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MICROENCAPSULATION OF INFUSED OLIVE OIL WITH SPIRULINA AND *MORINGA OLEIFERA* EXTRACT

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Abstract:
Complex coacervates of gelatin and Sodium Alginate was used to microencapsulate infused olive oil with spirulina and moringa olifera extract with multiple functional ingredients like oleic acid, palmitic acid, vitamins, calcium, magnesium and macromolecules like proteins, carbohydrates, essential fats. A homogenization speed of rpm for 30minutes resulted in low surface oil content (0.12%), high encapsulation efficacy (97.23%) and encapsulation yield (92.14%) with significant enhanced stability index. The Fourier Transform Infrared Spectrum analysis showed that there was no observable oxidation of microencapsulated infused olive oil.

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INTRODUCTION:

Microencapsulation:

Microencapsulation can be defined as the process of enclosing or enveloping solid, liquid droplets with a coating material to give microcapsules. Microencapsulation is an emerging technology and promising technique used in various departments like pharmaceutics, cosmetics, textiles, food processing, defence, printing. Microencapsulation market was valued at USD 7.57 billion in 2019 and is projected to reach USD 15.62 billion by 2027.

Entrapping of API, foods or nutrition supplements inform of microcapsule with a protective barrier increases the stability and shelf life of substances.

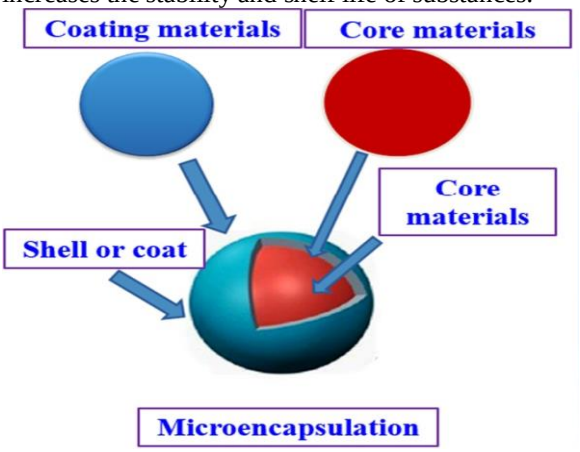


Fig 1: Microencapsulation model

Aim of Microencapsulation:

- To reduce volatility of core material
- To increase shelf life of product
- To prevent pharmacological toxicity of product
- To promote the activity of active core material
- To protect the core material from external degradation factors

Application:

- Textile industry
- Pharmaceutical industry
- Agriculture
- Food industry
- Printing and die preparation
- Cosmetic formulation
- Defense sector
- Waste water management

Microencapsulation techniques:

Physical method:

Air suspension techniques
Coacervation process
Spray drying
Pan coating
Solvent evaporation
Polymerization
Extrusion
Supercritical fluid method

Chemical methods:

Interfacial polymerization
In-situ polymerization
Matrix polymerization

Complex co-acervation phase separation:

It is one of the easily accessible method of microencapsulation of particles like essential oils, vitamins, emulsions or suspensions enclosing of substances in complex co–acervation involves two oppositely charged polymer for effective polymer–polymer interaction. First research on microcapsule procedure of pharmaceutical was nearly 1930's deals with preparation of gelatin spheres by Bungen Berg De Jong & Kan.

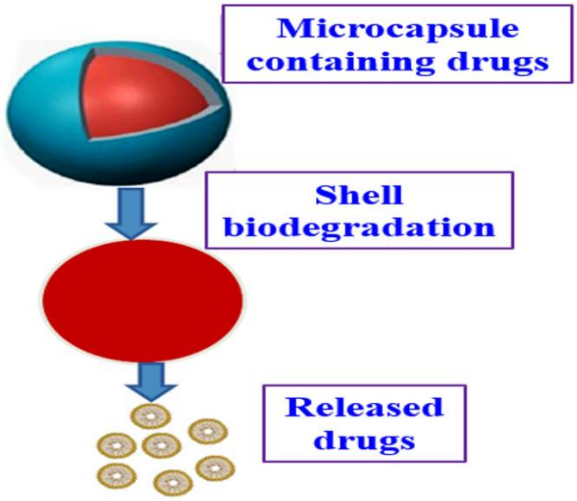


Fig 2: Pharmacological action of microcapsules.

Principle of complex co-acervation phase separation:

The main driving force for complex co-acervation is the reduction in free electrostatic energy of the reaction system resulting from the interaction between oppositely charged ions.

Factors influencing complete co-acervation:

- Molecular structure
- Mixing rate
- Ionic strength

- pH
- Temperature

Nutraceutical:
Term nutraceutical coined in 1989 by Stephen Defelice.

According to FSSAI:
Nutraceutical is a combination of nutrition and pharmaceuticals and refers to a food product that reportedly provide health benefits.

According to FDA:
Most nutraceuticals would be categorized as dietary supplements. These are extract, concentrates or combination of vitamins, minerals, or dietary substances. Nutraceutical is a food product that provides physiological benefits and maintain good health. Dietary fiber, probiotic, prebiotic, polyunsaturated fatty acids, antioxidants vitamins, polypherols are some category of nutraceutical.

In India, nutraceutical market stood at a promising USD 4.5 billion in 2023 with projected CAGR of 11.39% within period of 2025 – 2029.

Materials Required:

Requirements	Quantity
Beaker(100ml)	4
Petridish	3
Spatula	1
Funnel	1
Measuring cylinder (10ml)	1
Measuring cylinder (50ml)	1
Glass rod	1
Filter paper	1
Muslin cloth	1
Weighing balance	1
Magnetic stirrer	1

Chemical Required:

- Olive oil
- Spirulina
- Moringa oleifera powder
- Gelatin
- Sodium alginate

Fig 3: Chemicals involved in microencapsulation

Chemical constituents:

Spirulina:

Protein	57/100g
Carbohydrates	24g
Sodium	3g
Potassium	3g
Fiber	3g
Vitamin – C	16%
Iron	158%
Vitamin – B6	20%
Magnesium	48%

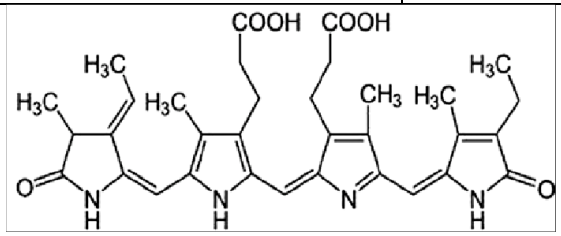
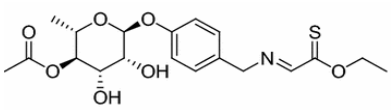


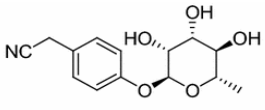
Fig 4: chemical structure of spirulina

Moringa Oleifera:

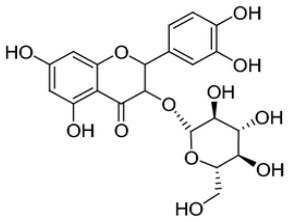
Protein	24.3g/100g
Carbohydrate	38.2g
Calcium	1.4g
Fiber	19.2g
Magnesium	53mg/100g
Iron	53mg/100g



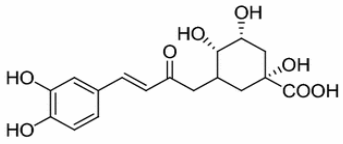
Niaziminin A



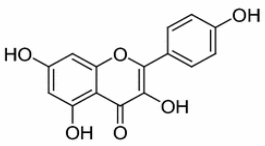
Niazirin



Quercetin-3-glucoside



Chlorogenic acid



Kaempferol

Fig 5 :Chemical structure of *MORINGA OLEIFERA*

Olive oil:

Oleic acid	
Palmitic acid	
High no of vitamins	(α, β, γ, δ tocopherols)

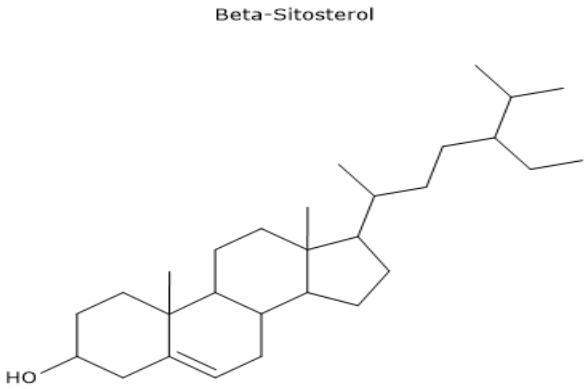


Fig 6: Chemical structure of Olive Oil

Procedure:

Solution preparation:

Solution -1: Gelatin solution

In 100ml beaker 0.5g of gelatin is dissolved in 75ml distilled water at 55°C.

Solution -2:

In 100 beaker 0.25g of sodium alginate is weighed and dissolved in 25ml distilled water at 55°C.

Solution 3:

In 100ml beaker, measure 10ml of olive oil, 1g of spirulina, 1g of *Moringa oleifera* is kept for infusion for about 3 days and filtered. The filtered oil solution is the core material for encapsulation.

Solution -4:

In 100ml beaker add 2.5ml of concentrated hydrochloric acid and 12.5ml of water to get 20% hydrochloric acid solution.

Solution -5:

In 100ml beaker 2.5ml of 25% glutaraldehyde and 22.5ml distilled water to get 2.5% glutaraldehyde.

Microcapsule preparation:

In 250ml beaker pour 75ml of gelatin solution and place in magnetic stirrer at 55°C at 500 rpm. Slowly add the infused olive oil and leave for 5 minutes. Add 25ml of sodium alginate batchwise and leave it to spin for 15 minutes and the temperature is maintained at 55°C. After 15 minutes reduce the temperature to 5°C and add (20%) diluted hydrochloric acid dropwise until it reaches to pH 4 (~50 drops) and it is maintained at same spin rate in magnetic stirrer and left for 30 minutes. After 30 minutes 2ml of (2.5%) glutaraldehyde solution is added. It is covered with Aluminium foil and left for 2 hours in magnetic stirrer at 55°C temperature.

After 2 hours the beaker is transferred into an ice bath with occasional stirring with glass rod. After 1 hour the solution is filtered using filter paper and the collected microcapsules are washed with ethanol and dried and kept in dry closed container.

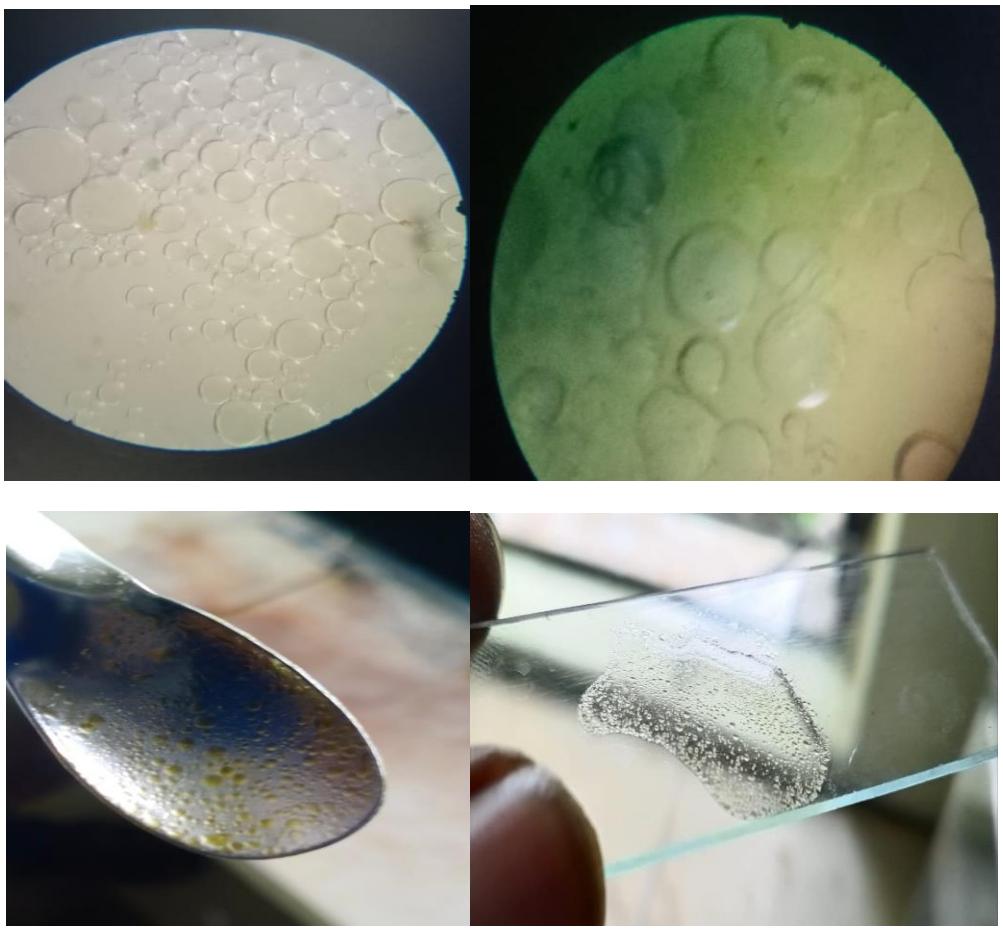
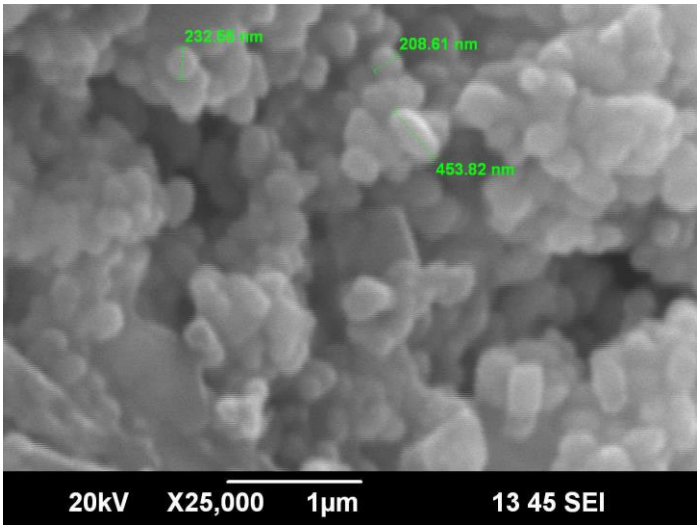
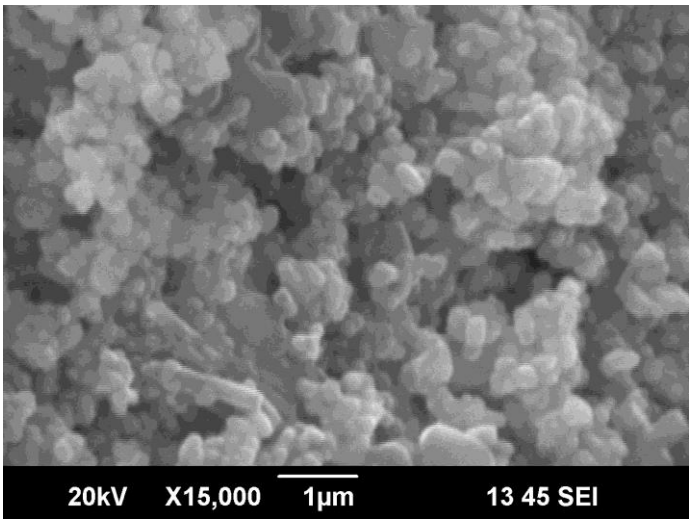


Fig 7: Observation of Microcapsules under Microscope and Naked eye

RESULTS AND DISCUSSION:

1.Scanning Electron Microscope (SEM):

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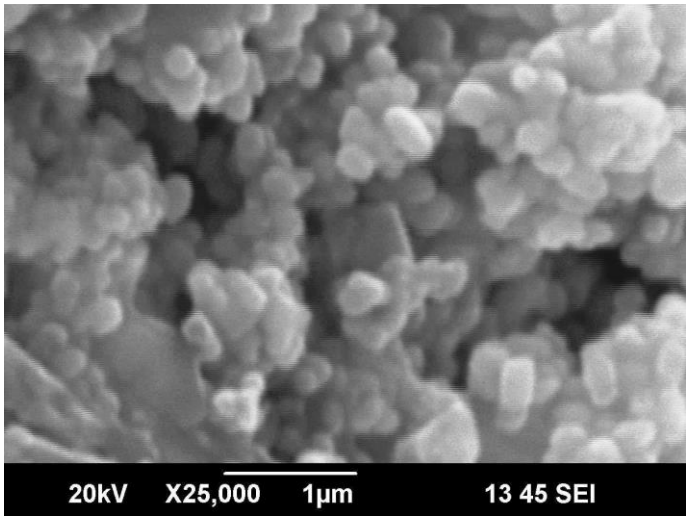
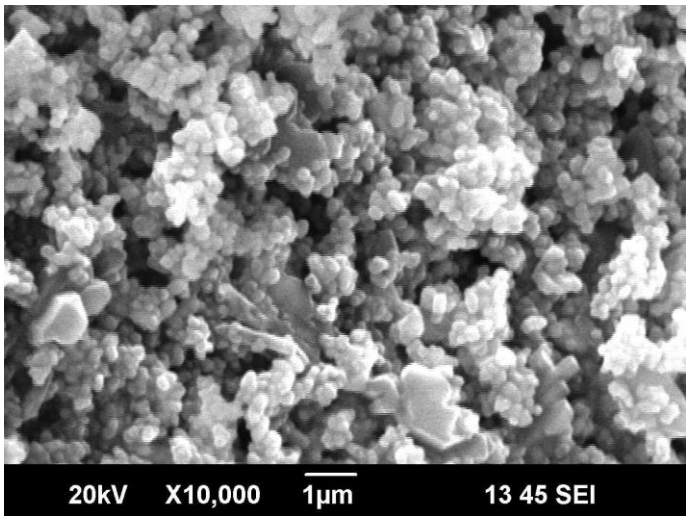
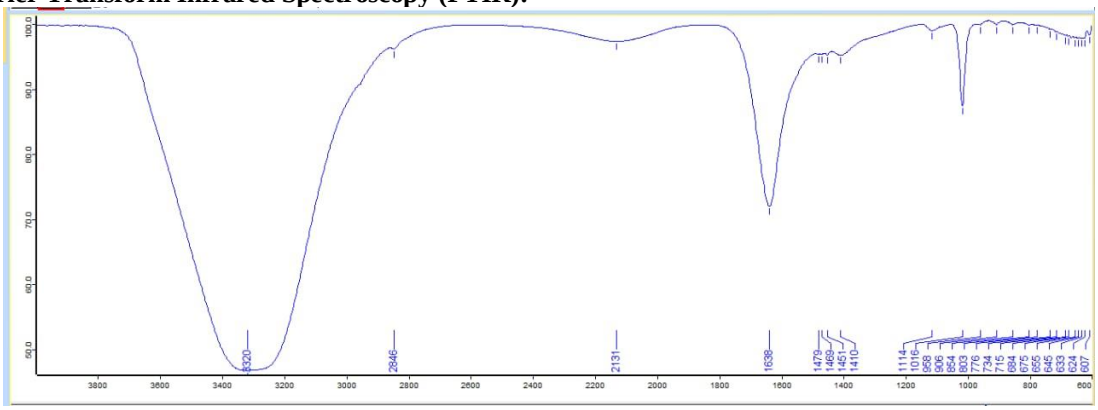

20kV X25,000 1µm 13 45 SEI


20kV X10,000 1µm 13 45 SEI

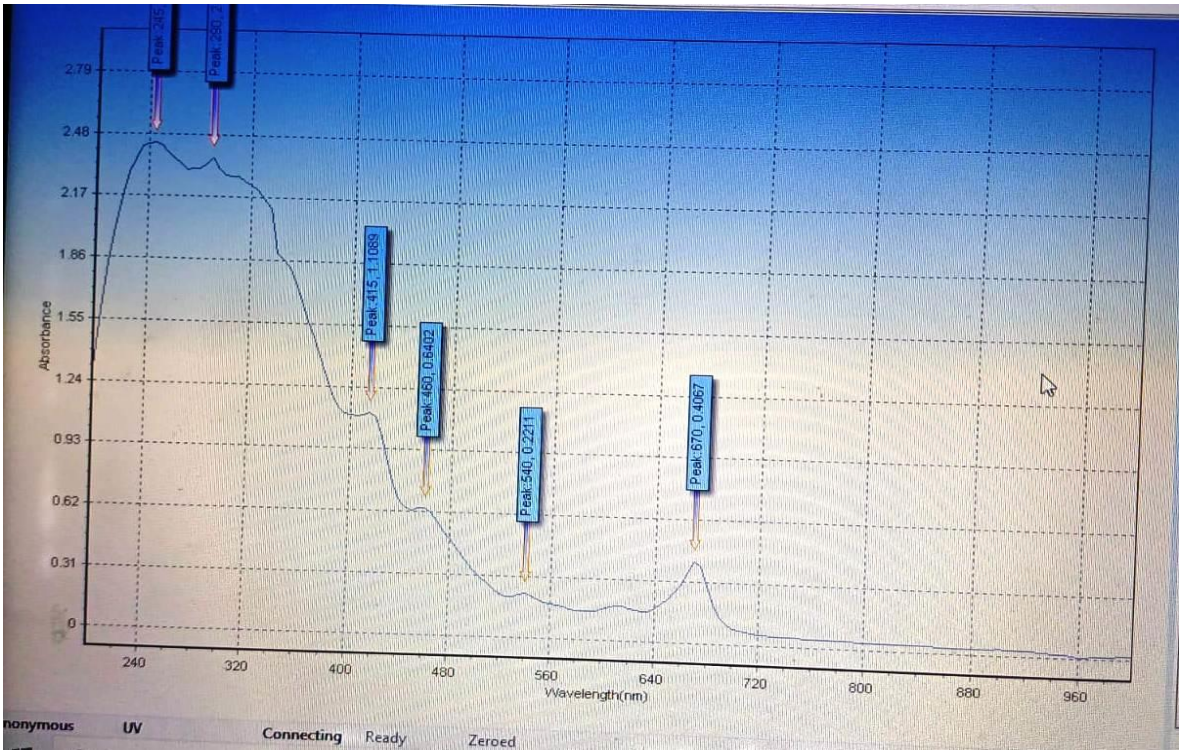
On observing the formulation under scanning electron microscope (SEM), the signals generated during analysis produce a two dimentional magnified image of sample with size ranging from 208.6nm to 232.55nm with irregular oval shape of microcapsule particles

2. Fourier Transform Infrared Spectroscopy (FTIR):



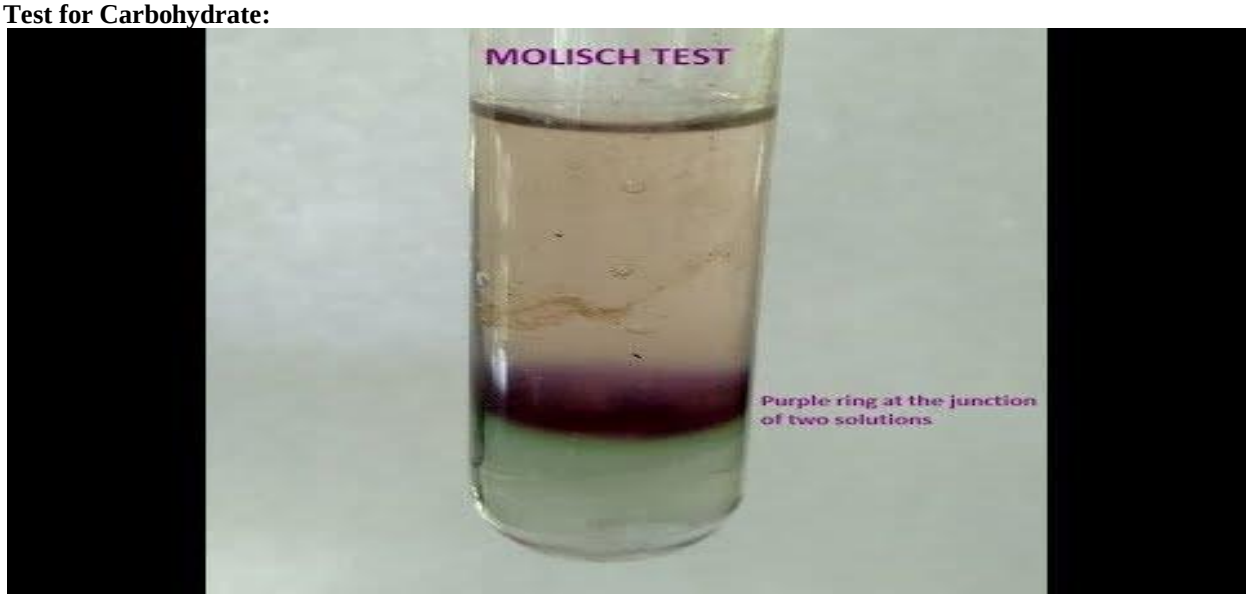
On observing the sample under IR spectroscopy. The spectrum was found at the range of 1410 – 3430 which confirms the presence of functional group alkane, 550 – 680 which confirms the presence of halo compound and 800 – 960 which confirms the presence of aliphatic ether.

UV-Visible spectroscopy:



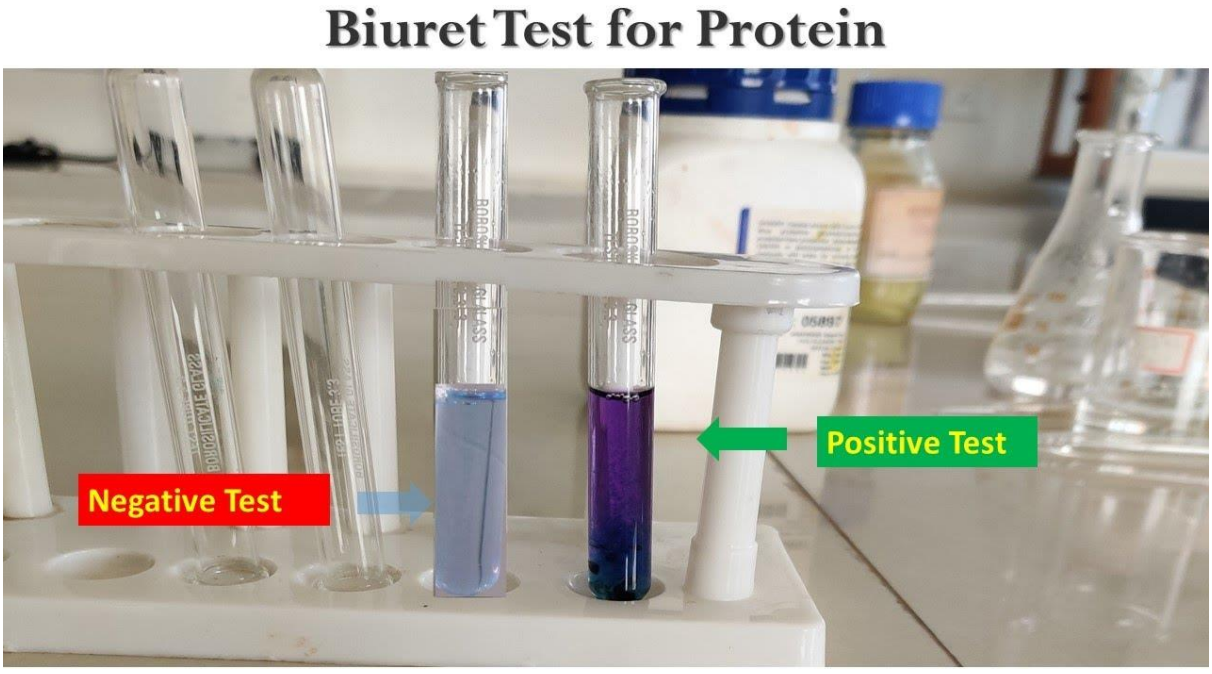
On observing the sample under UV spectroscopy certain peaks were obtained. Peak was obtained in the range of 245, 2.3821 which represents the presence of strong C=C and C=O bond that confirms the presence of secondary alcohol.

Test for Carbohydrate:



Procedure:
In a test tube take 2ml of sample, add α-napthol and add concentrated sulphuric acid around the inner side of test tube.
Observation:
Appearance of purple colour solution
Inference:
Presence of carbohydrate.

Test for Protein:



Procedure:
In a test tube take 2ml of sample and add 2ml of ninhydrin solution, shake well and keep it in a water bath.
Observation: Appearance of bluish purple colour solution
Inference: Presence of protein.

CONCLUSION:

The main objective of this work is to optimize the condition of nutritional deficiency in rising environment. Microencapsulation of infused olive oil provides sustained release and controlled release of prepared product in systemic circulation. Thus preventing toxicity and degradation of product. During investigation, we found that complex coacervation is widely used, effective and cost efficient method. During preparation of microcapsule we found the degradation limit of microcapsule of olive oil is 71°C ± 3°C.

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