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Recent Advances in Pharmaceutical Suspension: Patents and Future Prospective

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ABSTRACT

Suspension are the biphasic liquid dosage form of medicaments in which the finely divided solid particles. The range of solid particles in suspension from 0.5 to 5.0 micron. suspensions are used in orally, parentally and also externally. They are chemically stable than solution.

The benefits of suspension dosage forms include efficient intramuscular depot therapy, effective hydrophobic drug dispensing, avoiding the use of solvents, masking the taste of some ingredients, providing resistance to drug degradation due to hydrolysis, oxidation, or microbial activity, and easy swallowing for young or elderly patients. The preparation of suspensions involves several techniques such as precipitation, milling, and dispersion. These methods aim to achieve a uniform dispersion of solid particles in the liquid medium, often utilizing stabilizers or surfactants to prevent agglomeration and maintain particle dispersion. The choice of preparation method depends on factors such as particle size, desired particle morphology, and the nature of the liquid medium.

In conclusion, suspensions are important colloidal systems with distinct characteristics, preparation methods, stability considerations, and wide-ranging applications. Understanding the behavior and manipulation of suspensions is crucial for developing effective formulations, optimizing material properties, and advancing various technological and biomedical applications. Further research in suspension science is warranted to explore novel strategies for improving stability, enhancing particle dispersion, and expanding their applications in emerging fields.

KEYWORDS: suspension dosage form, particle size, optimization. Solid particle

I. INTRODUCTION

The finely separated insoluble solid drug particles areuniformly distributed in a liquid or semi-solid media to create a pharmaceutical suspension,Thisis a biphasic liquid or semi-liquid dosage form. The drug's insoluble solid particles. serve as the internal or disseminated phase. The solid particles within the internal phase range in size from 0.5 to 5 µm[1]

Due to their thermodynamic instability, suspensions, like other disperse systems, require a suspending agent or stabilizer to slow down the pace of settling. make it possible for Any settled particle matter can be readily moved. This is accomplished by improving the consistency of the suspending medium and offering protective colloidal activity. [2,3].

Suspending agents are compounds that are employed to maintain the stability of a suspension as a suspending medium's viscosity rises, its sedimentation rate decreases, reduced compact bulk formation, convenientredispersible and increased sedimentation volume Suspending agents can come from synthetic (polyvinyl pyrrolidone), semisynthetic (cellulose derivatives), or natural (mucilage) polymers.[4,5].

Their attraction for both the dispersion and the dispersion media, Hydrophilic colloids are suspending agents that form colloidal dispersions with the aqueous medium on their own. According to Stokes law, they help slow down the Increasing the viscosity of the liquid medium increases the process of sedimentation. They might easily be resuspended by agitation or shaking because they usually avoid catching at the base of the suspension [6].

1.1.SUSPENSION:

Pharmaceutical suspensions are liquid formulations used to deliver medications when the active ingredients aren't easily soluble in water.

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Imagine it as a tiny medicine world floating in a liquid universe. These formulations contain tiny solid particles distributed in a liquid. ensuring an even distribution of the medication[7].

When you see instructions like "Shake well before use" on a medicine bottle, it's because the particles tend to settle over time. This mixing ensures you get the right dose each time. The liquid nature of suspensions makes them easy to swallow, especially for people who find it challenging to take pills[8].

They play a crucial role in pediatric and geriatric medicine where swallowing solid forms can be difficult. The suspension's design allows for controlled and precise dosing, improving the effectiveness of the treatment. So, next time you take a liquid medicine, remember that it's not just a drink; it's a carefully crafted pharmaceutical suspension, designed to make sure you get the right amount of healing power with every sip[9].

1.2. SUSPENDING AGENT:

A suspending agent is a special substance added to liquid formulations, particularly in pharmaceutical suspensions, to prevent solid particles from settling at the bottom. It's like a magical force holding tiny particles in suspense, ensuring that when you reach for that medicine bottle, you're getting a consistent dose of healing power. These agents, often polymers or other stabilizing compounds, act as molecular glue, preventing the active ingredients from clumping together. This is especially crucial in medications where uniform distribution is vital for effectiveness. Whether in a vibrant pink liquid antibiotic or a soothing cough syrup, the suspending agent quietly performs its duty, maintaining a harmonious blend that enhances the medicine's efficacy. So, next time you encounter a smoothly mixed pharmaceutical suspension, know that the suspending agent is the unsung hero ensuring that every drop delivers the healing [5][6].

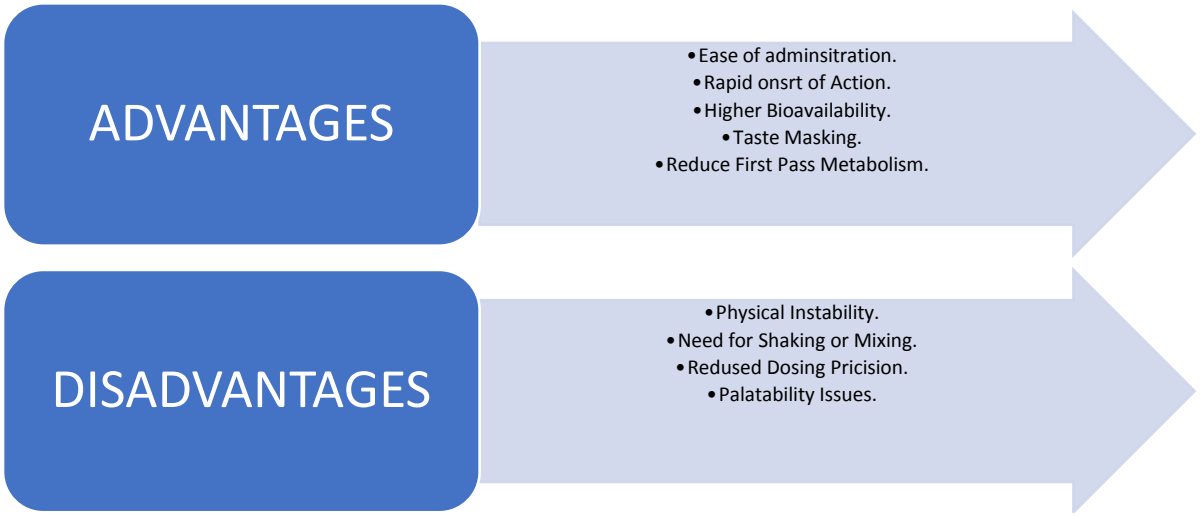

Fig. (1).Advantages, Disadvantages of suspension.

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II. TYPES OF SUSPENDING AGENTS:[6]

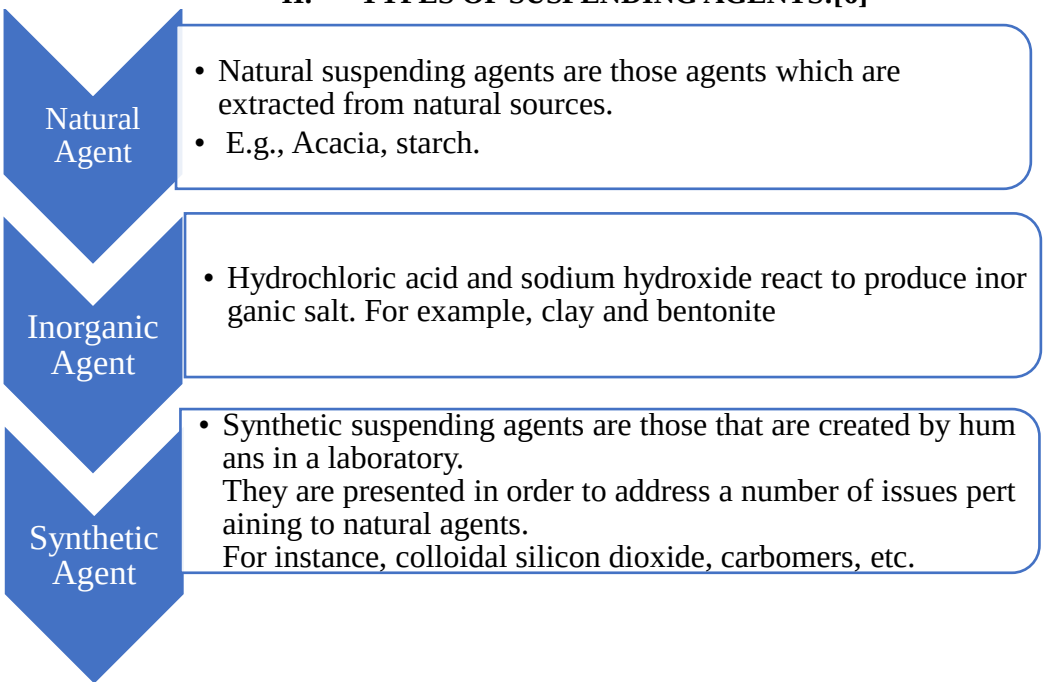

Fig. (2). Type of Suspending Agent.

2.1.Brief Review of Commonly Used Suspending Agents:

2.1.1: Sodium Carboxymethyl Cellulose:A cellulose derivative called sodium carboxymethyl cellulose (CMC-Na) is used as a suspending agent in food, personal care items, and medicines.In summary, by keeping solid particles from settling out of the liquid phase, sodium carboxymethyl cellulose functions as a suspending agent and contributes to the stability and homogeneity of suspensions [10].

2.1.2. Guar Gum: Native to India guar gum is a naturally occurring polysaccharide obtained from the seeds of the guar plant, Cyamopsis tetragonoloba. It is farmed largely for its galactomannan gum content and is a member of the legume family [11].

2.1.3. Veegum: A kind of magnesium aluminum silicate known by the brand name "Veegum" is frequently used as a suspending agent in a variety of sectors, including the pharmaceutical, cosmetic, and personal care product industries. Veegum is well-known for its capacity to uniformly suspend solid particles in liquids, avoiding settling and guaranteeing consistency in mixtures [12].

2.1.4. Sodium Alginate: A naturally occurring polysaccharide, sodium alginate is sourced from seaweed, specifically brown algae. Due to its extensive use as a suspending agent, it is found in many different sectors, such as food, medicine, and cosmetics. The salient features of sodium alginate as a suspending agent are as follows: used in liquid formulations and oral suspensions to maintain consistent dosage and suspend active components [13].

2.1.5. Carbopol: The term "Carbopol" refers to a class of artificial high molecular weight polymers that are mostly utilized in the pharmaceutical and personal care sectors as rheology modifiers. Carbopol aids in the uniform dispersion of solid particles in a liquid, avoiding their eventual settling [14].

2.1.6. Carrageenan: Natural polysaccharide carrageenan is made from red seaweed and is widely utilized as a suspending agent in the food, medicine, and cosmetics sectors. as an agent that suspends. It is well acknowledged as a secure and reliable suspending agent in both sectors[15].

2.1.7. Tamarindus Indica: Among the twenty-one families of evergreens is Tamarindus indica. Tamarind gum, which is also referred to as Tamarind Kernel Powder (TKP), is extracted from seeds and forms microspheres that range in size from 230 to 460 µm. Diclofenac sodium matrix tablets containing TSP were examined in a different

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study. The wet granulation technique tablets were assessed for their drug release characteristics[16].

2.1.8 Locust Bean Gum: Locust bean-based gum Bean Gum Locust (LBG), often known as Carob Gum, is derived from the refined endosperm of seeds from the Ceretonia siliqua L. carob tree. It's an evergreen legume tree. The endosperm of carob tree seeds is extracted and processed, yielding carob bean gum[17].

2.1.9. Honey Locust Gum: Botanically, it is known as Gleditsia triacanthos and belongs to the Leguminosea order. (Suborder Mimoseae). The seeds are used to make the gum [18].

I. **Khaya Gum:** Khaya gum is a polysaccharide obtained from the incised trunk of the tree Khaya grandifoliola (family Meliaceae). The fact that the gum is naturally available, inexpensive and non-toxic has also fostered the interest in developing the gum for pharmaceutical use. Further work has also shown its potential as a directly compressible matrix system in the formulation of 61 controlled release tablets [19].

II. Hakea Gum: Hakea gum is a dried exudate derived from the Proteaceae family plant Hakea gibbosa. Gums with acidity type A arabinogalactans the molecular proportions (%) of the sugar components galactose, arabinose, mannose, xylose, and glutaric acid are 12:43:32:5:8[20].

III. Iranian Gum: Iranian gum, commonly known as gum tragacanth, is a natural gum made from the sap of various Middle Eastern legume plants of the Astragalus genus. It has traditionally been utilized as a suspending agent in a variety of sectors, most notably medicines and cosmetics. Iranian gum acts as a suspending agent, keeping particles from settling and stabilizing suspensions. When hydrated, it produces a gel-like matrix that retains solid particles and ensures they are evenly distributed throughout the liquid[21].

2.1.10.Starch: Starch can act as a suspending agent in certain uses, although it is better recognized for its thickening qualities. This is how starch may function as a suspending agent.

Starch granules may absorb water and expand when spread in a liquid. This swelling produces a gel-like structure that may sustain solid particles and keep them from sinking to the bottom of the mixture[22].

III. SEDIMENTATION:

Sedimentation is the process by which particles or floccules settle in liquid compositions as a result of gravity. The sedimentation process is governed by Stoke's Law. formula that represents the sedimentation velocity in terms of

$$v = \frac{d^2(\rho_i - \rho_0)g}{18\eta}$$

Where ,
d = particle diameter,
ρi=density of the dispersed phase, and
v = sedimentation rate in cm/sec.
ρ0= dispersion media density
g = gravitational acceleration.
η =dispersing medium's viscosity in poise

There are some limitations to Stoke's equation. It can be used with 1. spherical particles in a suspension that is very diluted (0.5 to 2 gm per 100 ml).
2. Particles that freely separate from one another without coming into contact
3. particles that don't communicate with the dispersion medium in any way.

Table 1. Herbal suspending agent in marketed product formulation.

Herbal Suspending Agent	Marketed Product Examples	Botanical Name	Application	References
Acacia Gum(Gum Arabic)	Various cough syrups,suspensions for children, throat lozenges	Genus Acacia	Suspends insoluble particles,increasesviscosity,improves palatability	[24],[25]
Agar-agar	Herbal suspensions for digestive ailments,antacids	Eucheuma	Suspends insoluble particles,creates gels, promotes stomach emptying	[26]

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Alginic Acid	Mouthwashes, herbal cough syrups	Alginate	Suspends insoluble particles, improves viscosity, provides taste-masking ability	[27],[28]
Gum Tragacanth	Topical herbal suspensions, ophthalmic preparations	Astragalus gummifer	Suspends insoluble particles,provides adhesive properties,promotes film formation	[29],[30]
Guar Gum	Suspensions for constipation,topical herbal creams	Cyamopsis tetragonoloba	Suspends insoluble particles,increases viscosity, improves stability	[31]
Psyllium Husk	Laxatives,herbal suspensions for digestive health	Plantago scabra	Suspends insoluble particles,increasesviscosity,promotes bulking and laxation	[32]
Xanthan Gum	Nutritional supplements, herbal suspensions for children	Xanthomonas campestris	Suspends insoluble particles,increasesviscosity,improves texture and stability	[33],[34]

Table 2. A brief account of the recent patents on suspending agents.

S. No	Patent No.	Year of App. Filling	Patentee	Suspending Agents	(Highlight)	Inventor	Country	Application Granted	Reference
1	US9603870 B2	2009	Clene Nanomedicine,Inc,	Xanthan Gum	Gold based metallic nano crystals suspension or colloidals	Mark Gordon Mortenson,	US	2017	[35]
2	EP2764046 B1	2009		Carboxymethylcellulose	Used as a binder and Pharmaceutical tablet as a suspending agent.	TAZ,Zheng,	EP	2021	[36]
3	US1059032 4B2	2018	Halliburton Energy Services, Inc,.	Kaolin	suspending agent use as dry from in a liquid suspension.	Sandeep D. Kulkarni,	US	2020	[37]

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4	US11160757B1	2020	GW Research Limited, Cambridge (GB)	Gellan Gum	pH dependent release polymer.	Jitinder Wilkhu,	US	2021	[38]
5	US9668966B2	2015	Terra Via Holdings, Inc.	Acacia	Spray dryer,material in a liquid suspension.	Geoffrey Brooks, Reno,NV(US).	US	2017	[39]
6	US20210322317A1	2021	Elektrofi, Inc.	Carboxymethylcellulose	Use as a Powder formulation creame, pastes, and cosmetics.	Chase Spenser Coffman,	US	2021	[40]
7	US20210361646A1	2021	Otsuka Pharmaceutical Co.,Ltd., Tokyo (JP)	Carbopol	Freeze dried formulation from the aripiprazole suspension.	Shogo Hiraoka ,Osaka-shi (JP)	US	2021	[41]
8	US11911491B2	2021	FallienCosmeceuticals,Ltd.	Xanthan gum and guar.	Suspending agent for formulation Cellulose Gum.	David J. Milora.	US	2024	[42]
9	US20220403107A1	2022	The Procter &Gamble Company,	Polyvinyl alcohol and carboxmethylcellulose	Biodegradable Graft polymers Suspending agent for Polyvinyl alcohol compound.	Sophia Rosa Ebert,	US	2022	[43]
10	AU2023229465B2	2023	Zoetis Services LLC	Carbomer	Aqueous Pharmaceutical Suspension and process for preparation thereof	Kuhn, Michael ;Ewin.	AU	2024	[44]

3.1. TheSedimentation Behaviour of Flocculated and Deflocculated Suspensions

3.1.1.Flocculating Suspension:

The creation of flocs, or loose aggregates, in a flocculated fluid can quicken sedimentation. because the size of the sedimenting particles will increase. Particles. As a result, flocculated suspensions settle faster.In this case, the porosity of the flocs as well as their size affect the sedimentation process. In this case, the porosity of the flocks as well as their size affect sedimentation. There is a noticeable amount of trapped liquid in the sediment due to the loose structure of the rapidly settling flocs in flocculated suspension. As a result, the resulting sediment has a large volume and is easily redistributed by stirring.[45],[46].

3.1.2.Deflocculating Suspension:

flocs, thus the supernatant does not seem murky; yet, in a settled suspension, bigger particles

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settle fast while smaller particles remain in the liquid suspensions with deflocculations. Because the individual particles in the deflocculated solution settle, the sedimentation rate is modest, preventing the liquid medium from entrapping and making it more difficult to re-disperse by agitation.This phenomena is sometimes called "claying" or "cracking."Indilated suspension Supernatant in a flocculated dispersion includes even the tiniest particles[47].

3.1.3.Brownian Movement (Drunken walk)

Particle Brownian motion maintains the scattered material moving randomly, which prevents sedimentation. The density of the dispersed phase, as well as its density and viscosity, define the Brownian movement of the dispersion medium. As long as the particles are smaller than the critical radius (r), the molecules in the suspending liquid will kinetically assault them, keeping them suspended. Brownian movement may be observed at particle sizes ranging from 2 to 5 mm. The most popular approach for eliminating the usual motion, or Brownian motion of the smallest particles in pharmaceutical suspension, is to disperse the sample in a 50% glycerin solution with a viscosity of around 5 cps. [48].

Equation provides the movement or distance traveled (Di) as a result of Brownian motion.

$$Di^2 = \frac{RTt}{N_{3\pi\eta r}}$$

Where
R = gas constant.
T =temperature in Kelvin.
N =Avogadro number.
η = medium viscosity
t = time.
r = radius of the particle.

IV. STRATEGIES FOR INCREASING SUSPENSION VISCOSITY:

4.1.Viscosity Enhancers A material or additive used to raise a fluid's viscosity is called a viscosity enhancer. Viscosity refers to a fluid's resistance to flow, and it is a crucial property in various industries, such as automotive, oil and gas, pharmaceuticals, and food processing[49].

4.1.1.Polymers:A big molecule made up of repeated structural units, usually joined by covalent chemical connections, is referred to as a "polymer". The polymer is created when these repeating components, sometimes referred to as monomers, combine to form lengthy chains or networks.[50].
Example-
- Hydroxypropyl methylcellulose (HPMC)
- Carboxymethyl cellulose (CMC)
- Polyvinyl alcohol (PVA)
- Polyethylene glycol (PEG)
- Guar gum
- Xanthan gum

4.1.2.Clays: In the context of pharmaceuticals, "clays" typically refer to specific types of clay mineralsare used in various pharmaceutical and medical applications. One commonly used clay in the pharmaceutical industry is kaolin[51],[52].
Example:
- Bentonite
- Montmorillonite

4.1.3. Acrylic Polymers: This is especially helpful for increasing the therapeutic effectiveness of several medications that have poor solubility.[53],[54]
Example:
- Carbomer

4.1.4.Natural Polymers: natural polymers are often utilized for various purposes due to their biocompatibility, low toxicity. One such natural polymer commonly employed in pharmaceutical formulations is chitosan[55].
Example-
- Sodium alginate
- Acacia gum

4.1.5. Inorganic Compounds: Inorganic compounds are chemical combinations without any carbon-hydrogen (C-H) bonds. They are typically ed from minerals and elements other than carbon, although some exceptions exist[56].
Example-
- Silica
- Magnesium aluminum silicate.

4.1.6. Microcrystalline Cellulose (MCC): A partially depolymerized cellulose material used as a viscosity enhancer and suspending agent[57].

4.1.7. Salicylates: Salicylates are a family of chemical compounds generated from willow tree bark that include the salicylic acid component. Salicylic acid possesses antipyretic (fever-reducing) and analgesic (pain-relieving) qualities[58].
- Sodium silicates
- Sodium magnesium silicate

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Table 3. Disperse systems are classified based on the particle size of the dispersed phase.

Category	Range of partical size	Characteristics	Example	References
Molecular dispersion	<1.0 nm	Electron microscopy cannot detect particles that pass through semipermeable membranes and have a high diffusion rate.	Oxygen, potassium, and chloride ions are dissolved in water.	[59]
Colloidal dispersion	1.0 nm -1.0µm	Particles are visible under electron microscopy, pass through filter paper but not semipermeable membranes, and have sluggish diffusion rates.	Colloidal silver sols, surfactant micelles in water, latexes, and pseudolatexes.	[60]
Coarse dispersion	>1.0 µm	Particles visible under conventional microscopy do not pass through filter paper or semipermeable membranes.	pharmaceutical emulsions and suspensions	[61]

Table 4.Disperse systems are classified according to the physical condition of the dispersed phase and the dispersion medium.

Dispersion Medium				
Dispersion phase	**Solid**	**Liquid**	**Gas**	**References**
Solid	solid suspension	tetracycline oral suspension USP,	Solid aerosol.	[62]
Liquid	Solid emulsion	mineral oil emulsion USP.	Liquid aerosol (nasal sprays, fog)	[63]
Gas	Solid foam	rectal and topical foams	None	[64]

V. ELECTROKINETIC PROPERTIES:

5.1.Zeta Poential: The zeta potential is the potential difference that exists between the solution's electro-neutral area and the firmly bonded layer's surface (shear plane). The potential steepens less steeply after decreasing sharply in the first place as the distance from the surface increases. This is because the counterions close to the surface operate as a screen, reducing the electrostatic attraction between the charged surface and the counterions farther away from the surface[65],[66].

5.2.Flocculating Agent: Flocculating substances induce the suspended charged particles to aggregate (floc) and reduce the particle's zeta potential.[67]
Flocculating agents include, for example:
-Electrolytes that are neutral, like NaCl and KCL.
-Salts of calcium
- Alumni

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-Salts with phosphates, citrates, and sulfur.

5.3.Electrolytes: The electrolytes are particles that carry an electrical charge and are required for many physiological processes in the human body. Common electrolyte sodium, potassium, calcium, magnesium, chloride, phosphate, and bicarbonate.

Electrolytes draw particles together to create floccules by lowering the electrical barrier between them. They bring the zeta potential close to zero, which causes a bridge to form. between neighboring particles, creating a loosely organized structure by lining them together. Zeta potential decreases and the production of crystals indicate that electrolytes lower the electric barrier between the particles, acting as flocculating agents[68].

VI. EVALUATION.

6.1.Sedimentation Volume: The sedimentation volume (F) is the ratio between the final volume of material after sedimentation (Vu) and the beginning volume of sediment before settling (Vo)To determine the sedimentation volume, transport an established amount of solution (measured in milliliters) to a measuring cylinder. Next, measure the volume of sediment produced and record the results every 24 hours for seven days[69],[70].

In terms of expression, the sedimentation volume, F (%), is

F=100Vu/Vo.

6.2.Viscosity Measurement: The suspension's viscosity, which is a mixture of solid particles in a liquid, can be measured to understand its flow behavior. The rotational viscometer is used to calculate the samples' viscosity at 25°C[69],[71].

6.3.Drug Release: Studies on drug release are carried out at 37±0.5°C in a beaker with sufficient volume. The suspension is suspended in an appropriate dissolving media and put inside a cellophane membrane. When given enough time between samples, they are removed. Following the appropriate dilution, UV spectrophotometer is used to evaluate the samples[69],[72].

6.4.Zeta Potential: It is employed to verify the distributed system's stability. Measurements are made of the formulation's Zeta potential at 250 C and 1.33 refractive index. The principles are recorded weekly at consistent intervals following formulation preparation [68],[70].

6.5.PH Measurement: To keep suspensions of high quality, pH testing is necessary. A pH paper or other measuring tool can be used to determine pH[68],[73].

VII. RECENT ADVENCEMENT:

7.1. Novel Plant Sources:

7.1.1. Moringa Oleifera Gum: Because of its high galactomannan concentration, this gum, which is extracted from Moringa tree seeds, has potential suspending qualities. Research indicates that because of its moderate flavor, it may be useful for pediatric formulations and have the ability to sustain poorly soluble medicines[74].

7.1.2.Tamarind Seed Polysaccharide: This polysaccharide, which is derived from tamarind fruit seeds, has remarkable thickening and suspending qualities. Its mucoadhesive nature makes it appropriate for topical and oral applications, and it has been investigated for the purpose of suspending different medication[75].

7.1.3.Fenugreek Gum This gum, which is extracted from fenugreek seeds, has strong suspending and stabilizing properties. Studies indicate that it may be used to make drug solutions for poorly soluble substances, and that its natural bitterness can be covered up with the right flavored[76].

7.2. Modified Herbal Suspending Agents:

7.2.1.Chemically modified Guar Gum: It is possible to improve guar gum's suspending qualities by adding certain functional groups. This allows for more control over stability and viscosity, which makes a larger variety of medications and formulations possible[77].

7.2.2.Enzymatically Treated Xanthan Gum: Enzymatic treatment can tailor the molecular weight and structure of xanthan gum. one can enhance its suspending ability and decrease its inclination to gel. When creating suspensions with the appropriate flow and release properties, this can be helpful[78].

7.2.3.Combination of Herbal Suspending Agents: Nanocomposite formulations: Integrating herbal suspending agents with nanoparticles can create novel delivery systems with improved drug targeting, controlled release, and enhanced bioavailability[79].

7.3. Advanced Characterization Techniques: [80]

7.3.1. Rheological Studies: Modern rheometers offer comprehensive insights intothe viscoelasticcharacteristics and flow behavior of

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herbal suspensions, enabling formulation optimization and reliable performance.

7.3.2. Microencapsulation Techniques: Advances in microencapsulation technology can contribute to stability and controlled release of herbal suspensions.

7.3.3.Innovations in Traditional Knowledge: Herbal research focuses on fusing traditional herbal knowledge with contemporary scientific methods. In order to create novel suspending agents or enhance already-existing ones, researchers are researching ancient herbal compositions and techniques.

VIII. NEED OF HERBAL SUSPENDING AGENT:[81],[82]

8.1. Easy availability: They areproduced in many nations since they are used in numeroussectors.

8.2.Economic: When compared to natural material they are less expensive and require less manufacture.

8.3. Biocompatible and non-toxic: Almost all of these pigment pigments are formed of repeating monosaccharide units and are hence non-toxic due to their carbohydrate nature.

8.4. Safe and without adverse effects:

They are harmless and don't have any negative consequences because they originate from a natural source.

8.5.Biodegradable:

They have no negative consequences on the environment or human beings.

IX. FUTURE PROSPECTS OF HERBAL SUSPENSION:

9.1. Targeted Drug Delivery:

9.1.1.Nano-suspensions: Drugs can be suspended in nanoparticles to increase absorption, decrease adverse effects, and improve target specificity. This has potential for the treatment of diseases like cancer, where precise delivery is essential [83].

9.1.2.Mucoadhesive suspensions: Suspensions with the ability to stick to mucosal surfaces can increase local activity and prolong drug contact. This can be used to treat diseases like inflammatory bowel disease and mouth infections[84].

9.2. ImprovedBioavilability:

9.2.1.Controlled release suspensions: Drugs can be made into suspensions that release gradually over time improving patient compliance and lowering the frequency of doses[85].

9.2.2.Taste masking: Palatability can be enhanced by stopping the use of bitter or unpleasant-tasting medications, particularly for elderly and pediatric patients. Better treatment outcomes and more adherencemay result from this[86]**.**

9.3. Personalized Medicine:

9.3.1. On-demand suspensions: Suspensions can be designed to be freshly made at the point of care, enabling customized dosing according to the needs of each patient and genetic differences. This can minimize side effects and maximize the effectiveness of treatment[87].

9.3.2. Multi-drug suspensions: For patients who take various medications, combiningdifferent prescriptions into a single solution can streamline their regimes and increase convenience and adherence[88].

X. CONCLUSION:

This review looks into the fundamentals of pharmaceutical suspensions, concentrating on unique herbal suspending agents and patents. Nanotechnology, taste masking, and prolonged release have enhanced the physiochemical properties of traditional dosage forms, including drug release, permeability, dissolution rate, bioavailability, and stability. Pharmaceutical suspensions have been a common and effective dose method for pediatric patients for ages. Combining conventional qualities with cutting-edge developments can improve medicine targeting, patient compliance, dose regimen, and stability.Pharmaceutical suspensions continue to evolve as a preferred dose form, particularly for young patients, by combining standard strengths with cutting-edge innovations. The combination of nanotechnology, taste masking strategies, extendedrelease systems, and proprietary herbal suspending agents not only improves drug delivery and patient compliance, but also propels advances in medicine targeting, dose regimen optimization, and overall stability in pharmaceutical formulations.

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