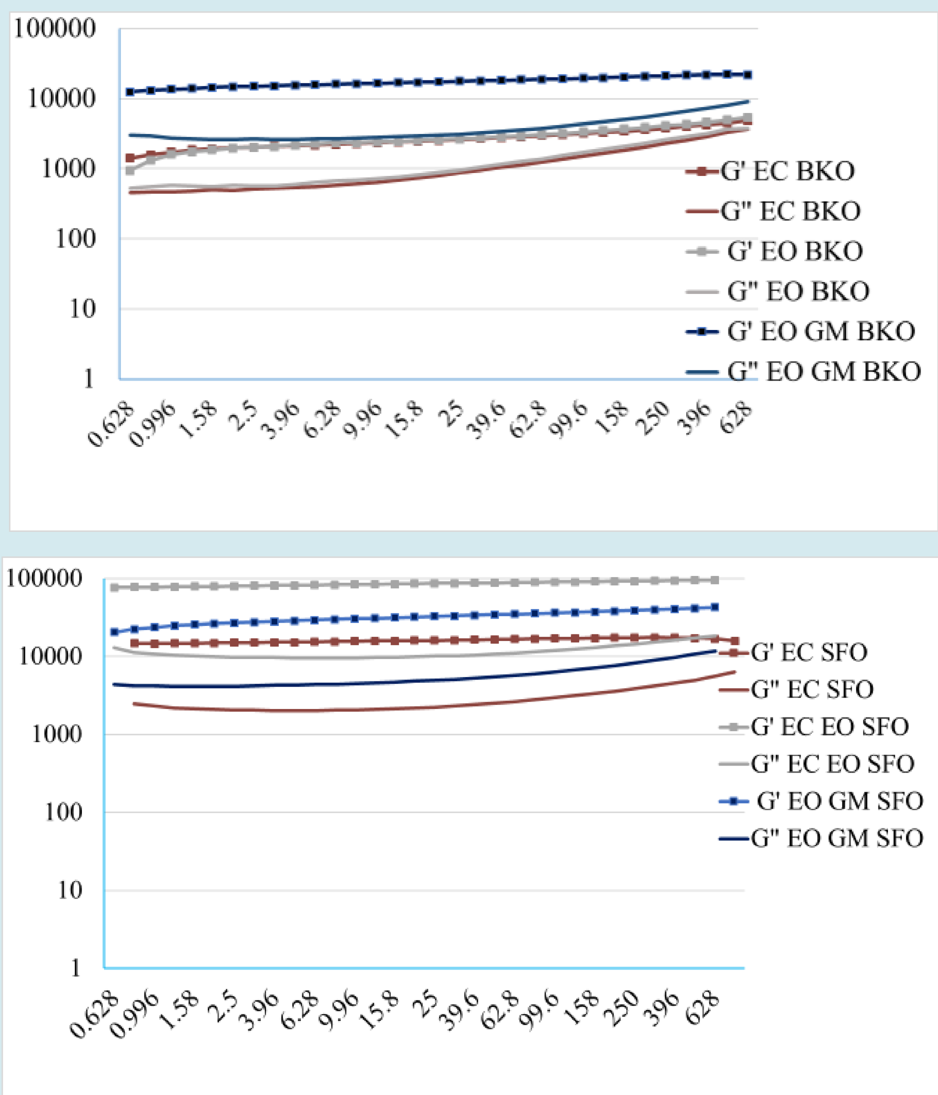


Fig. 2 Frequency dependance of BKO and SFO ethyl celullose oleogels as affected by addition of 1% cinnamon essential oil and 2% glycerol monostearate.

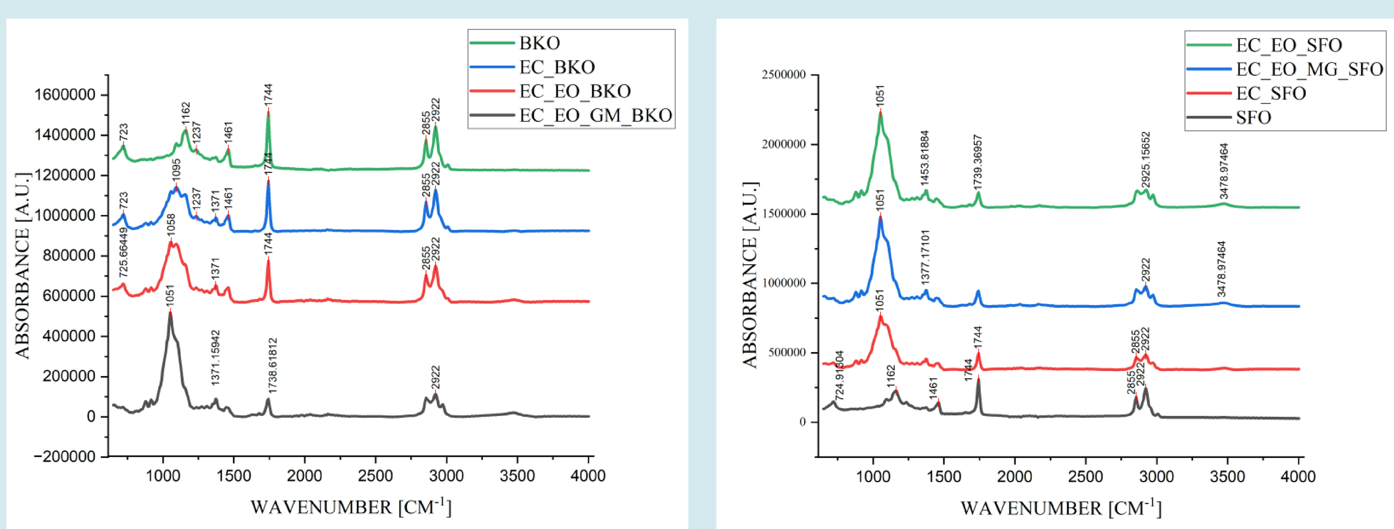


Fig. 3 FTIR spectra of of BKO and SFO ethyl celullose oleogels as affected by addition of 1% cinnamon essential oil and 2% glycerol monostearate

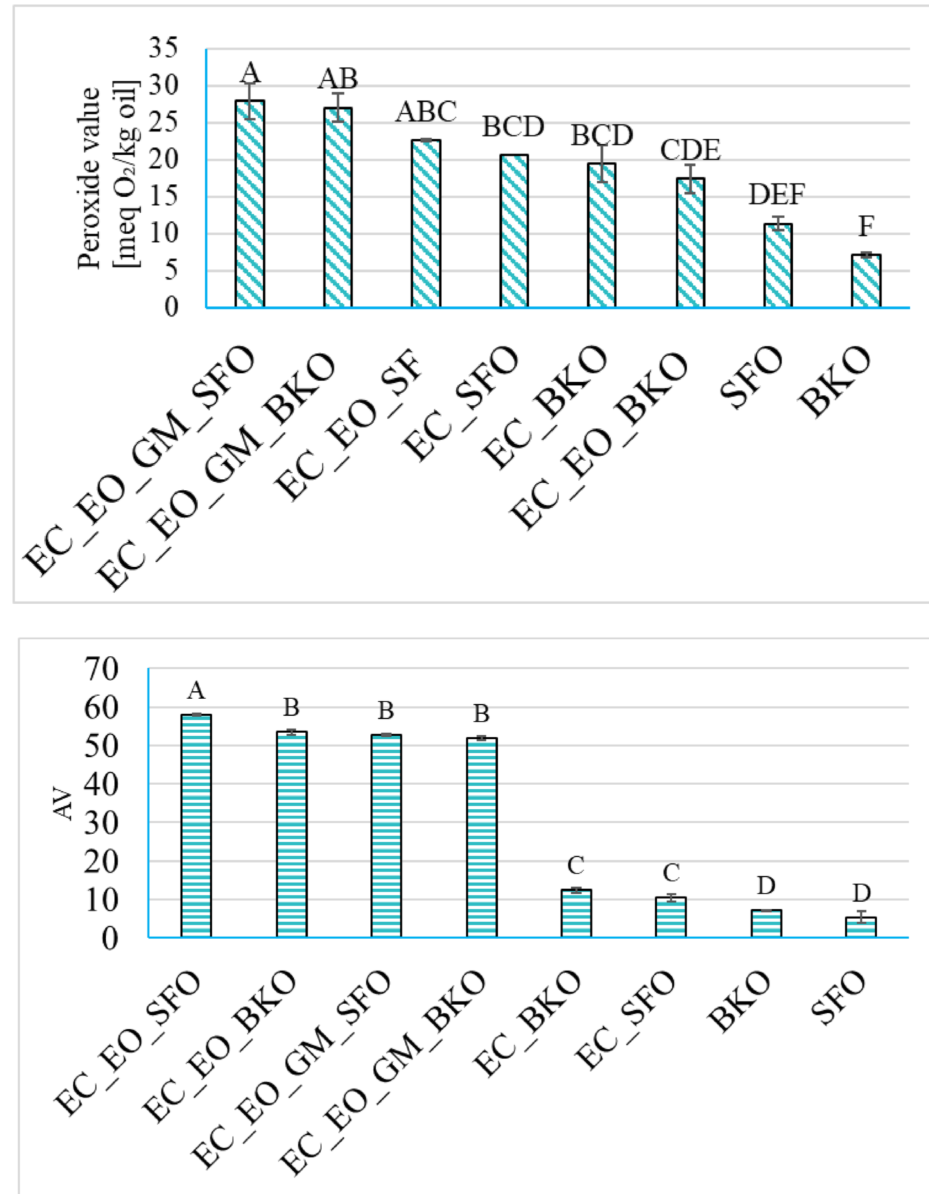


Fig. 4 Oxidative status of oleogels samples (1- Peroxide value assessment is depicting primary oxidation. 2 p-AV depicting the presence of **secondary oxidation products.**

## CONCLUSION

The inclusion of EO in the formulation, increased the hardness of BK oleogels from 0.93 ±0.03 N to 0.69±0.17 N, while the addition of GM to 3.72±0.47N. BK oleogels registered lower hardness compared to SF oleogels. GM increased the adhesiveness and cohesiveness of the oleogels, regardless of the oil type.

In frequency sweep test (0.01-100 Hz), BK oleogels were frequency dependent, while SF oleogels presented less frequency dependance.

FTIR analysis (conducted with Agilent Cary 630 FTIR spectrometer) revealed peaks with higher intensities in 1051 cm $^{-1}$ region for oleogels, while BK samples also presented modification in 1744 cm $^{-1}$ and 2922 cm $^{-1}$ regions and the presence of some peaks at 723 cm $^{-1}$.

Samples containing EO, but also GM, were more oxidized, registering higher values for peroxides and p-anisidine, compared to the oils. Despite conducting to enhanced mechanical properties, the inclusion of 1% cinnamon EO unexpectedly presented a pro-oxidant activity and further research on improving the EC oleogels oxidative status is required, while the inclusion of 2% GMS conducted also to improved structural properties. However, differences in the oxidation occurred due to the fatty acid profile of the samples, and BKO presented slightly improved status.

## ACKNOWLEDGEMENT

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