



Mezinárodní konference  
**Konopí a věda XI**

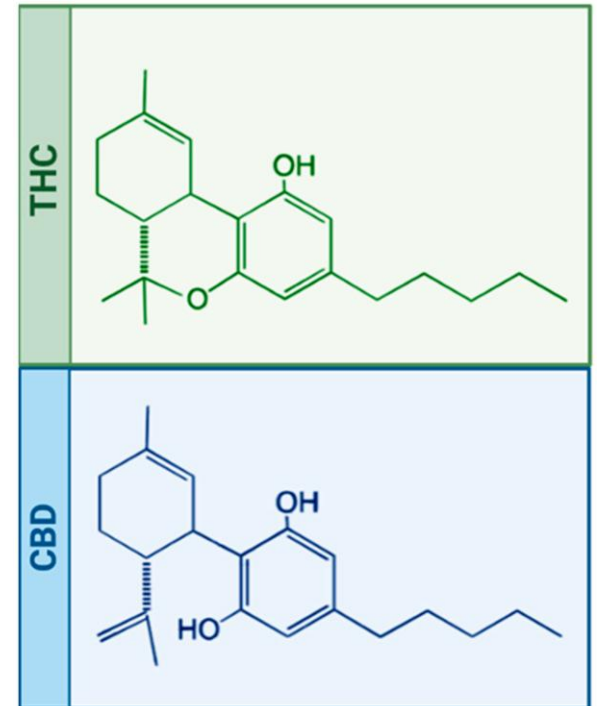
22. 4. 2026

**ENHANCING THERAPEUTIC EFFICACY OF  
CANNABIDIOL THROUGH THE DEVELOPMENT OF  
ADVANCED DELIVERY SYSTEMS**

**Viktorija Maksimova PhD**

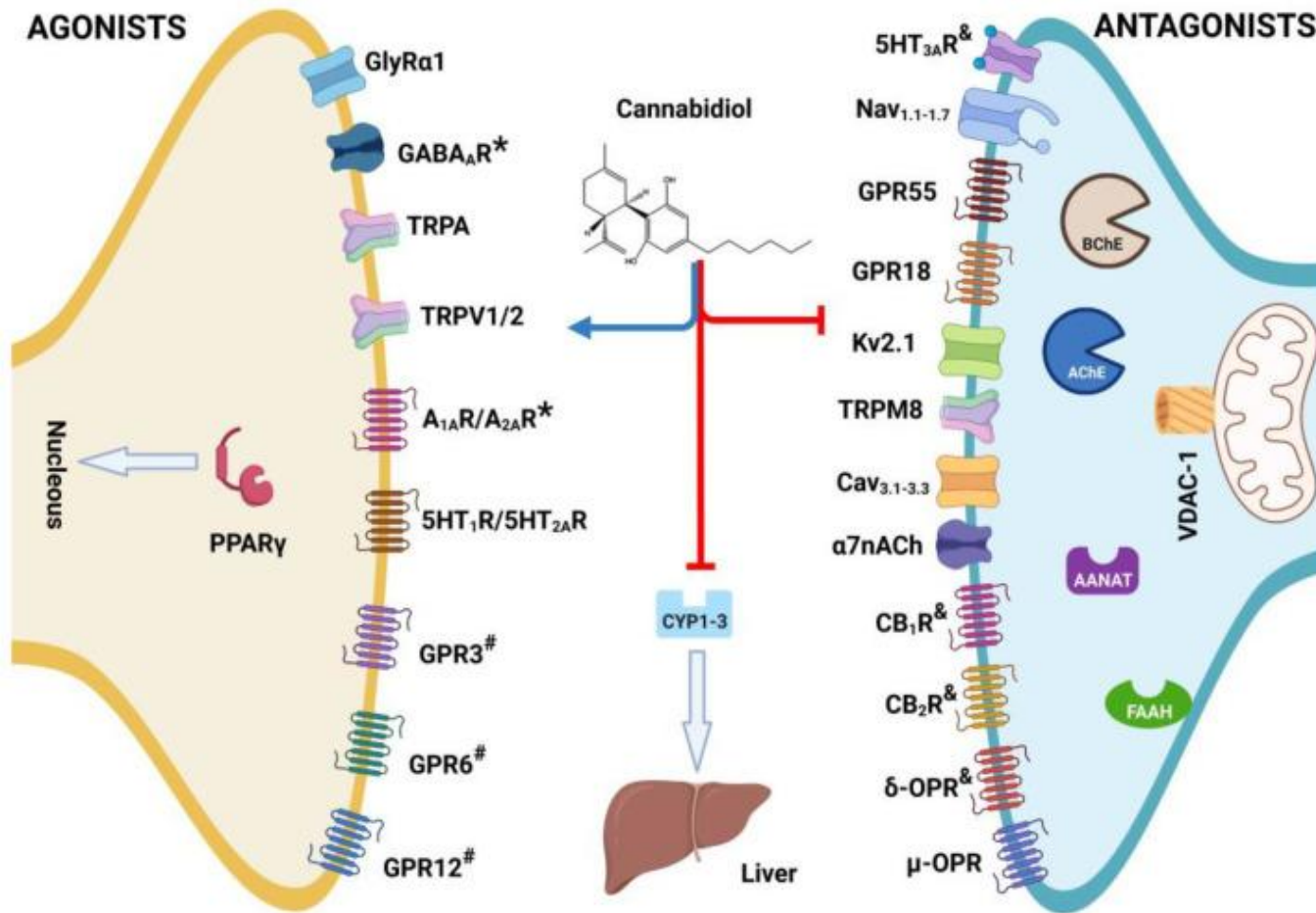
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Why CBD, not THC?

# CBD is a complex multi-target molecule

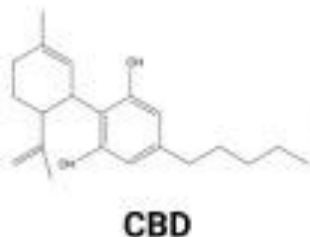


Broader  
therapeutic  
potential of CBD

agonistic effects for TRPV1-4 and TRPA1 channels, with antagonistic effects on the TRPM8 channel.

TRP channels mediate, at least in part, the effects of CBD on seizure, inflammation, cancer, pain, acne, and vasorelaxation

CBD as agonist or \* = positive allosteric modulator (PAM), antagonist, # = inverse agonist, & = negative allosteric modulator (NAM) on multi-target receptors and enzymes



**Neurodegenerative & psychiatric disorders**



**Epilepsy:** clinical: approved for Tuberous Sclerosis Complex, Dravet syndrome and Lennox-Gastaut syndrome  
**Alzheimer:** pre-clinical: improved cognitive deficits  
**Parkinson's disease:** pre-clinical: anti-cataleptic and improvement of motor system  
**Huntington's disease:** pre-clinical: neuroprotection against striatal degeneration  
**Schizophrenia:** clinical: improvement in psychotic symptoms  
**Anxiety & Depression:** pre-clinical: anxiolytic and anti-depressant effects

**Inflammatory diseases and pain**



**Arthritis:** pre-clinical: anti-inflammatory and analgesic effects. Clinical: pain relief, improved physical function and sleep quality in osteoarthritis  
**Inflammatory Bowel Disease:** pre-clinical: prevention of gut permeability and morphological changes. Clinical: Attenuation of colon damage and intestinal hypermotility. Clinical: improvement in quality of life  
**Multiple sclerosis:** pre-clinical: anti-inflammatory effects and prevention of axonal damage and motor deficit  
 Reduced microglial activation and motor deficit

**Cardiovascular diseases**



**Ischemic heart disease:** pre-clinical: ischemia-reperfusion injury (I/R) protection  
**Cardiomyopathy induced by Doxorubicin:** pre-clinical: reduced oxidative stress and inflammatory response  
**Myocarditis / Pericarditis:** pre-clinical: anti-inflammatory effects and reduced fibrosis  
**Arrhythmias:** pre-clinical: reduced incidence of ectopic beats and ventricular fibrillation in I/R injury

**Hypertension & vasodilatory effects**



**Vasodilatory effects:** pre-clinical: vasorelaxation in arteries  
**Hypertension:** clinical: reduced systolic and diastolic blood pressure in healthy and hypertensive individuals

**Diabetes**



**Cardiomyopathy:** pre-clinical: reduced fibrosis and preserved cardiac function  
**Retinopathy:** pre-clinical: preservation of blood-retinal barrier  
**Nephropathy:** pre-clinical: reduced leukocyte infiltration in kidney

**COVID-19**

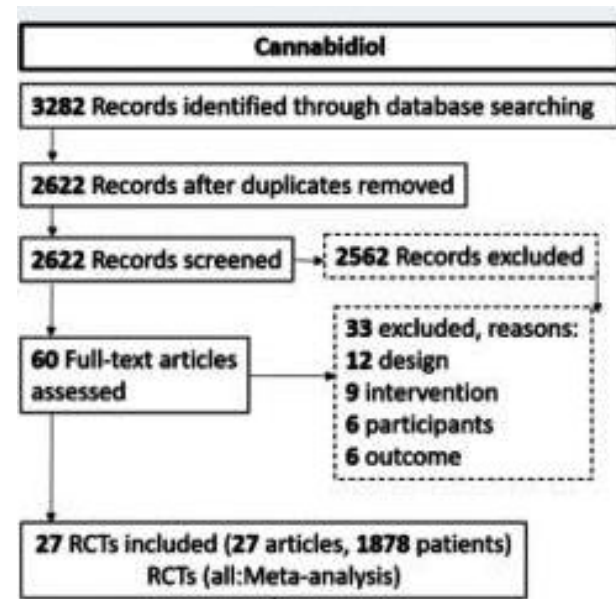


**Acute lung injury:** pre-clinical: reduced lung inflammation  
**Antiviral properties:** pre-clinical: reduced viral replication

# CBD: Opportunities & Challenges

- ✓ Therapeutic potential
- ✗ Poor solubility
- ✗ Low bioavailability
- ✗ Instability

Indications confirmed by randomized clinical trials for CBD



Chronic Pain	Chronic pain
Sy	Nausea/ loss of appetite
N	Huntington syndrome
ALS (0:0)	
Chorea	
Dystonia (0:0)	
Epilepsy (6:6)	Epilepsy
Glaucoma (0:0)	
Irritable Bowel Disease (0:0)	
Multiple Sclerosis (0:0)	
Parkinson (3:3)	Parkinson
ADHD (0:0)	
Anorexia Nervosa (0:0)	
Anxiety (11:11)	Anxiety
Dementia (0:0)	
Depression (6:6)	Depression
PTSD (0:0)	
Schizophrenia/Psychosis	Schizophrenia
Sleep (9:8)	
SUD (7:7)	Sleep disorders
Tourette (0:0)	
Retention (27:22)	
Adverse events (22:22)	SUD

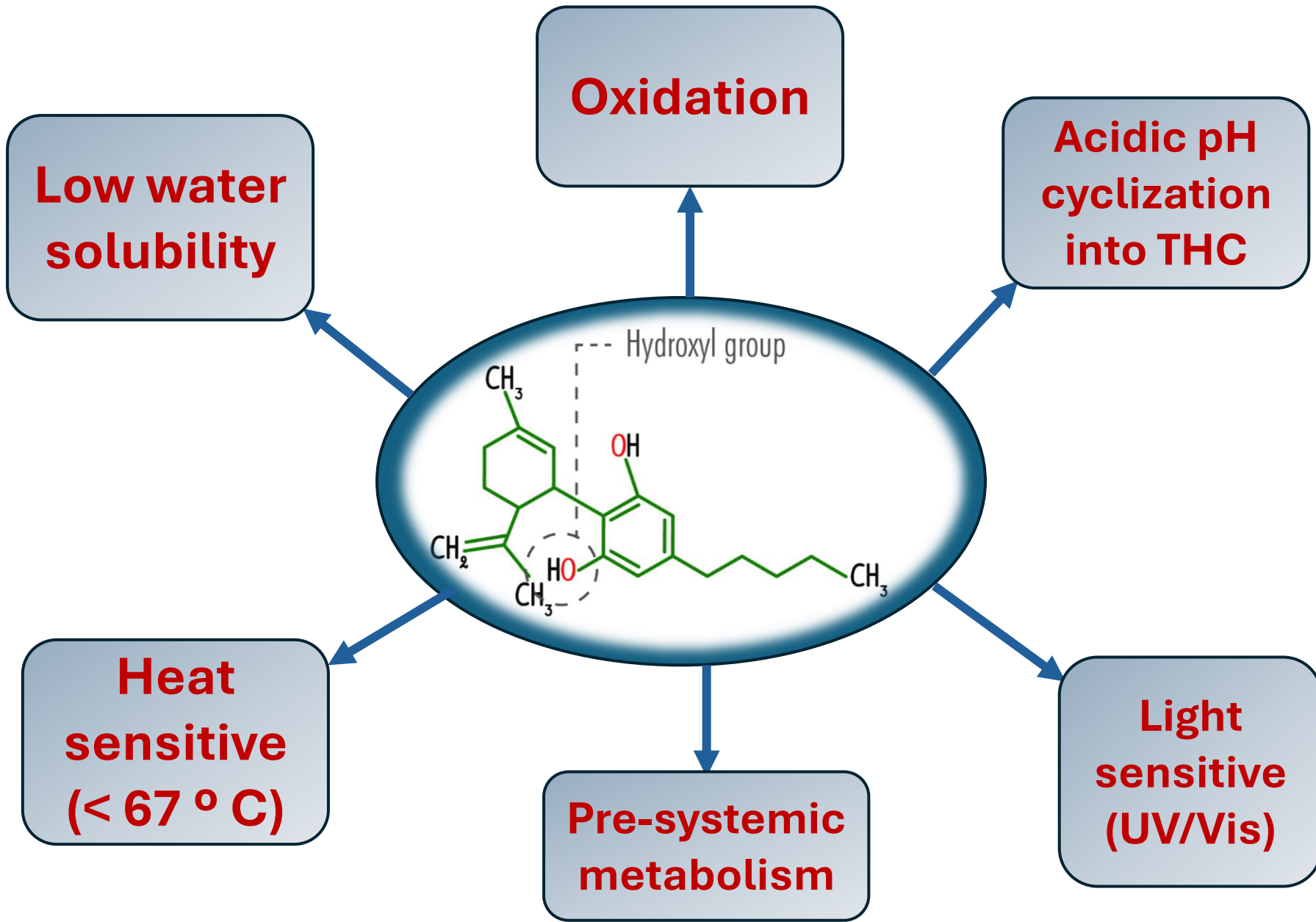
# CBD: Opportunities & Challenges

- x Therapeutic potential
- ✓ **Poor solubility**
- ✓ **Low bioavailability**
- ✓ **Instability**



Limited by  
physicochemical  
properties

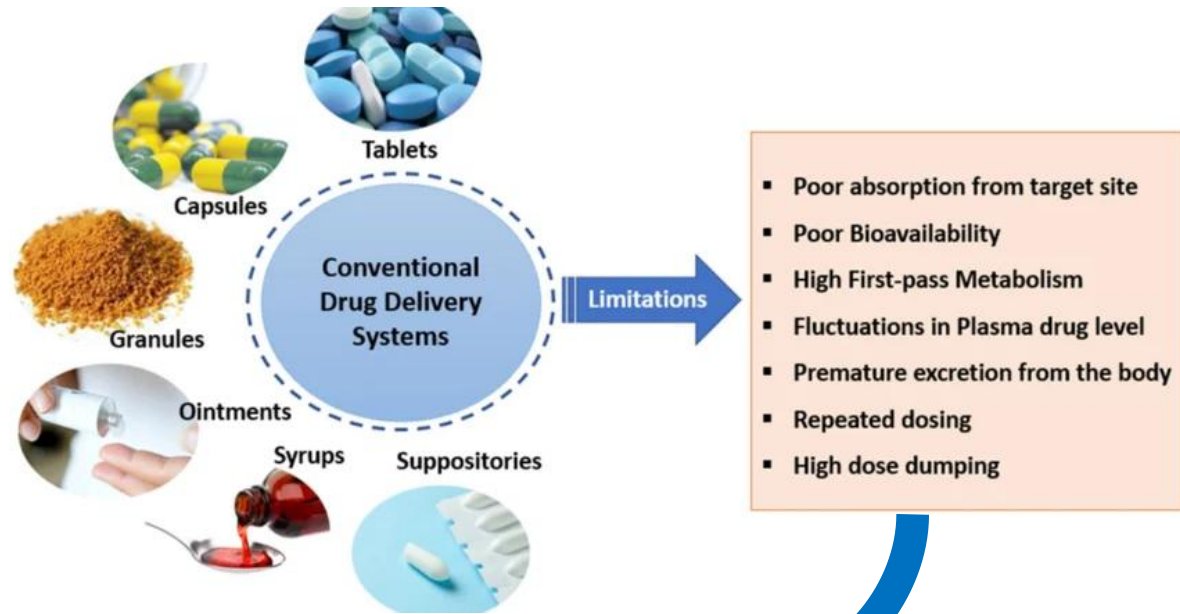
# Cannabidiol instability and challenges



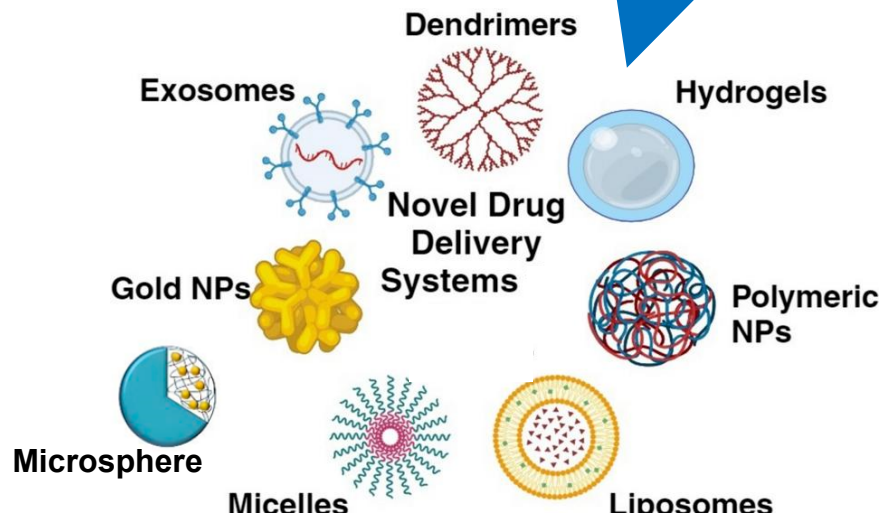
# Research Aims and Objectives



- To **evaluate and develop advanced delivery systems** for CBD
- To **optimize the microencapsulation technique** using protein and polysaccharide matrices
- To **improve stability, solubility, and bioavailability** of CBD



## Conventional v.s advanced pharmaceutical delivery systems



# Types of microparticles

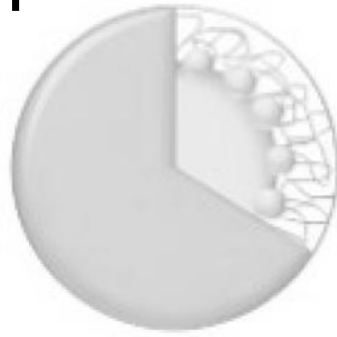
## Why microencapsulation?



B.



C.



D.



E.

Simple

Cost-effective

Scalable



G.



H.



I.



J.



Polym



Core

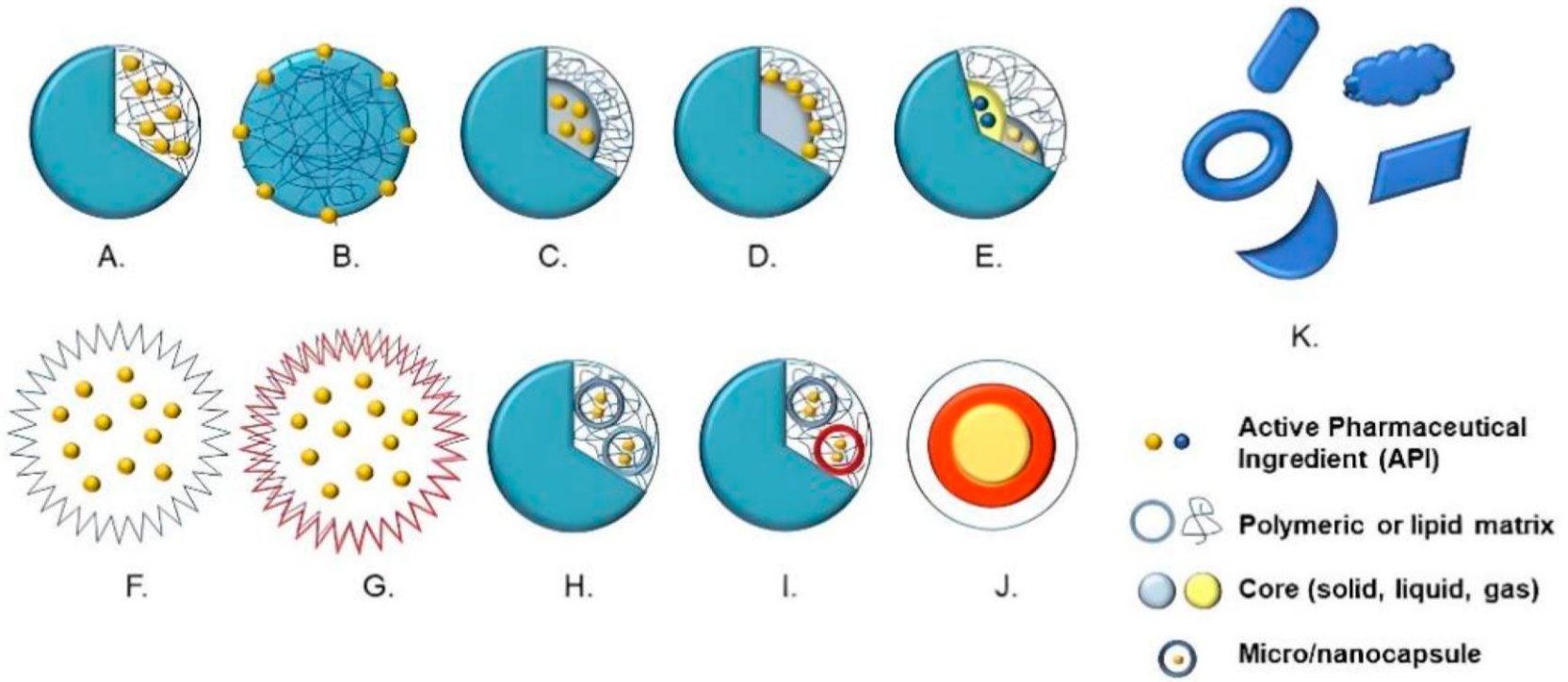


Micro

Activ  
Ingre

K

# Microparticles as delivery systems for CBD



## Types of microparticles:

- (A) Microsphere with encapsulated active pharmaceutical ingredient (API),
- (B) Microsphere with adsorbed API,
- (C) Microcapsule with encapsulated API,
- (D) Microcapsule with adsorbed API,
- (E) Multicore microcapsule,
- (F) Hollow microparticle,
- (G) Hollow multilayer microparticle,
- (H) Microparticle containing microcapsules,
- (I) Microparticle containing multicore microcapsules,
- (J) Multilayered microparticles, and
- (K) Microparticles with irregular shapes.

Sizes ranging from 1 to 1000  $\mu\text{m}$

# Microencapsulation

**Microencapsulation** is a process of coating solid, liquid, or gaseous components with thin polymeric shells to form microcapsules. The polymer coating protects the core from degradation and enables controlled release of the active substance.



The selection of coating material is crucial for the stability and effectiveness of the active substance.



**Coating materials:**



**Lipids:** wax, paraffin, hydrogenated oils



**Carbohydrates:** cellulose, chitosan, gum arabic, alginate, carrageenan



**Proteins:** casein, gelatin, albumin, protein isolates



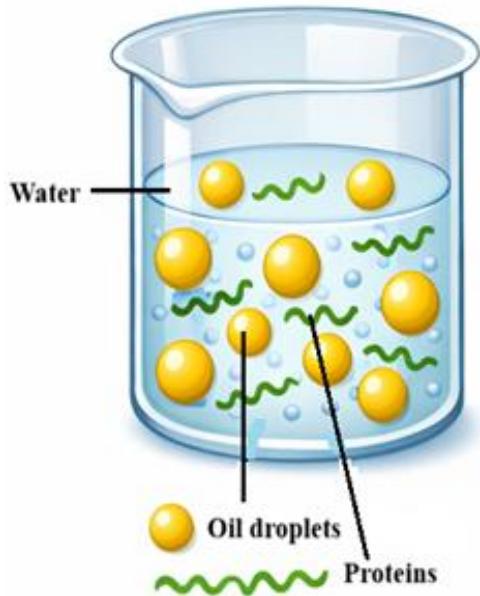
**Inorganic materials:** calcium sulfate, silicates



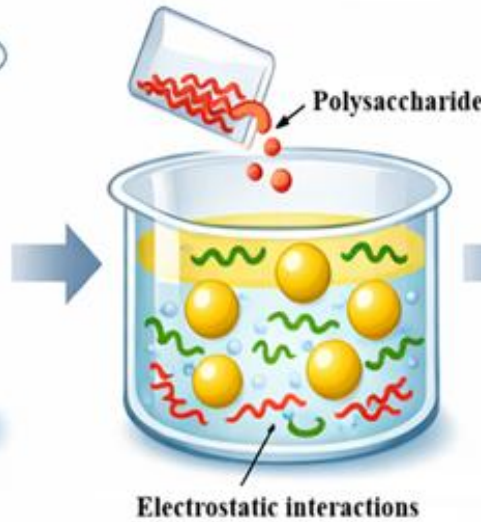
# Materials and methods

COMPOUNDS (ACTIVE SUBSTANCES/ EXCIPIENTS)	ROLE OF THE COMPONENTS IN FORMULATION
Hemp seed oil	Core/oil phase
CBD oil 20%	Core/oil phase
CBD (API)	Core/oil phase
Pea protein isolate	Plant protein forming the hydrophilic matrix
Whey protein isolate	Animal protein forming the hydrophilic matrix
Gum Arabic (Gummi arabicum)	hydrophilic matrix ; emulgator ; polysaccharide shell
Strach	Film forming compound; Emulsion stabilizer, hydrophilic
Polysorbat 80 (Tween 80)	Emulgator (oil phase); Unionic surfactant

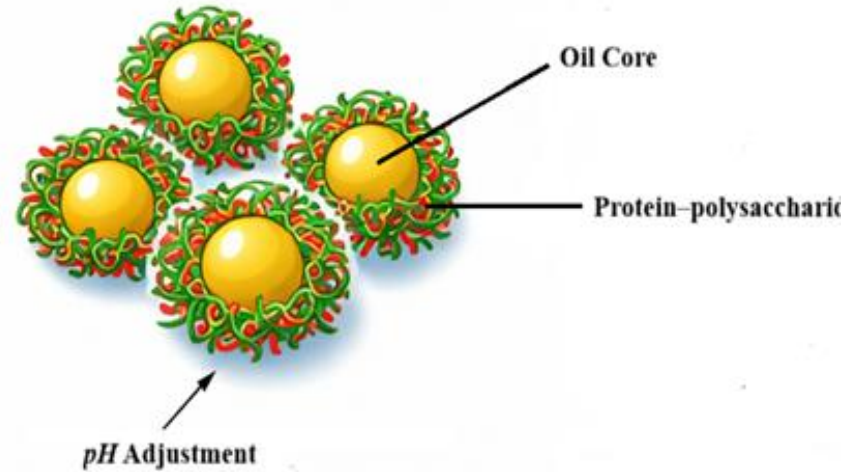
Oil-in-Water Emulsion



Polysaccharide Addition



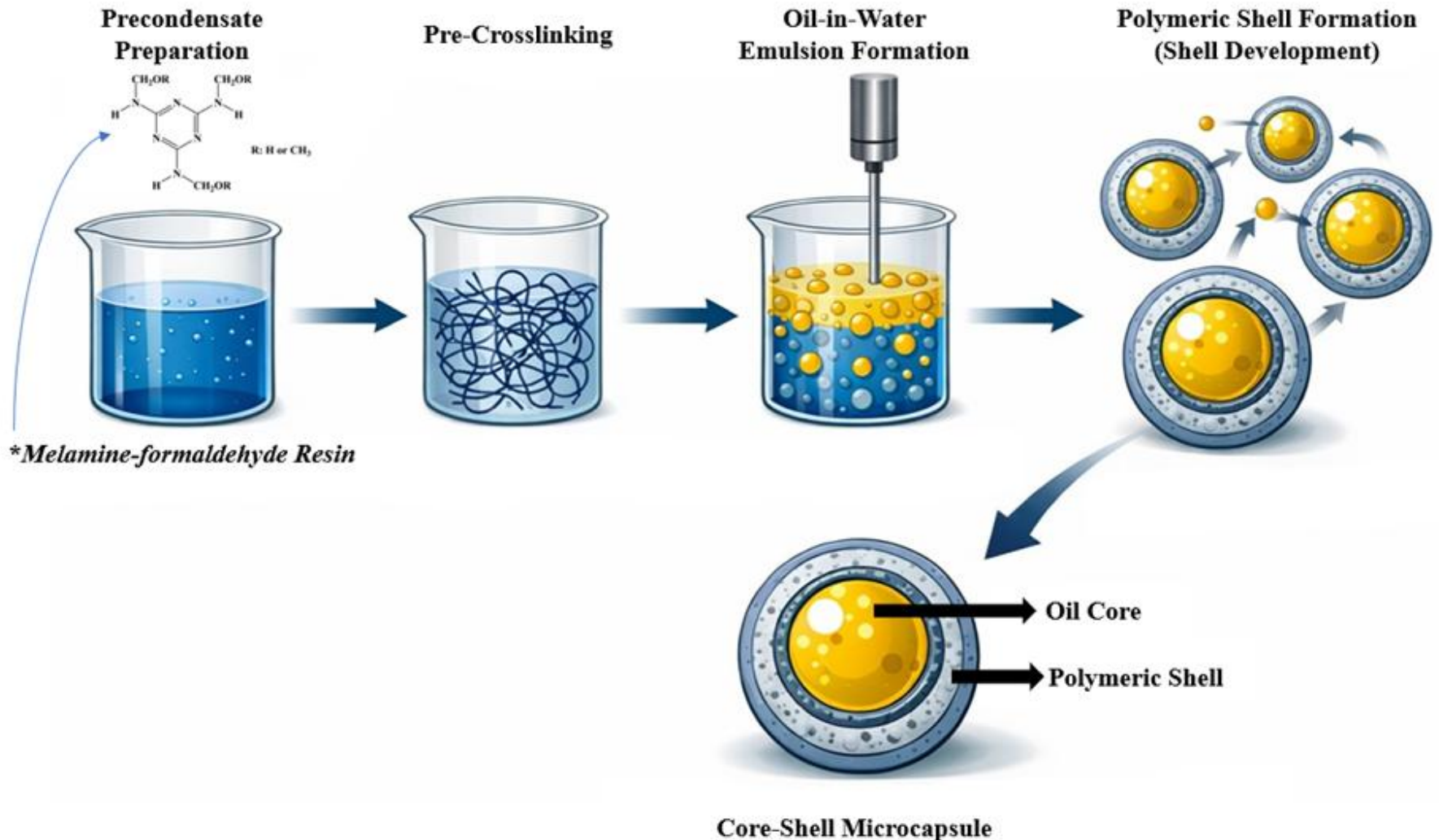
Complex Coacervation & Microcapsules Formation



Protein-polysaccharide complex coacervation in the oil microencapsulation process

Aleksandrov, Maksimova, Smilkov. Archives of Pharmacy (2026)

# Oil microencapsulation with a bioactive compound via *in-situ* polymerization

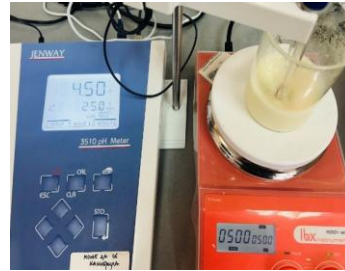


# Overview of the method of production of CBD microcapsules

Complex coacervation  
pH-induced precipitation



Preparation of the water phase in which biopolymers are degraded



pH adjustment of o/w emulsion until forming of coacervates

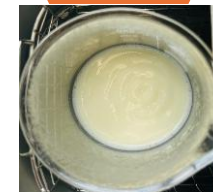


Treatment of microemulsion by ultrasound



Liophilisation (with and without cryopreservation)

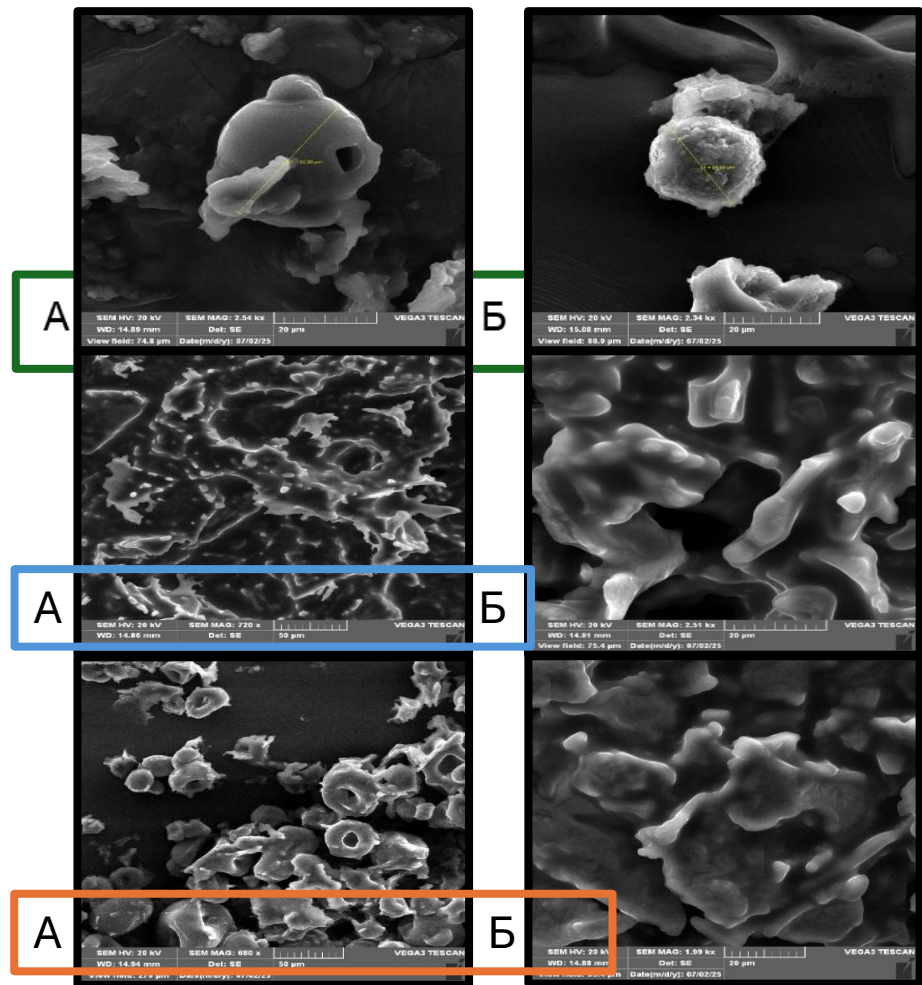
Emulsification – formation of oil in water (o/w) emulsion



# Preliminary results and discussion

## Morphology and size of lyophilized CBD microparticles

- By using a scanning electron microscope (SEM) (TESCAN VEGA3 LMU)



Lyophilized microparticles with CBD (**protein matrix** used for encapsulation); A) without and B) with the cryoprotectant sucrose

Lyophilized micro-particles with CBD (**polysaccharide matrix** used for encapsulation); A) without and B) with cryoprotectant sucrose

Lyophilized CBD microparticles (**protein-polysaccharide matrix** used for encapsulation); A) without and B) with the cryoprotectant sucrose

# Limitations of obtained CBD microparticles

## ❖ **Low electrostatic stability**

indicates:

- weak particle repulsion
- high risk of aggregation and sedimentation

## ❖ **Broad size distribution**

- Reflects: heterogeneous particle population
- Leads to:
  - variable drug release
  - inconsistent dosing

## ❖ **Presence of multiple particle populations**

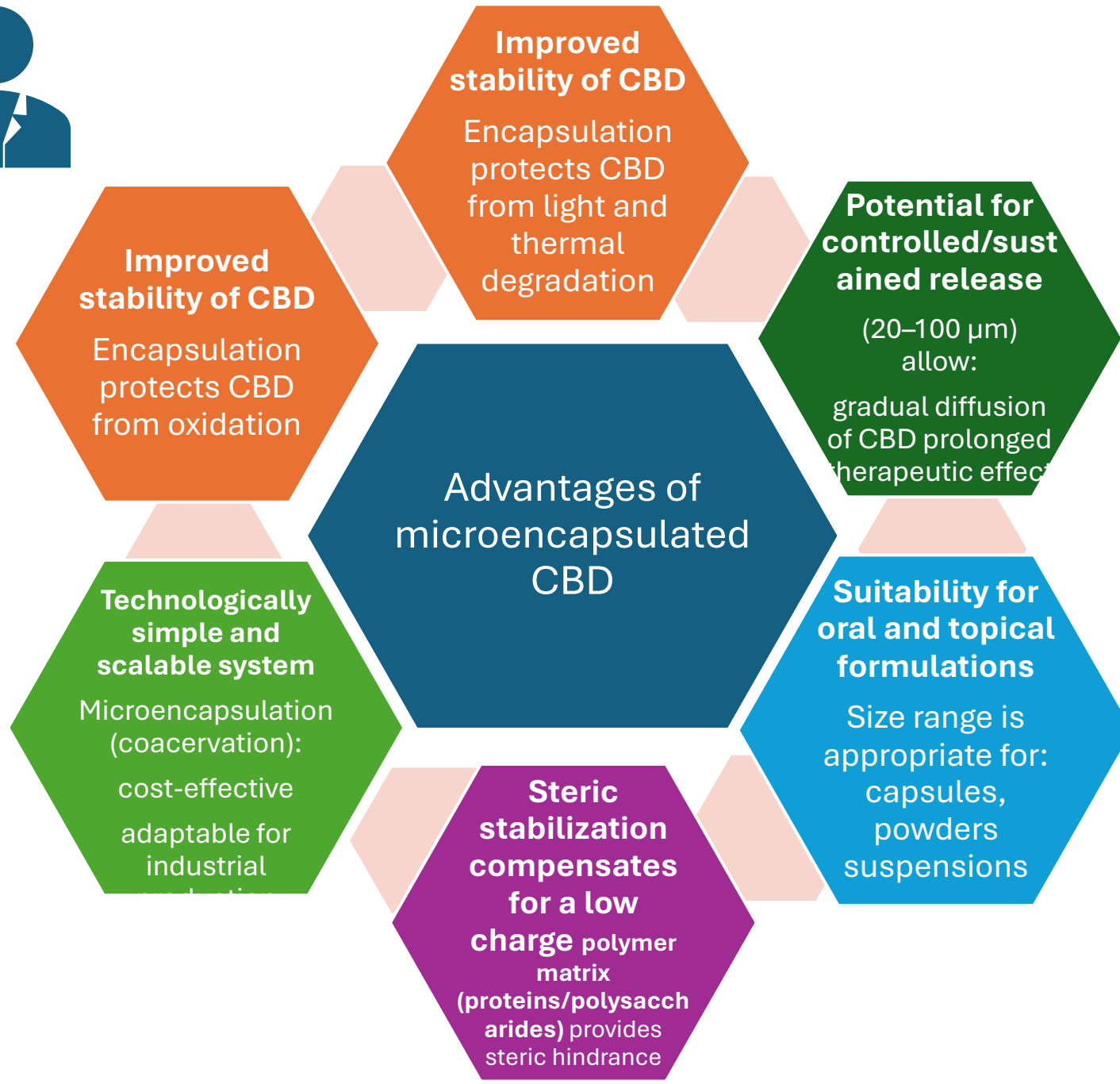
- Fine particles ( $\sim 1\text{--}10\ \mu\text{m}$ ) + larger aggregates ( $>100\ \mu\text{m}$ )
- Suggests: incomplete process control or possible instability during storage

## ❖ **Potential reproducibility issues**

- Broad dispersity may affect:
  - batch-to-batch consistency
  - regulatory acceptance

## ❖ **Limited bioavailability improvement (yet)**

- Microparticles improve stability, but:
  - may not significantly enhance **CBD solubility or absorption** without further modification



# Future Directions

## Optimization of formulation parameters

- Improve particle size uniformity and stability

## Stability studies

- Evaluate physicochemical and storage stability of CBD microparticles

## Bioavailability assessment

- Investigate in vitro and in vivo performance and absorption

# Conclusions:



**Microencapsulation is a promising strategy for enhancing cannabidiol stability and delivery but requires optimization of formulation and process parameters.**

**Investment in Cannabis science brings enduring returns for the cannabis industry and patients' health.**



## • Acknowledgment:



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