The 4th Polish-Slovenian International Seminar on
26th - 27th January 2026
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The 4th Polish-Slovenian International Seminar on
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Nature, Foods, Cosmetics & Soft Matter

Supercritical Properties of Linseed Oil as Revealed from High Pressure & Temperature Studies

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LINSEED OIL is an amazing pro-HEALTH agent – but NOT ONLY

- ❑ food additive and a skin conditioner for natural cosmetics
- ❑ supports heart health by acting towards maintaining desired cholesterol level
- ❑ can help wound healing and exhibits anti-inflammatory and regenerative properties
- ❑ broadly recognized is the positive influence of linseed oil in the fight against obesity, arthritis, and hypertension
- ❑ there are suggestions for its stimulation impact on the immune system

- Longo L, Veronese M, et al. Direct evidence for processing Isatis tinctoria L., a non-nutritional plant, 32–34,000 years ago 2025 Plos ONE 20(10) (2025) e0335850
- Haram Sarfraz, Iffat Zareen Ahmad, A systematic review on the pharmacological potential of L.: a significant nutraceutical plant 2023 Journal of Herbal Medicine
- Jie Wang, et al., Potential of natural products in combination with arsenic trioxide: Investigating cardioprotective effects and mechanisms 2023 Biomedicine & Pharmacotherapy
- X. Li, Q.Chen et al. Effects of high levels of dietary linseed oil on the growth performance, antioxidant capacity, hepatic lipid metabolism, and expression of inflammatory genes in large yellow croaker 2021 Front. Physiol. 12
- D. Duran The pharmacological evaluation of flax seed oil 2020 J. Curr. Med. Res. Opin. 3
- B. Szymczyk, W. Szczurek Effect of dietary pomegranate seed oil and linseed oil on broiler chickens performance and meat fatty acid profile 2016 J. Anim. Feed Sci. 25
- A. Goyal et al. Flax and flaxseed oil: an ancient medicine & modern functional food 2014 J Food Sci Technol. 51

- ❑ Linseed oil is also used in the production of paints, wood preservatives, varnishes, stains, linoleum, putty
- ❑ Linseeds and linseed oil were also used internally to treat digestive disorders, such as stomach problems, and as a laxative

30,000-Year-Old Wild Flax Fibers

Michael Balter: October 2009 Science 325(5946):1359 DOI:10.1126/science.1175404

- Georgian caves are not only beautiful to look at, but they are also culturally important
- One example is Dzudzuana Cave near Chiatura, an important archaeological site. Archaeologists found a processed and dyed thread there that is about 34,000 years old
- This shows that cloth was already being made in Georgia around 34,000 years ago, based on what we know today.

https://www.anthropology.net/p/the-blue-shadows-of-dzudzuana

Archaeologists excavating a cave in Georgia discovered the world's oldest known textiles - flax fibers dating back more than 30,000 years. Some of the fibers were dyed, suggesting that early humans used local plants to color textiles.

According to Harvard archaeologist Ofer Bar-Yosef microscopic analysis of cave pollen revealed that many pollen structures actually contained flax fibers, offering new insight into daily life during the last Ice Age.

"Her major discovery was that many of these pollen chambers actually contain fibers of flax."

https://www.science.org/doi/10.1126/science.1175404

In opinion of textile expert at the University of California in Los Angeles ⇒ "Flax is notoriously difficult to dye."

Archaeologist Elizabeth Barber of Occidental College in Los Angeles points out ⇒ „the variety of colors ... suggests this was intentional, not accidental. You wouldn't get the local soil staining them in so many different colors."

Direct evidence for processing Isatis tinctoria L., a non-nutritional plant, 32–34,000 years ago

Longo L, Veronese M, et al.: 30 Oct 2025: PLOS ONE 20(10) (2025) e0335850

- In this paper, morphological and spectroscopic analyses (μ-Raman, μ-FTIR) were combined to provide reliable, multiscale physical and biomolecular evidence for the deliberate pounding and grinding of Isatis tinctoria L. leaves between 34,000 and 32,000 years ago.
- Fragments of leaf epidermis were found embedded in the microtopography of the working surfaces of unmodified pebbles, in association with use-wear traces.
- Although the bitter taste of the leaves renders them essentially inedible, they possess well-documented medicinal properties and contain precursors of INDIGOTIN— the chromophore responsible for the blue colour of woad, a plant-based dye that is insoluble in water.

Rough INDIGO pigment blocks.

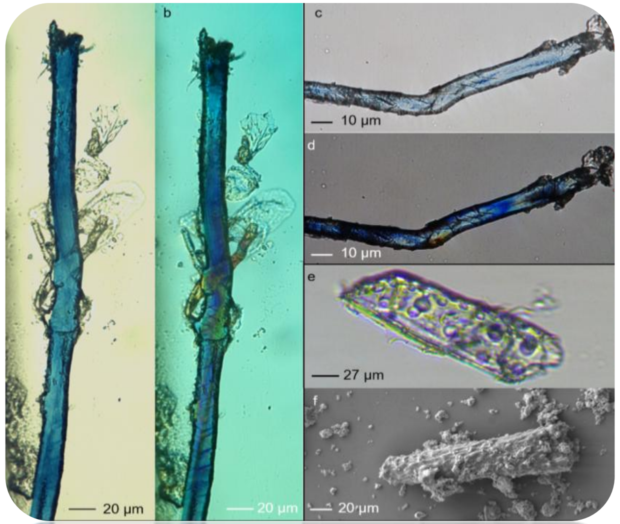
The color blue is difficult to obtain. Unlike red, yellow, and white, which occur naturally in mineral form, blue is rare.

For the first time, researchers have found evidence that prehistoric people produced a blue pigment. Stone tools dating back about 34,000 years, discovered in a cave in Georgia, were found to contain INDIGOTIN, identified by scientists from Ca' Foscari University of Venice.

It remains unclear whether this substance was used as a dye, a medicine, or for another purpose.

To produce the color, the leaves of a biennial plant were ground against a stone surface, and water was added to initiate a fermentation process that creates indigotin, a dark blue compound. After drying for several days or weeks, the residue was ground further and prepared for use.

"The presence of this molecule in a Paleolithic context is unprecedented."



Archaeological elongated blue micro-fragments that were extracted. Photo: courtesy Plos One.

Flax Fiber _ in book: Kirk-Othmer Encyclopedia of Chemical Technology

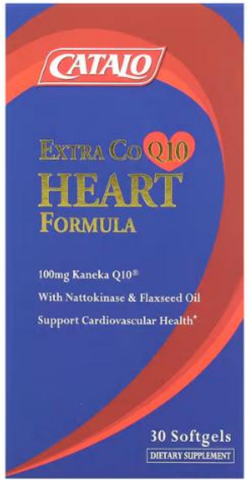
Marta Preisner et al. September 2014: Publisher: John Wiley & Sons

Flax Fiber

- has a complex structure, and even small changes affect its quality and yield
- key properties include tensile strength, absorptivity, and biological activity

Flax Fiber popularity declined in recent decades due to:

- poor elasticity
- time-consuming processing
- sensitivity to biotic and abiotic factors



Today, growing demand for natural fibers has renewed interest in Flax Fiber – new applications include:

- biocomposites
- bioremediation
- medical uses
- biofuels

- The discovery of wild flax fibers in Upper Paleolithic layers of Dzudzuana Cave in Georgia reveals that prehistoric communities used plant materials to produce cordage, baskets, and clothing.
- Radiocarbon dating shows that the cave was occupied intermittently between 32,000 and 11,000 years ago, and the repeated presence of spun and dyed flax fibers indicates long-term plant use despite changing climatic conditions
- Fiber fragments, seeds, yarns and various fabrics from 8000 B.C. also found in Switzerland.

DOI:10.1002/0471238961.0612012401110914.a01.pub2

Linseed OIL ⇔ Flaxseed OIL

- The Latin name for the FLAX plant, from which the oil is extracted, means most useful.

Chemically it is rich in omega-3-fatty acids in common with fish oils.

Typical fatty acid composition would be linolenic (57%), oleic (19%), linoleic (15%), palmitic (6%), stearic (3.5%)

Flax seed oil is the richest plant source of the polyunsaturated fatty acid alpha-linolenic acid

precursor to

eicosapentanoic acid (EPA) → docosahexanoic acid (DHA)

important for maintaining the integrity of CELL MEMBRANES

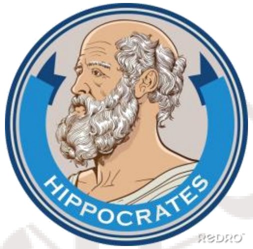
Flaxseed OIL

- significantly increases cardiac glutathione levels
- Enhances the activity of antioxidant enzymes
- Inhibits pathological damage to the heart
- May be used as an adjunct therapy or dietary suplement
- Particularly beneficial for cancer patients undergoing ATO treatment
- Helps reduce arsenic-induced cardiac toxicity

Linseed OIL ⇔ Flaxseed OIL

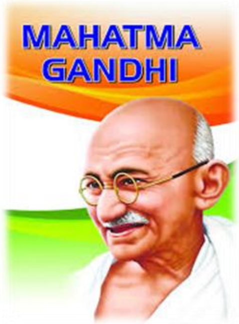
The extraordinary pro-health properties of flax seeds and linseed oil have been known since ancient times

Hippocrates, the 'father' of medicine (~400 BCE), recommended them as a significant food remedy



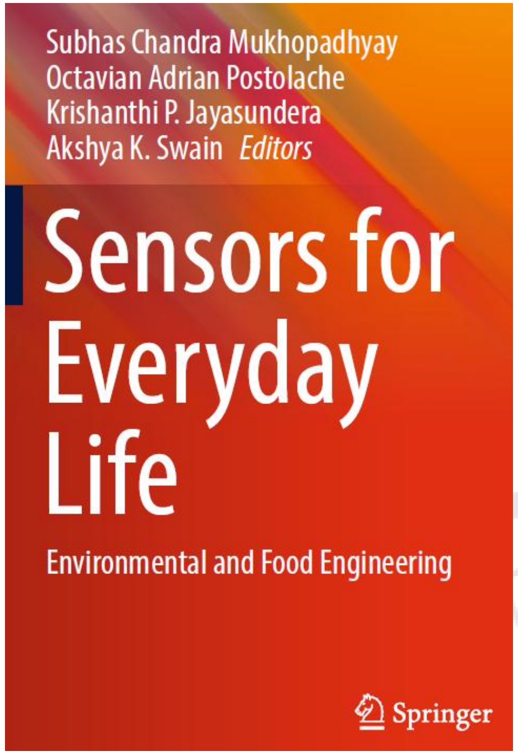
Near 800 CE, King and Emperor Charles the Great (Charlemagne) indicated them to be essential for a healthy life in a special emperor's mandate.

In modern times, Mahatma Gandhi recommended linseed oil as a health-promoting remedy and a food additive.



These opinions are shared by doctors and nutritionists nowadays.

Linseed oil: the meaning of dielectric spectroscopy

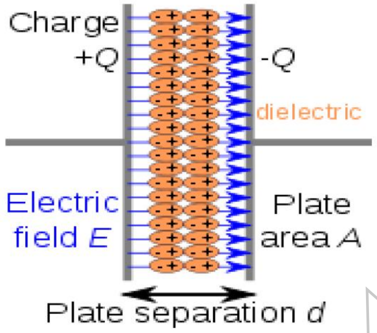


DIELECTRIC SPECTROSCOPY:

'It is used for assessing the dielectric properties of VEGETABLE OILS utilized as electrical insulating liquids for defining the quality of fatty acids and vegetable oils, as well as to develop requirements for their transportation and storage, is one of the methods for determining the physicochemical properties and quality of vegetable oils.

Also, the relationship between the dielectric characteristics of oils and their physicochemical properties can be found by this method.'

What does Broadband Dielectric Spectroscopy (BDS) mean ?

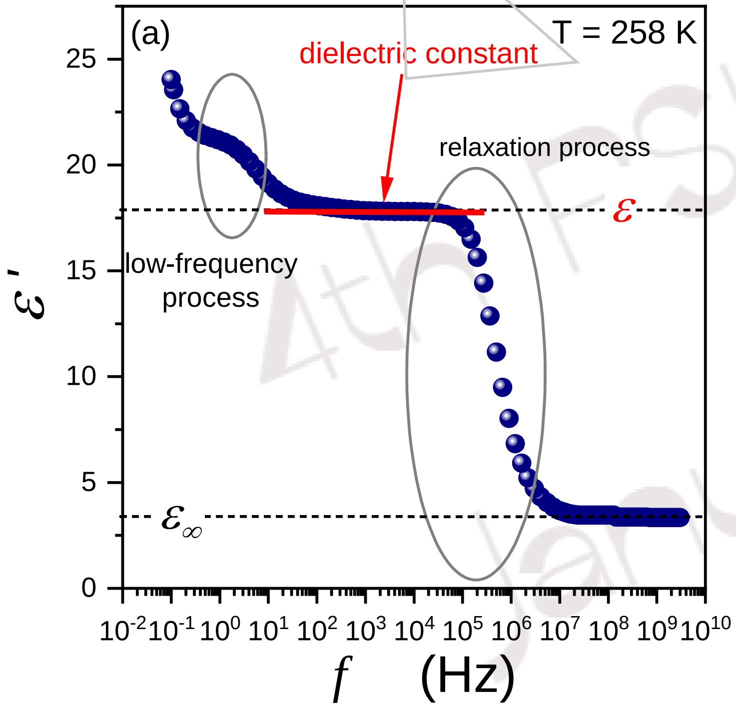


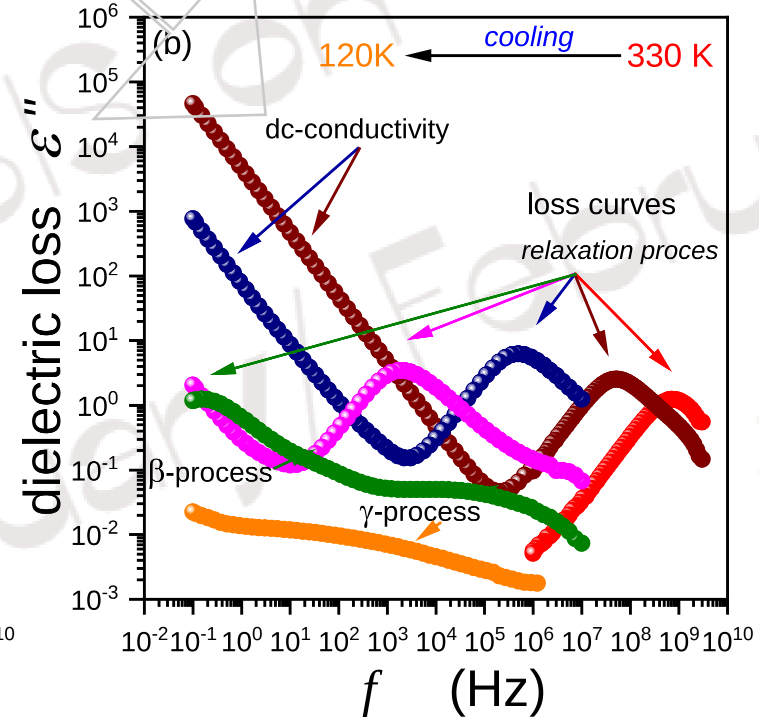
Typical BDS spectra

Schematic presentation of dielectric material inside an electric capacitor

BDS output determines real (ε') and imaginary (ε'') components of dielectric permittivity.

They enable estimations of dielectric constant (reflected intermolecular interactions), relaxation time, diffusion rate ...





$$\varepsilon^* = \varepsilon' - i\varepsilon''$$

$$\varepsilon'' = \frac{1}{2\pi f R C_0} \qquad \varepsilon' = \frac{C}{C_0}$$

$$\tau = \frac{1}{2\pi f_{peak}}$$

$$\tan\delta = \frac{\varepsilon''}{\varepsilon'}$$

In older.'traditional' tests instead of ε'' the ,loss' defiemd as follows is used

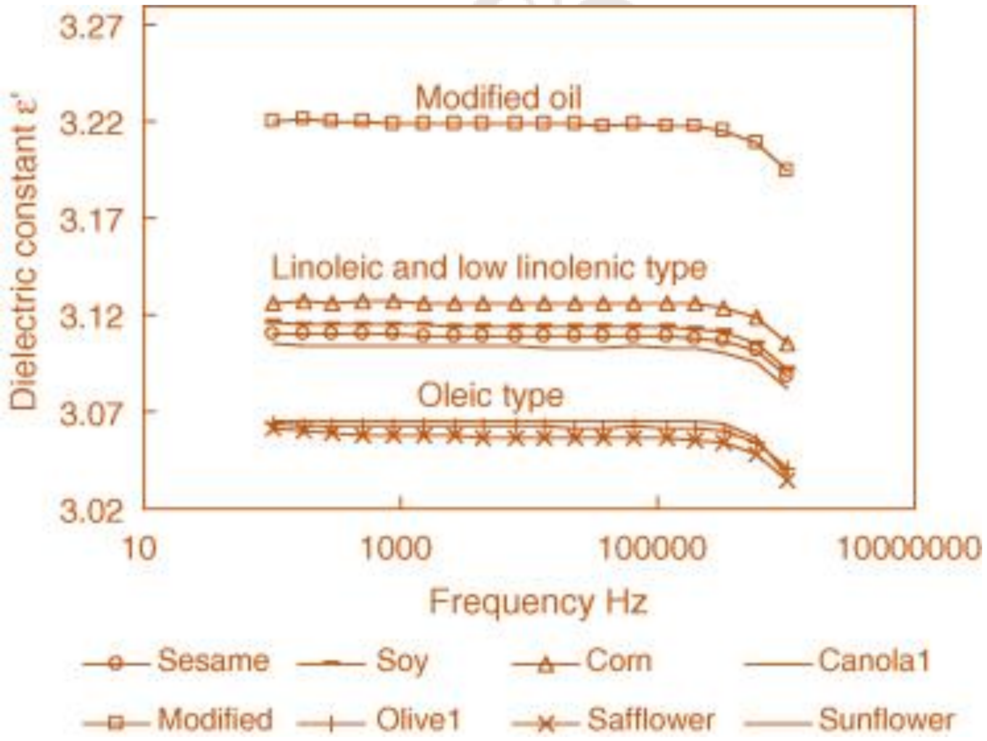
A. Drozd-Rzoska, S.J. Rzoska, J. Łoś, Supercriticality, Glassy dynamics, and the new insight into melting/freezing discontinuous transition in linseed oil. Biophysica 4, 2024, 34-57

Examples of reference results....

Dielectric properties of 10 edible oils were measured over the range 100 Hz—1 MHz and tmperature range 20—45 °C
Results indicated that dielectric constant ε′ of the oils exhibited same frequency dependence, i.e., a general plateau from 100 Hz to 500 kHz and a decrease from 500 kHz to 1 MHz significantly ($p < 0.05$).

The dielectric loss ε″ of the oils decreased with increasing frequency from 100 Hz to 13.2 kHz and then increased with increasing frequency.

The ε′ of fatty acids increased with an increase in the number of double bonds or molecular chain length. The ε′ of oils were mainly affected by the C18 unsaturated fatty acids. Both ε′ and ε″ of oils decreased with increasing temperature.

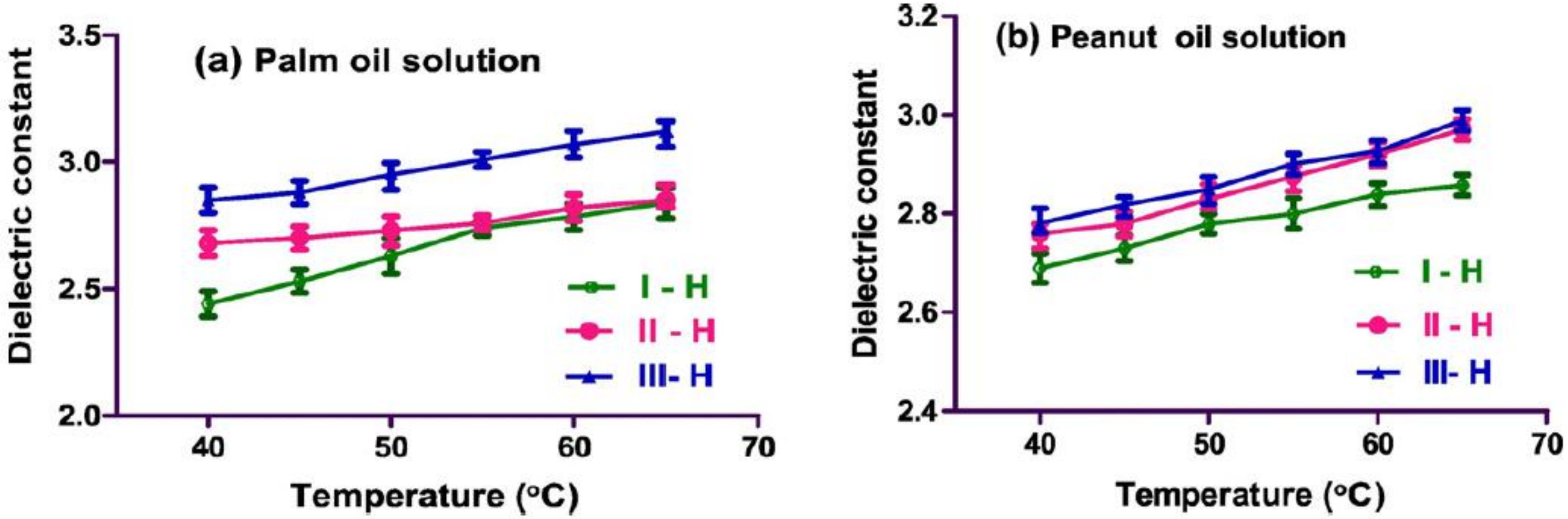


H. Lizhi, K. Toyoda, I. Ihara, Dielectric properties of edible oils and fatty acids as a function of frequency, temperature, moisture and composition, 2008 J. Food Engn. 88, 151-158.

Examples of reference results....

Dielectric constant was measured using a designed layered capacitive cell in the quality analysis of palm, peanut and corn oil after three cycles of heating up to 190 °C of temperature. Dielectric constant value (at 2 MHz frequency)

Measured density, and dielectric constant (ε_r) were used to calculate specific refractive index & polarization using Debye's equation.



The designed capacitor was used to measure dielectric constant of oil solution which would be a non-invasive and resolute property to study the storage life of oil in food industry.

S. R. Rubaya. Et al. Estimation of dielectric constant of oil solution in the quality analysis of heated vegetable oil, 2017 J. Mol. Liq. 238, 136-144

Examples of reference results....

In the opinion of the author existing results are ‚heuristic', with severe experimental and theoretical fundamental limitations…
In this respect worth noting is the most recent report.

In this report the evidence for a ‚melting/freezing' phase transition on cooling was detected.
It is preceded by a ‚bending behavior', in fact, the pretransitional effect in the liquid phase, above the melting temperature.
The authors did not comment this fact, but showed the evidence in Fig. 3 (from the above report).

ε

S. G. Agaev et al., Dielectric properties of vegetable oils, 2020 Russ. J. Appl. Chem. 93, 748-756

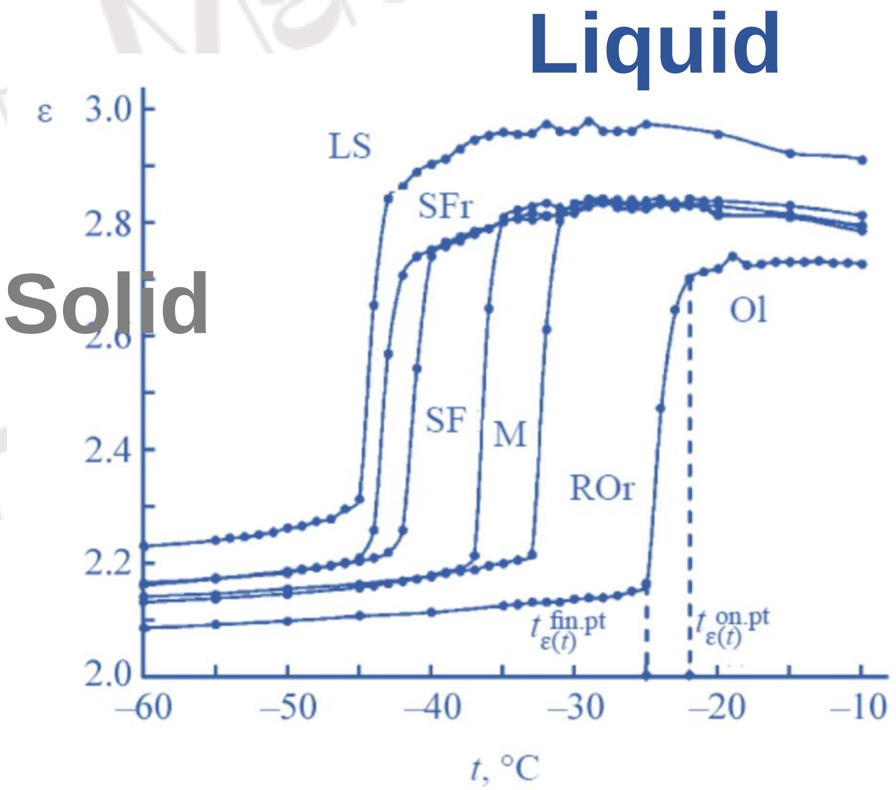


Fig. 3. Dielectric constant ε of vegetable oils vs. temperature at an electric field frequency of 90 kHz. Unrefined oils: (LS) linseed, (SF) sunflower, (MM) mustard, (OlM) olive; Refined oils: (SFr) sunflower, (ROr) rapeseed.

This report results

Golden Flax

Golden FLAX SEEDS, widely cultivated in Poland were used as the base for the preparation of the LINSEED OIL via cold-pressing of seeds in the our laboratory.

Preliminary DSC (Differential Scanning Calorimetry) scans of the LINSEED OIL between 200 K and 360 K were carried out, using the homemade apparatus, $m \sim 1g$ sample, and copper-constantan thermocouples. The scans obtained are shown right.

They are supplemented by earlier results:

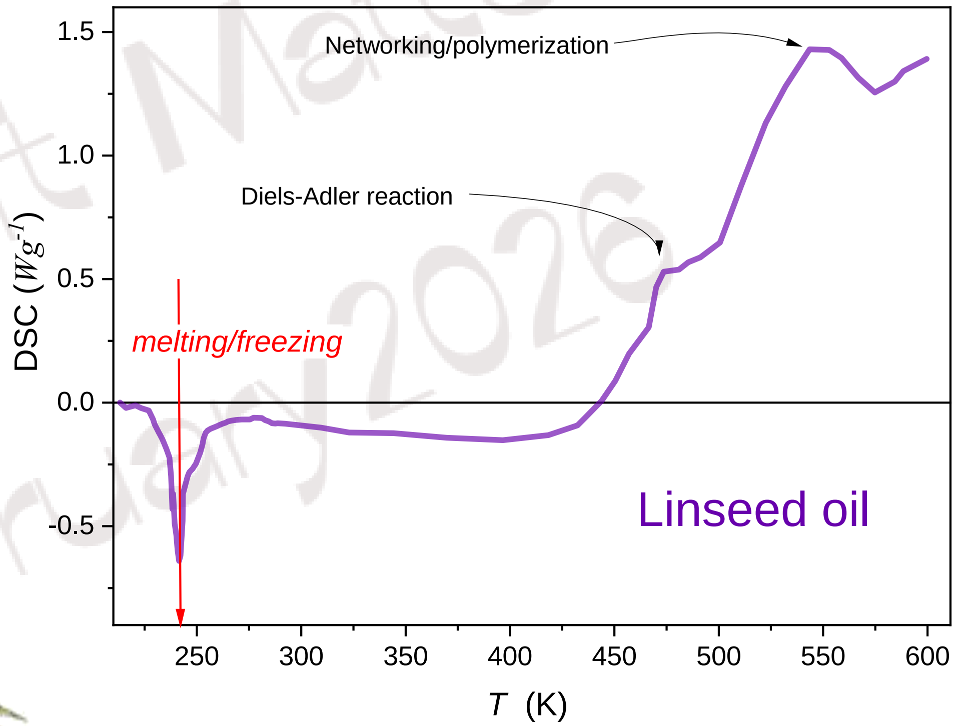


Fig. 1 DSC heat capacity related, scan in linseed oil. Note the substantial manifestation of the of freezing /melting near $T_m \approx 240K$

Note that using linseed oil for high-temperature food preparation (like frying) is not advised due to polymerization.

- J. Wang, S. Erhan, J. Am. Oil Chem. Soc. **76** (1999) 1211
- Zhang et al. J. Thermal. Anal Calorim. **115** (2014) 2129
- J. Tomaszewska-Gras, et al. Molecules **26** (2021) 1958

A. Drozd-Rzoska et al.. Supercriticality, Glassy dynamics, and the new insight into meting/freezing discontinuous transition in linseed oil. Biophysica 4, 2024, 34-57

This report results

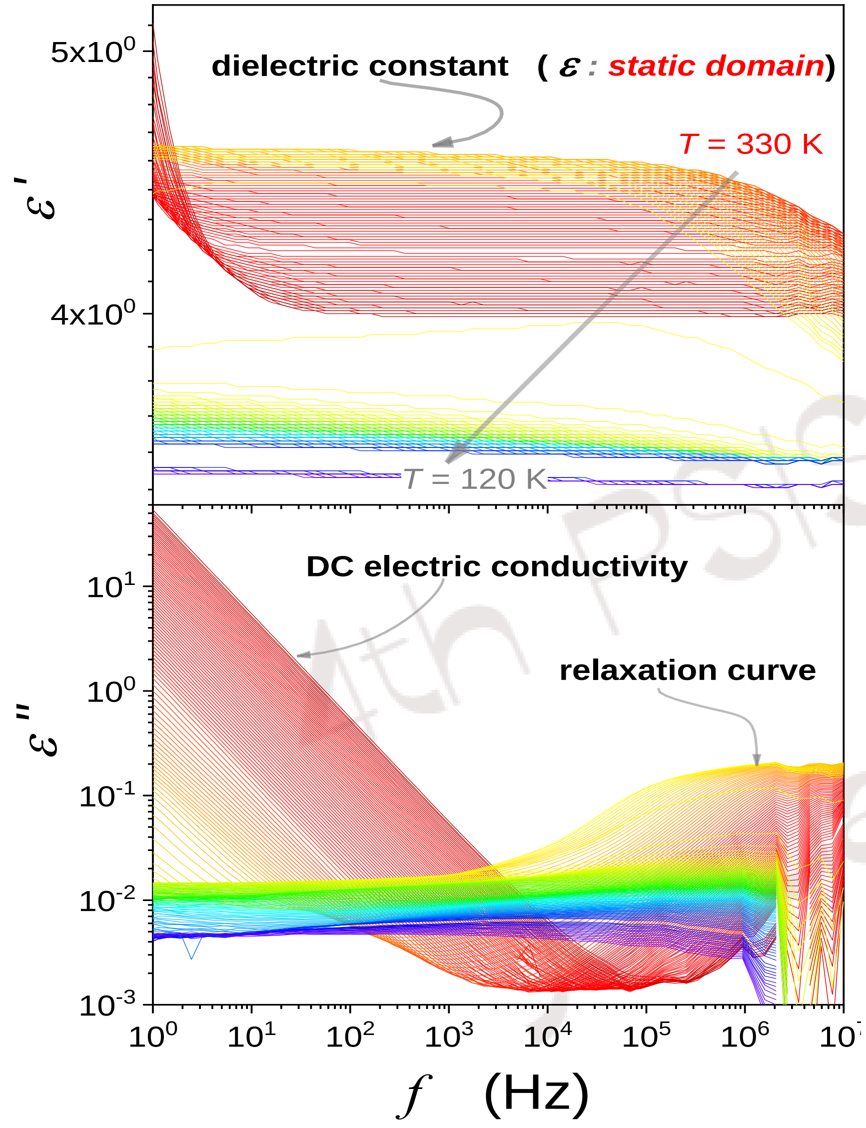


Figure: Real and imaginary components of dielectric permittivity tested for the wide range (210 K) of temperatures in LINSEED OIL.

The temperature shift is indicated by changing colors, from yellow (330 K), via red and green to deep-blue (120 K).

Basic features of the spectrum are indicated.

180 tested temperatures 120 K and 330 K. Semi-continuous frequency scan.

Note that in LINSEED OIL between dielectric constant should be tested in the mid of the static domain because of a notable static domain shift. For given temperature range the frequency range $f = 100$ Hz – 10 kHz is a good estimation.

The dominated part of studies carried out so far has been done beyond this domain, thus biased by relaxation processes, i.e.: they cannot be treated as dielectric constant, despite declarations in numerous reports.

A. Drozd-Rzoska, S.J. Rzoska, J. Łoś, Supercriticality, Glassy dynamics, and the new insight into melting/freezing discontinuous transition in linseed oil. Biophysica 4, 2024, 34-57

Linnseed oil: unique critical-like pretransitional (liquid) & premelting (solid) effects

Recently, it was shown that LINSEED OIL exhibits an extremely strong and long-range dielectric constant anomaly, similar to that in the isotropic phase of nematogenic liquid crystalline materials - but LINSEED OIL is not a mesogenic material.
In contrast, a 'premelting' effect with ferroelectrics-like characteristics, as well as the Mossotti Catastrophe, occurs in the solid phase.
These effects are particularly visible upon cooling to the freezing temperature T_f, which is constant regardless of the cooling rate.

Liquid (1)

We see scaling relations for dielectric constant in the liquid phase and solid phase

Solid (2)

$$\varepsilon(T) = \varepsilon^* + a(T - T^*) + A(T - T^*)^{\phi}$$

$$\frac{d\varepsilon(T)}{dT} = a + (1 - \alpha)A(T - T^*)^{-\alpha}$$

$$\chi(T) = \varepsilon(T) - 1 = \frac{M}{T - T_C} \quad \text{for } T > T_f,$$

$$T_C = T_f + 0.2K$$

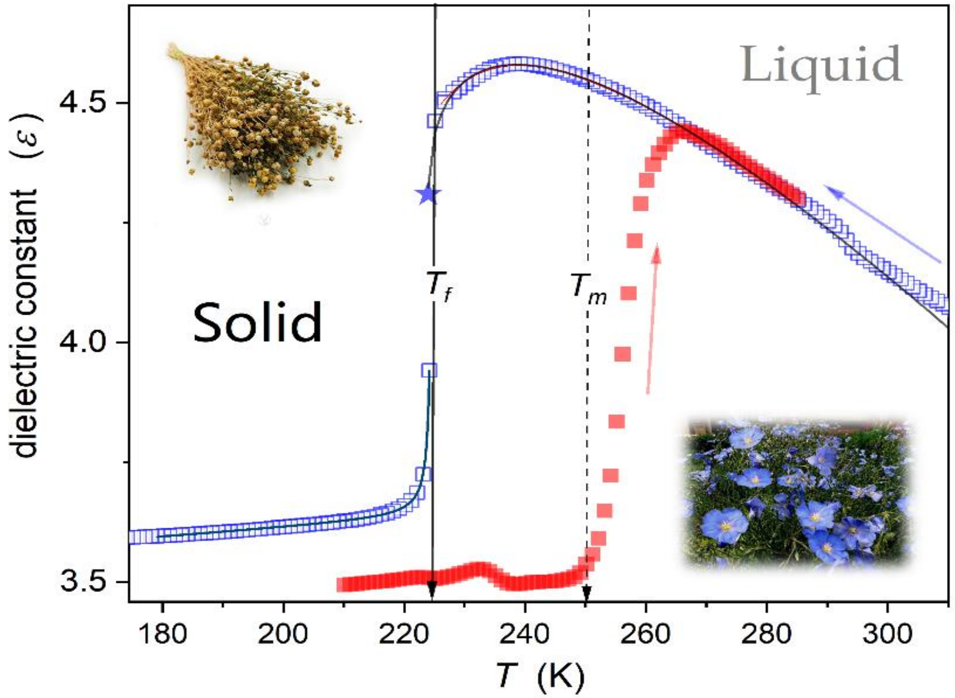
$T > T^* = T_{I-M} - \Delta T^*, T^*$ denotes the extrapolated temperature of a hypothetical continuous phase transition

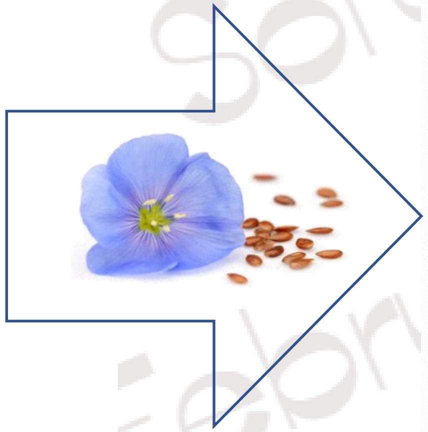
$\Delta T^* \approx 0.4\text{K}$ is the metric of the phase transition discontinuity. The exponent $\phi = 1 - \alpha = 1/2$

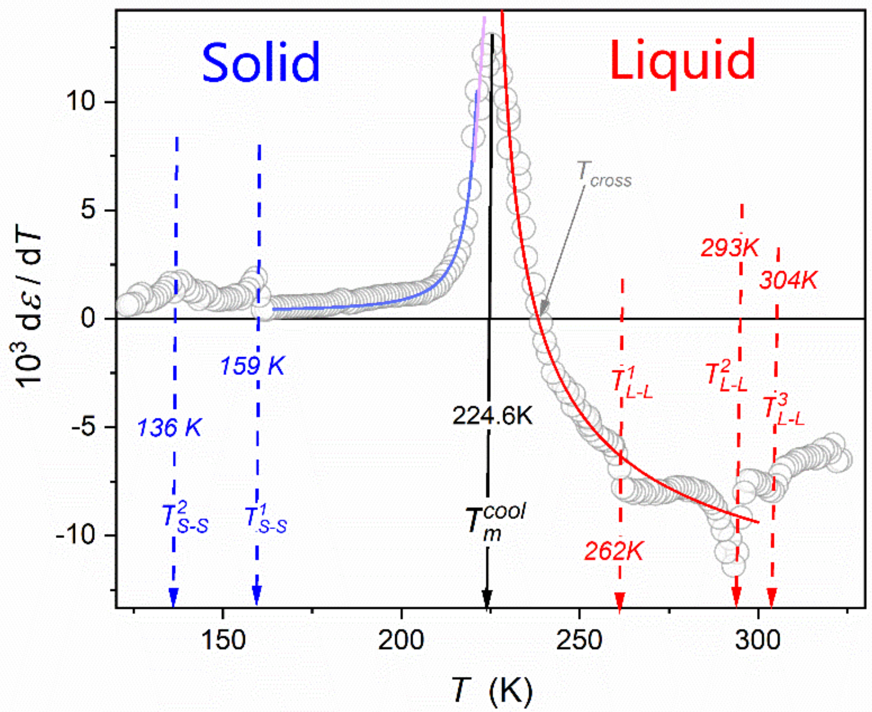
A. Drozd-Rzoska, S.J. Rzoska, J. Łoś, Supercriticality, Glassy dynamics, and the new insight into melting/freezing discontinuous transition in linseed oil. Biophysica 4, 2024, 34-57

Linnseed oil: unique critical-like pretransitional (liquid) & premelting (solid) effects

Dielectric Constant







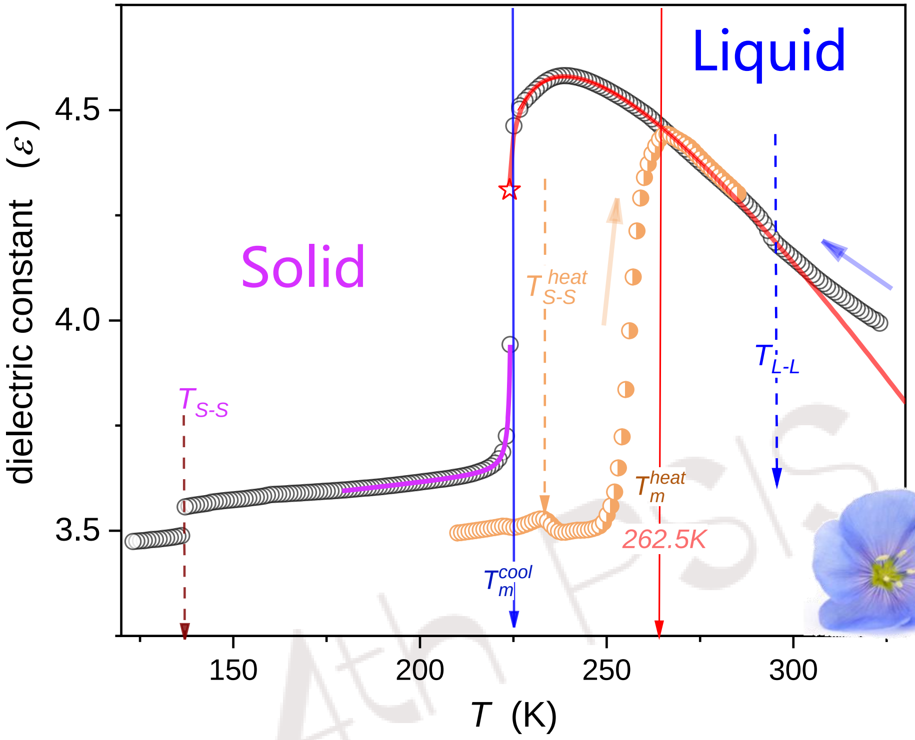
Temperature changes of dielectric constant on cooling (in blue) and heating (in red) in linseed oil. The parameterization of the pretransitional effect is related to Liquid (1) and Solid (2) phases. The star symbol denotes a hypothetical continuous phase transition.

Solid and dashed arrows indicate the freezing (T_f ~ 224 K) and melting (T_m ~ 250 K) temperatures, respectively.

A. Drozd-Rzoska et al., Supercriticality, Glassy dynamics, and the new insight into melting/freezing discontinuous transition in linseed oil. 2024 Biophysica 4, 2024, 34-57

This report results

Liquid side discussion



Focused insight into temperature changes of dielectric constant on cooling and heating in LINSEED OIL. Note the explicit manifestations of pretransitional effects on both sides of the freezing and melting temperatures. Results are for COOLING (open circles) and HEATING (orange, semi-filled circles).

Arrows show melting temperatures on cooling and freezing T_m and the unique liquid-liquid (T_{L-L}) transitions temperatures,

$$\varepsilon(T) = \varepsilon^* + a(T - T^*) + A(T - T^*)^{\phi}$$

$T > T_m = T^* + \Delta T^*$,

T^* denotes the extrapolated temperature of a hypothetical continuous phase transition

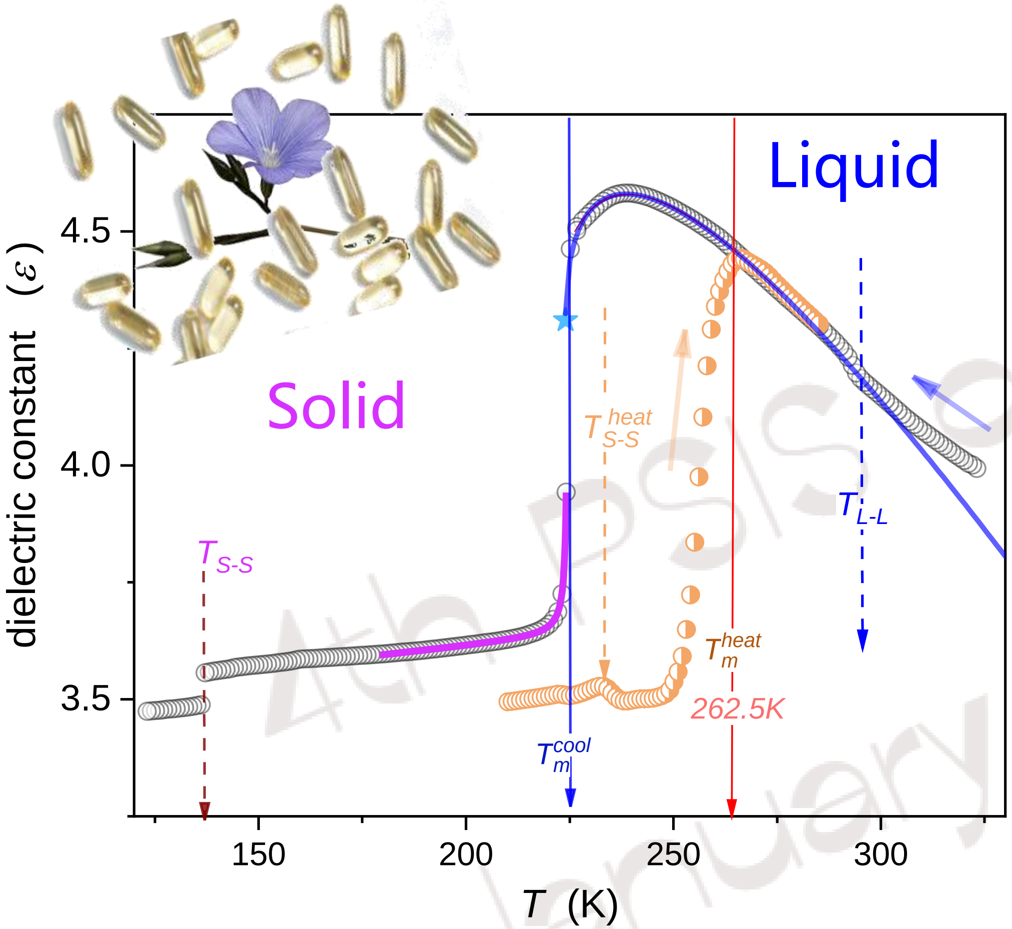
ΔT^* is the metric of the phase transition discontinuity $\phi = ½$ and $\Delta T^* = 0.4$ K

Such evolution, with extraordinary small value of ΔT^*, proves the supercritical behavior extending even well above the room temperature

A. Drozd-Rzoska, S.J. Rzoska, J. Łoś, Supercriticality, Glassy dynamics, and the new insight into melting/freezing discontinuous transition in linseed oil. Biophysica 4, 2024, 34-57

This report results

Solid side discussion



Focused insight into temperature changes of dielectric constant on cooling and heating in LINSEED OIL.

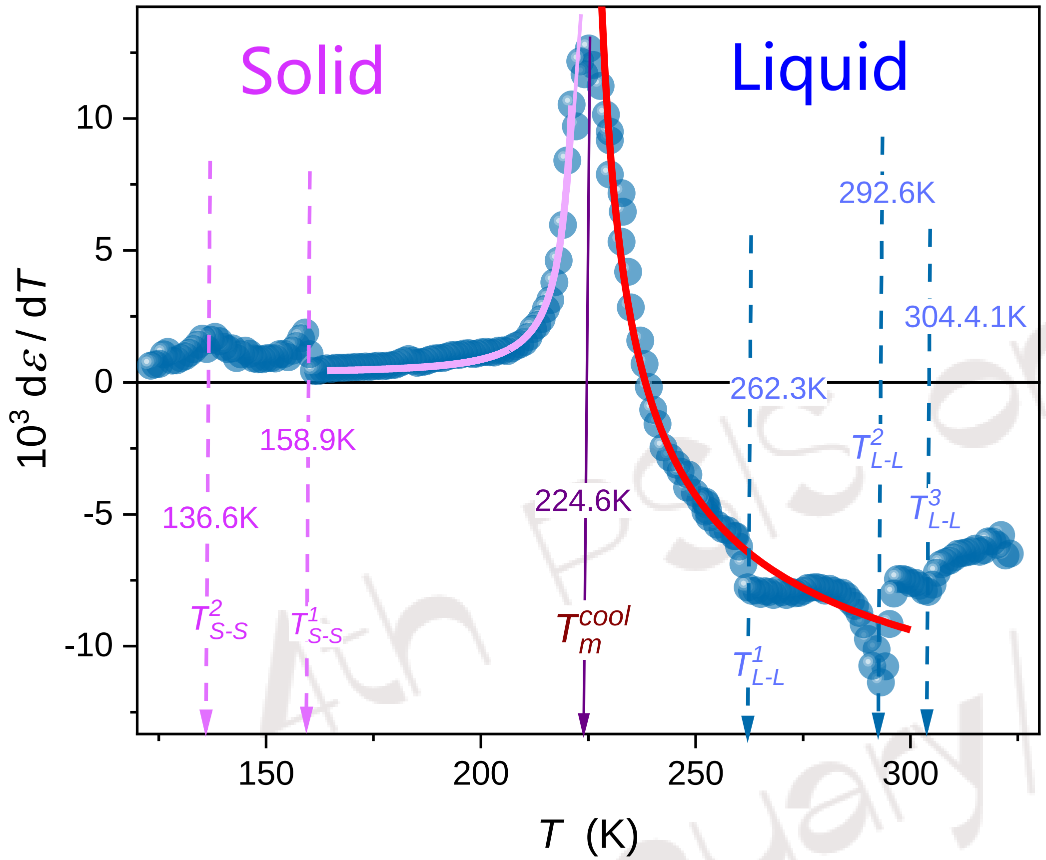
In LINSEED OIL also the unusual evidence for the ‚critical' like premelting effect in solid phase was noted.
It is portrayed by:

$$\varepsilon(T) = (T) - 1 = (aT + b) + \frac{M}{T^{**} - T}$$

It can be explained as the consequence of the ‚reversed Mossotti Catastrophe behavior'

There are TWO melting temperature on HEATING and on COOLING. The latter cannot be shifted for any cooling rate due to the almost continous character of the transition. Hence this is not the freezing temperature, which depends on the cooling rate.

This report results



Focused insight: The temperature evolution of the derivative of dielectric constant, detected on cooling in linseed oil.

The manifestation of pretransitional – Supercritical – behavior is even stronger when considering the derivative of dielectric constant.

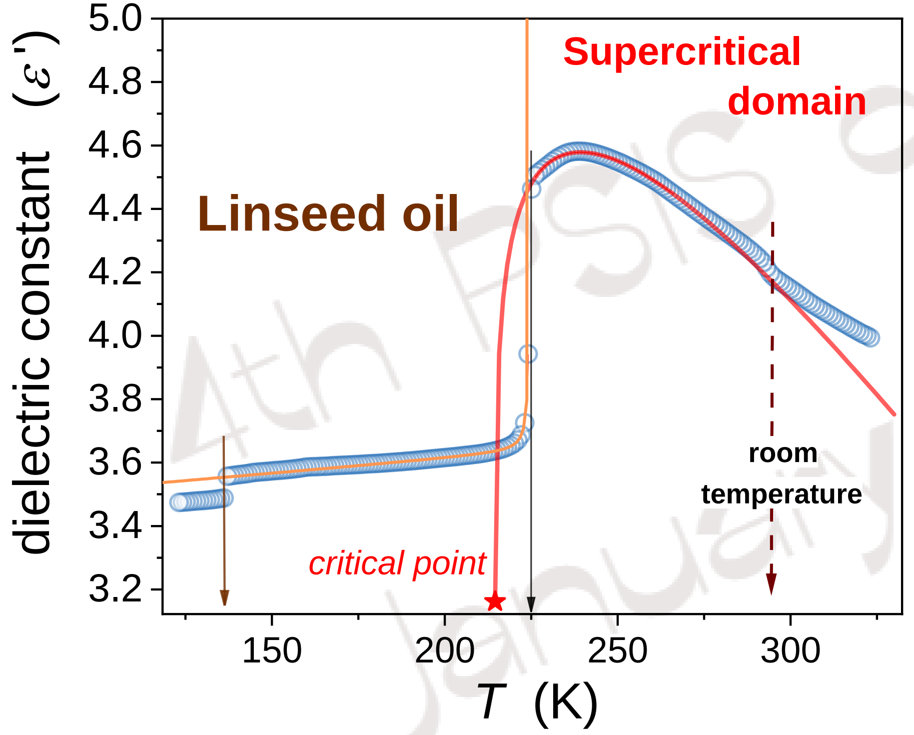
Note the emergence of additional phase transitions ,hidden' for the direct ε(T) plot.

The analysis was possible due to extreme resolution reaching 5 – 6 digits

A. Drozd-Rzoska et al., Supercriticality, Glassy dynamics, and the new insight into melting/freezing discontinuous transition in linseed oil. 2024 Biophysica 4, 2024, 34-57

Liquid-Liquid Supercriticality in Linseed Oil

The first step was the conclusion that the 'classic', constant frequency studies of dieelctric constant are essentially biased, due to the shift of the so called 'staionary domain'. Taking such cirrection the real dielectric constant was measured and the supercritical pretransitional anomaly associatyed with the semi-critical phase transition has been discovered



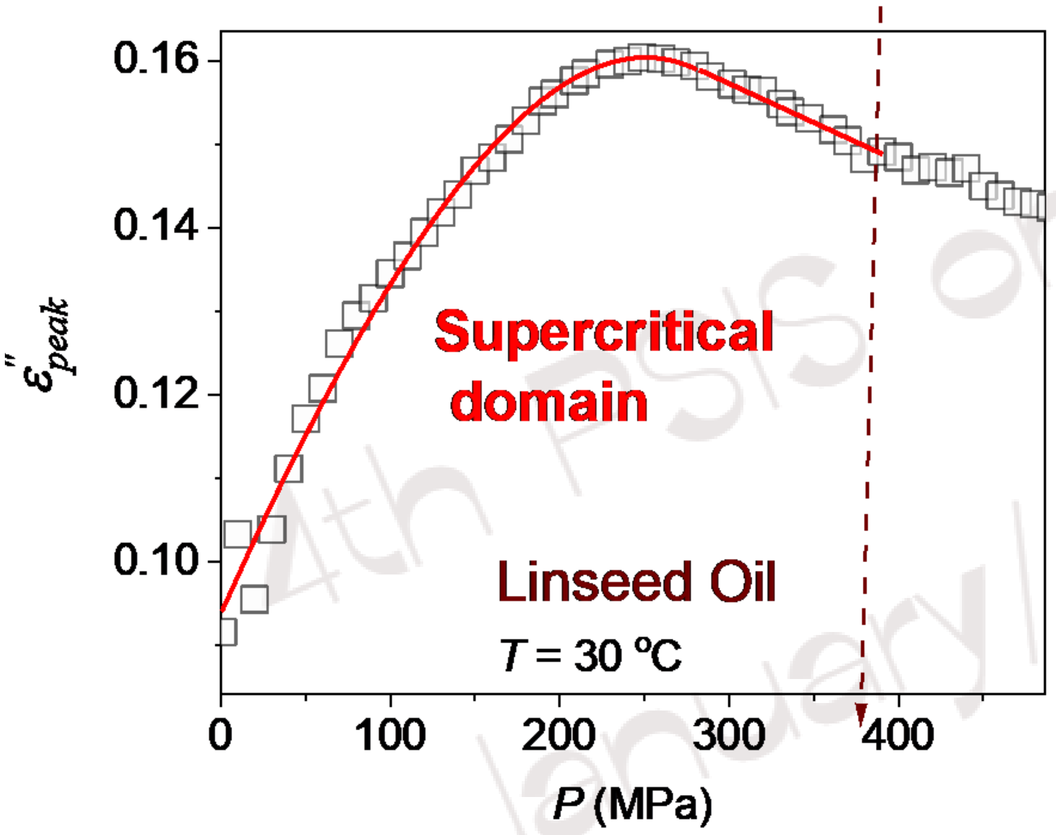
$$\varepsilon(T)=\varepsilon_C+A(T-T^*)+B(T-T^*)^{0.15}$$

The supercritical behavior, having decisive impact on the solubility and the reactiveness extends even above the room temperature !

L-L Supercriticality in Linseed Oil: pressure path

Even stronger supercritical behavior appear on comprssing – also at room temperature.

Here the evidence fo rthe absorption of the ,dielectric reorientation Energy' related factor



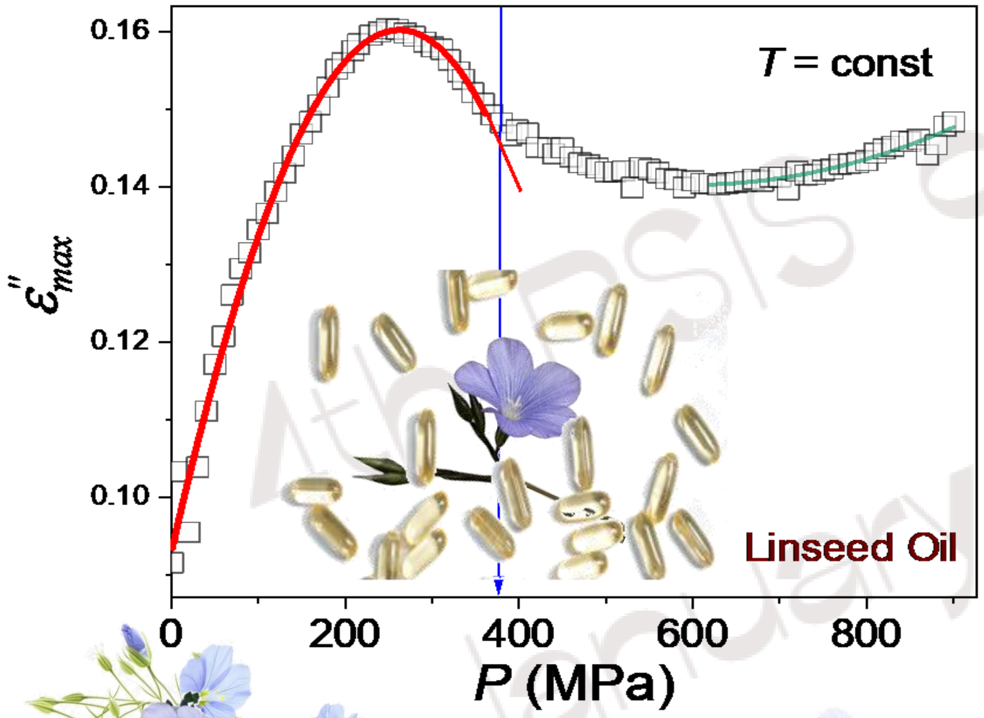
$$\varepsilon''_{peak}(P) = \varepsilon''_C + A(P^* - P) + B(P^* - P)^{0.15}$$

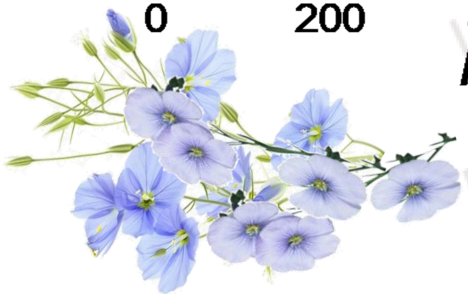
Moderate pressure – already 200 – 400 Mpa can shift the semi-critical phase transition and the extreme-impact part of the Supercritical domain even well above the room temperature !

Similarimpact have 5 % addition of water and only 0.2 % of barium tiitanate nanoparticles !

This report results – the first ever pressure studies

The loss curve maximum (peak height) indicates the energy loss during the interaction between the dipole moment and the electric field. It exhibits the strong pretransitional effect, for which the dielectric constant was not too sensitive.





Pressure changes of the loss curve maximum for linseed oil at $T = 258K$ isotherm. The arrow indicates the possibility of the second transition, hidden in the GPa domain.

Note the long-range pretransitional effect desribed by the relations below, with the exponent $\phi = 1/2$

$$\varepsilon''_{max}(P) = \varepsilon^{(*)}_{max} + A_P(P^* - P) + B_P(P^* - P)^{\phi}$$

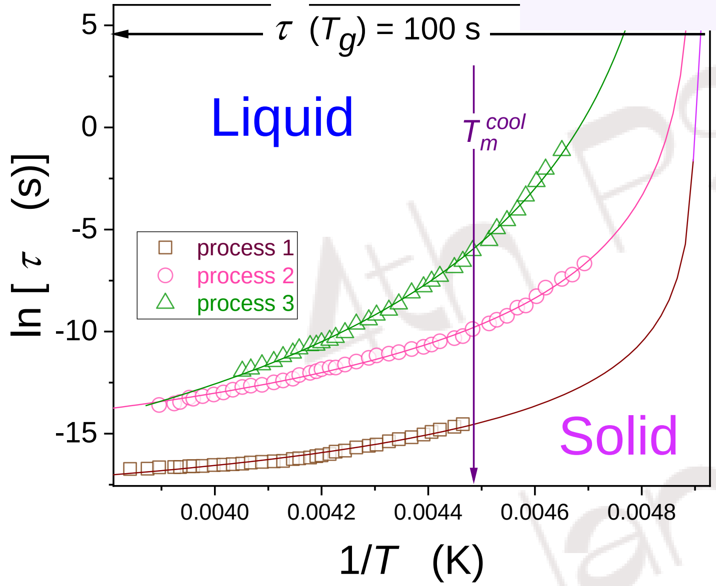
A. Drozd-Rzoska, S.J. Rzoska, J. Łoś, Dielectric spectroscopy in linseed oil uder compression. Submitted 2026

This report results

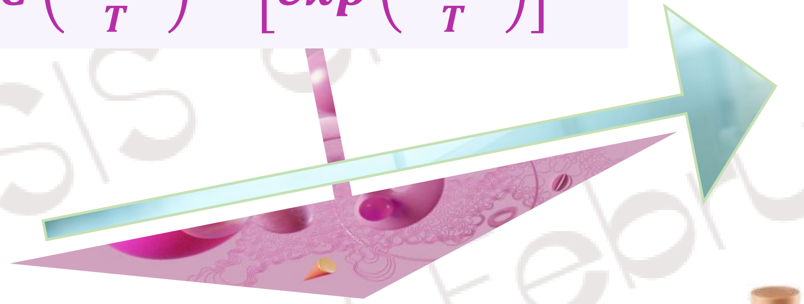
LINSEED OIL cannot be **Supercooled** to the solid glass state in the liquid phase.
It always solidifies at T_m due to the weakly discontinuous character of the transition.

Notwithstanding, the relaxation time (and the coupled viscosity) exhibit in the liquid state the 'glassy – type' (Non-Arrhenius) dynamics.

$$\tau(T) = C\left(\frac{T-T_g^*}{T}\right)^{-\theta}\left[exp\left(\frac{T-T_g^*}{T}\right)\right]^{\theta}$$

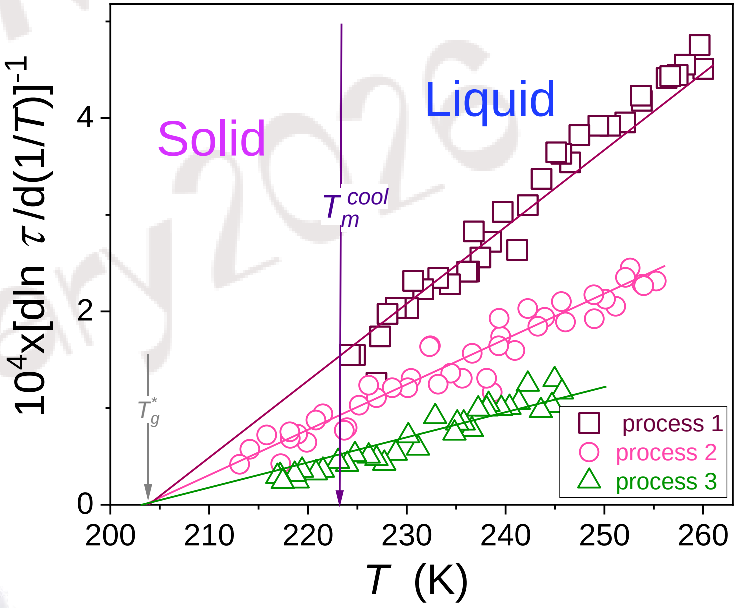


Temperature changes of basic relaxation processes detected for the primary loss curve for linseed oil.



Note the superior portrayal by critical & activated relations derived by A. Drozd-Rzoska

$$H_a(T) = \frac{H}{T - T_g^*}$$



The universal behavior of temperature evolutions of apparent activation enthalpy

$$H_a(T) = dln(T)/d(1/T)$$

A. Drozd-Rzoska, Universal behavior of the apparent fragility in ultraslow glass forming systems. Sci. Rep. 9, 6816 (2019)
A. Drozd-Rzoska et al.. Biophysica 4, 2024, 34-57

This report results

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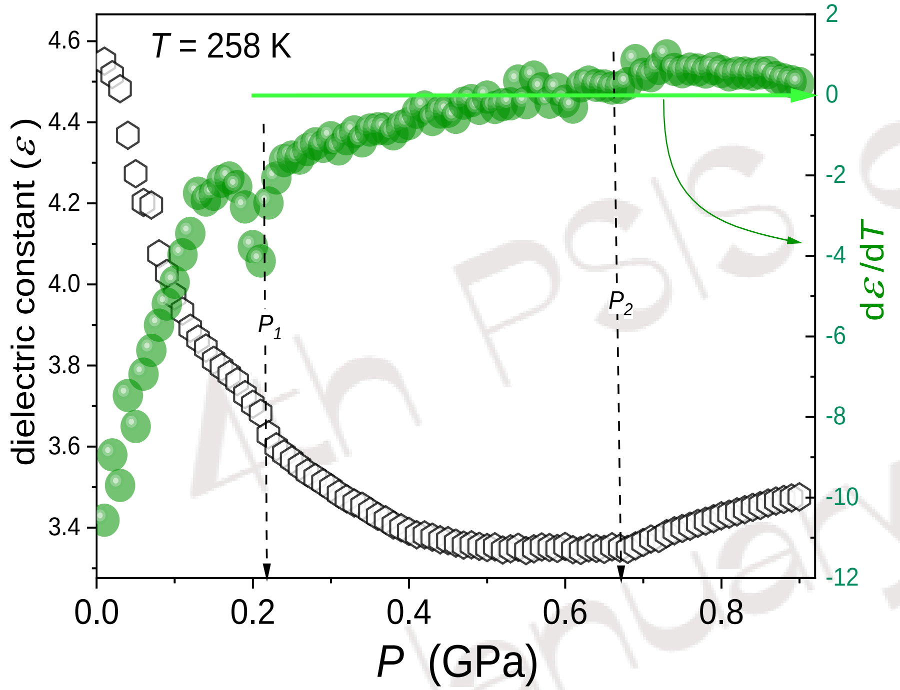
Cooling is associated with the apparent Activation Energy changes.

Compressing is coupled to apparent Activation Volume changes.

BDS studies up to 1 GPa (10 kbar) were carried out.

The patented design of the measurement capacitor for the total isolation of the sample from the pressurized medium was used.



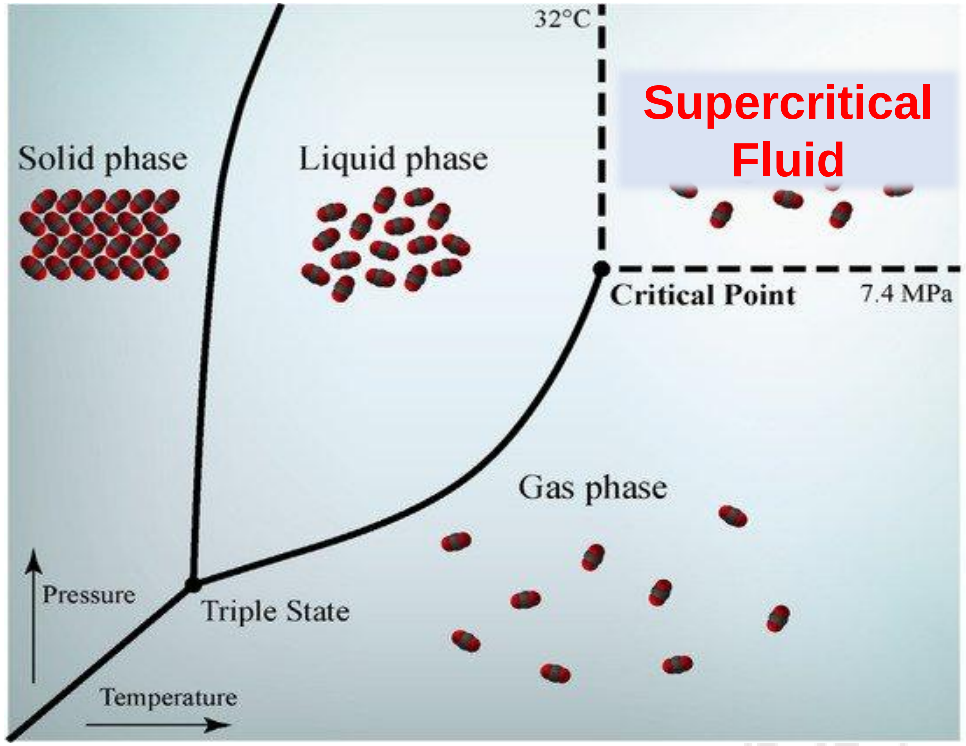
The plot shows pressure evolution of dielectric constant for $\mathbf{T = 253K}$ isotherm. The plot also shows changes in its derivative, strengthening subtle features, such as phase transformation or the crossover

$$d\varepsilon(P)/dP < 0 \Rightarrow d\varepsilon(P)/dP > 0$$

A. Drozd-Rzoska, S.J. Rzoska, J. Łoś, Dielectric spectroscopy in linseed oil uder compression. Submitted 2026

No long-range pretransitional effects are observed, but note that dielectric constant detects mainly changes in the global arrangement of permanent dipole moments. Only two ,weak, discontinous transitions are detected.

Supercritical Fluids (SCF) Phenomenon & Technology



Does the Unique Liquid Supercriticality in Linseed oil exist

Apart from the Solid, Liquid, and Gas phases, the Supercritical Fluid state exists. It is associated with extraordinary properties like extreme selective solubility, reaction rate or diffussion, for instance. In practice, it is implemented for the Supercritical Extraction technology, with Gas-Liquid critical point in CO_2 as the carrier.

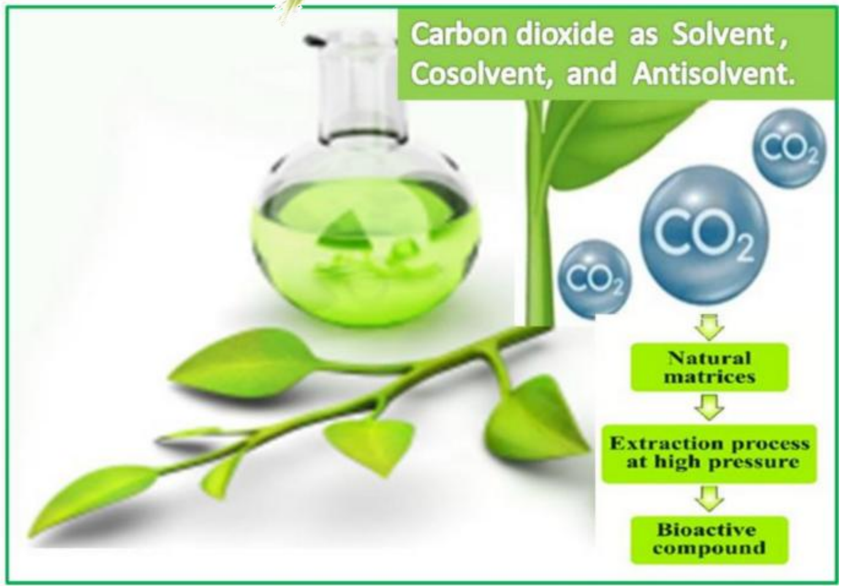
Are extraordinary pro-health properties of Linseed Oil supported by Supercriticality ?

Supercritical Fluids (SCF) Phenomenon & Technology

The name ‘supercritical fluids’ (SCF) can be linked to any liquid beyond (above) the critical point, in the homogeneous domain. For the SCF extraction technology, it is associated with the vicinity of the gas-liquid critical point, i.e., the domain above the critical pressure (P_C) and temperature (T_C). SCF often explores carbon dioxide as the ‘criticality carrier’, with a small addition of co-solvents to focus on the desired extraction target

The SCF gas-liquid critical point extraction technology is the most selective and fine-tuning method. Hence it is often indicated as the most promising ‘green’ approach.

The standard liquid-based extraction technologies (L, LL) are generally more effective - because they use a liquid carrier instead of a gas carrier - but essentially less selective than SCF technology. They also require strong cooling or heating, which raises costs, exacerbated by the post-process pollution challenge.



Supercritical Fluids (SCF) Phenomenon & Technology

The phenomenon is based on extraordinary properties in the broad vicinity of the critical point, in fact yielding unique Supercritical Fluid state which properties are driven by multi-scale pre-critical fluctuations , which size and life-time increases infinitely on approaching the critical point. It also leads to infinite order parameter coupled susceptibility and extraordinary solubility and diffusion, essential for SCF technology.

They are described by Kirkwood and Noyes – Withney equations:

$$k, s = p_\infty exp\left[\frac{A\Delta_P}{RT}\left(\frac{1}{\varepsilon} - 1\right)\right]$$

where k and s stand for the chemical reaction rate and the solubility; Δ_P is for the difference in polarity between the reactant and product; p_∞ is the prefactor related to the given property, A is the system-dependent constant.

$$\frac{dm}{dt} = S\frac{D}{d}(C_{S-}C_B)$$

where m is the mass of dissolve material, t - the processing time, S is the surface area of the solute particle, D diffusion coefficient, d - is the thickness of the concentration gradient layer, C_S and C_B particles surface and bulk concentrations (mol/L).

Only recently, its critical forms, explicitly showing the importance of dielectric constant and DC electric conductivity critical anomalies has been derived [*]: $\frac{dm}{dt} = CT(a_\sigma(T - T_C) + A(T - T_C)^{1-\alpha}) - + \cdots)$

$$k(T), s(T) \approx \frac{K}{T}\left(\frac{1}{\varepsilon_C + a(T - T_C) + A(T - T_C)^{1-\alpha}) + ..} - 1\right) + p_\infty$$

where $C = (S\Delta_C/d)(k_B/nq^3) = const.$

where the constant parameter $K = Ap_\infty \Delta_P/R$

Rzoska, S. J.; Drozd-Rzoska, A. Criticality-related fundamental bases for new generations of gas-liquid, liquid-liquid, and liquid (LE) extraction technologies. 2022, Eur. Phys. J. E 45, 67

Supercritical Fluids (SCF) Phenomenon & Technology

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The long-range and 'strong' pretransitional changes of dielectric constant, and unique critical – type dynamics suggest that LINSEED OIL can constitute the base for the new generations of liquid extraction supported by supercriticality. Notable, this is associated with the fluid phase treatment, which is essentially more effective than the 'gas matrix' use in standard CO_2 gas phase. For the latter, pollution by releasing CO_2 into the atmosphere is practically standard.

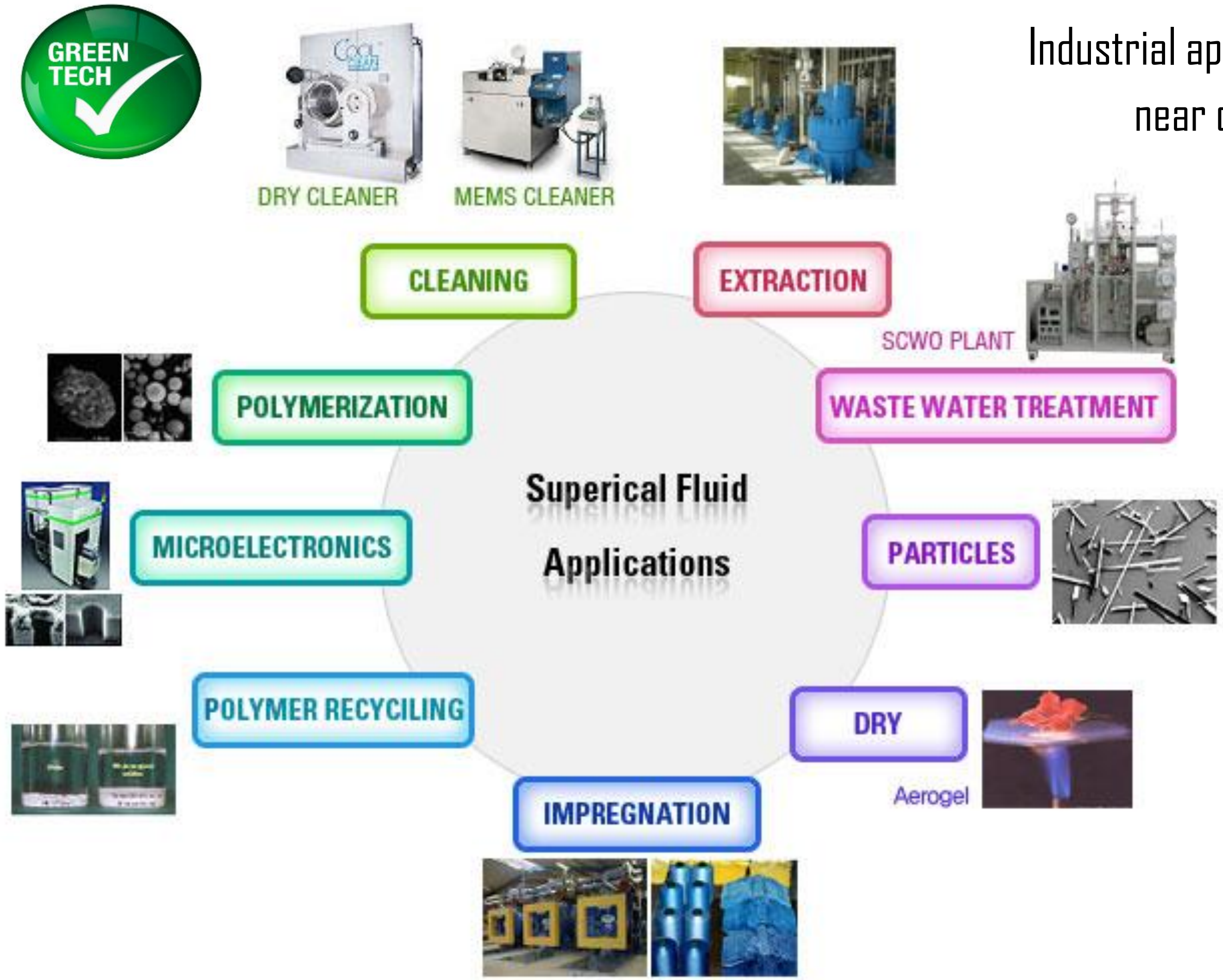
For LINSEED OIL- based implementation, such an environmental threat does not exist. Furthermore, it is a completely natural material that supports environmental safety.

The long-range and 'strong' pretransitional changes of dielectric constant can also suggest that LINSEED OIL can constitute the base for the new generations of liquid extraction supported by supercriticality. Notably, LINSEED OIL is a natural product with no harmful effects on human health.

The supercritical properties of LINNSEED OIL associated with extremely strong and long-range critical pre- transition anomalies raise a fundamental question:

Are the special health-promoting properties of Linnseed Oil not significantly supported by the unique characteristics of the Supercritical Domain?

Supercritical Fluids (SCF) Phenomenon & Technology



Industrial applications of the supercriticality . They explore the gas – liquid near critical domain for $T > T_C$ and $P > P_C$ mainly for CO_2

The supercritical behavior in linseed oil – the new challenge for skincare?

Possible implementations for innovative cosmetics

CONCLUSIONS

APPLICATIONS

Contrary to the classical SCF technology in Linseed Oil the supercriticality is within the materials.
It is the inherent feature of LINSEED OIL.

This can open the gate to the innovative solutions regarding both the product and its processing.

This innovative ‚Inherent Supecriticality' technology can benefit for extraordinary features of supercriticality but in the qualitatively new way

Is this a chance for the new generation of ‚Inherently Supercritical' super-cosmetics ?

https://7daysorganic.com/products/7-days-flaxseed-oil-cold-pressed-for-skin-breast-growth-hair-100ml-natural-

CONCLUSIONS

APPLICATIONS

I. Using the 'material engineering' of model cosmetics containing linseed oil one can 'design' the product which can become 'supercritical' just in the body temperature, often using on the skin.

The proper 'designing' can increase – for strictly 'programmed time', some properties and activities 100 - 1000 x, leading to the controlled 'boost efect'.

This can be the way to innovative super-cosmetics with a specific, inherent,, artificial intelligence (AI)'

Possible implementations for innovative cosmetics

APPLICATIONS

CONCLUSIONS

II. Nowadays available are large volume high pressure systems for food processing operating in the range of pressures up to 600 MPa. This is just the range required to yield , ,extreme Inherent Supercriticality; in Linseed Oils at room temperature.

Hence, one can locate the ,super-cosmetic' in a pressure chamber, to create under pressure new functionality never possible in classical treatment and suddenly decompress, to finsh the proces at the ,designed time and level'.

As the ,additional effect' the microbiological cleaning occurs, thus any ,chemical preservative' can be avoded.

Organic-Flaxseed-Unrefined-Dandruff-Aromatherapy

This report results

APPLICATIONS

CONCLUSIONS

This report shows that the long-range supercritical behavior in LINSEED OIL exists on cooling and compressing.

It leads to → the unique , double supercriticality' impact on liquid

LINSEED OIL properties are also similar to those at room temperature.

The impact can be even stronger when taking into account admixtures (for instance, water), which can significantly shift phase transition temperatures.

In the supercritical domain, collective mesoscale fluctuations can increase by orders of magnitude, including solubility, chemical reaction rates, diffusion rates, and support interactions that are absent under ,normal' conditions.

Well known is the antibacterial (preservative) activity in the supercritical state.

Possible extreme action selectivity.

This report results

APPLICATIONS

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CONCLUSIONS

There are 3 leading industrial extraction technologies:

1. **Supercritical extraction** based on the surroundings of the gas–liquid critical point, mainly CO_2. Extremely selective. However, difficult for ‚massive' applications, which limits efficiency. Requires advanced high pressure technology. Considered as the ‚Green Hope' in the given field.
2. **Liquid extraction,** based on the solubility preference for a chosen liquid and task. More efficient than (1) and easy in applications, then broadly used. However, it is efficient but poorly selective and associated with 'pollution production'.
3. **Liquid-liquid extraction,** based on different solubilities in coexisting liquid phases. It is efficient but poorly selective and ‚pollution productive'. Broadly used.

The current trend for (1) and (2) – the search for ‚natural carrier-liquids', then biodegradable and less burdensome for the environment.

The discovery of Supercriticality in Linseed Oil leads to the proposition of the innovative extraction technology linking features of (1) and (2) technololigies and based on a ‚natural' carrier.

Selective, Efficient & Eco-Friendly?

The 4th Polish-Slovenian International Seminar on
26th - 27th January 2026
& 2nd February 2026

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Thank you for your attention

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The 4th Polish-Slovenian International Seminar on Young 4 Soft Matter DAY
2nd February 2026

This report results

The focused insight on the imaginary part of dielectric permittivity change on copressing

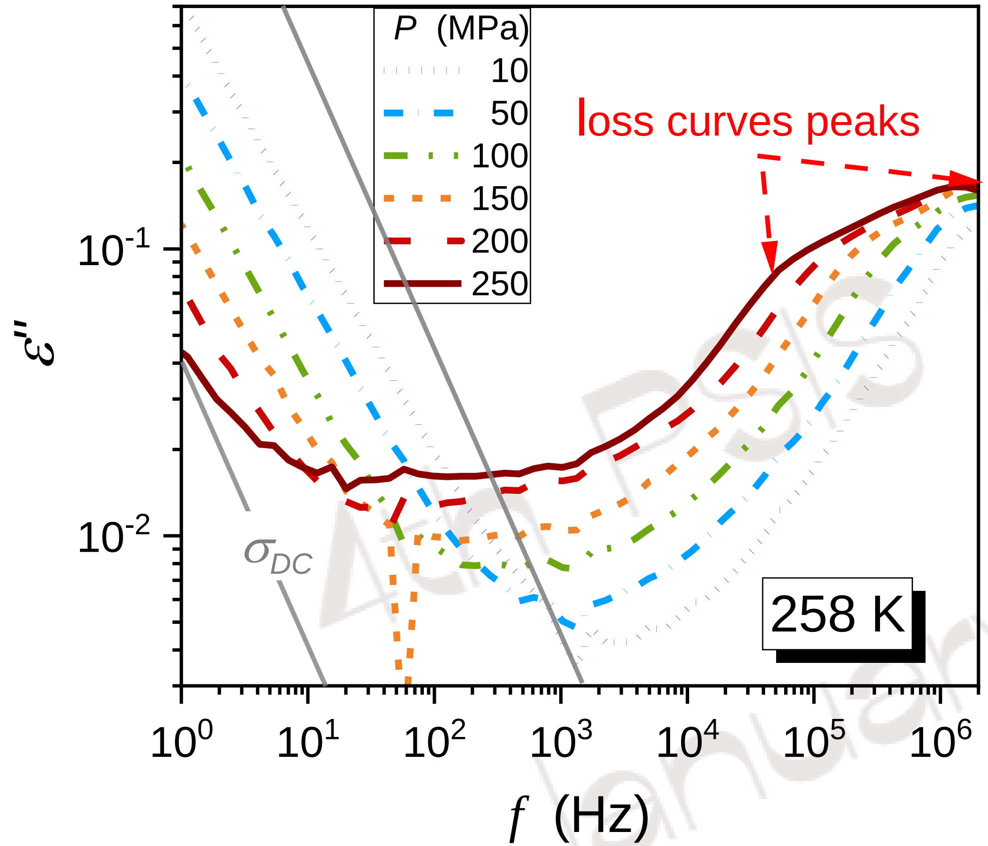

Fig. 8 Scans of $\varepsilon''(f)$ spectra for selected pressures, obtained on compressing linseed oil at $T = 258K$.

Note the loss curve: their peaks determine relaxation times

$\tau = 1/2\pi f_p$, and the height (peak) - its maximum

τ - estimates the energy loss associated with given relaxation proces.

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insight into melting/freezing discontinuous transition in linseed oil. Biophysica 4, 2024, 34-57