Review Article

Liquid dosage forms: Classification characteristics and recent advances

Sofi Azeem[1], Nidhi Chaudhary[2*],Esha Vatsa[2], Amandeep Singh[3], Krati[4]

[1]Student, School of Pharmaceutical Sciences, Jigyasa University, Dehradun, Uttarakhand, India

[2]Associate Professor, School of Pharmaceutical Sciences, Jigyasa University, Dehradun, Uttarakhand, India

[3]Principal and Professor, School of Pharmaceutical Sciences, Jigyasa University, Dehradun, Uttarakhand, India

[4]Assistant Professor, School of Pharmaceutical Sciences, Jigyasa University, Dehradun, Uttarakhand, India

Abstract

This review aims to provide a thorough understanding of every liquid formulation utilized in the pharmaceutical line. Syrups, elixirs, oral solutions, suspensions, emulsions, topical liquids, oral, parenteral, ophthalmic, otics, mouthwash & gargle, and inhalation are all included in the study's broad coverage of monophasic or biphasic systems. The benefits, drawbacks, and quality control tests of all liquid formulations are highlighted in this overview. The classification of the main liquid formulations, their types, which formulations are used for which routes of administration, and the types of formulations along with their instances have all been thoroughly explained. Its primary goal is to highlight their ongoing significance in the crucial role and various administration routes of contemporary pharmaceutical treatment.

Keywords: Nano emulsion, Suspension,Micro emulsion,Elixir, liniment, Lotion, oral remedies, Eye drops, Mouthwash, Nasal, ointment, Infusion ,Implants, Nebulizer

Introduction

A liquid formulation is a kind of dosage form where the medication is emulsified, suspended, or dissolved in an appropriate liquid phase. These easy-to-swallow formulations are mostly used for elderly patients and youngsters who have trouble consuming solid medications like pills or capsules. One or more medications are combined with water or any other liquid in these formulations. Due to their difficulty swallowing tablets or capsules, youngsters and the elderly are primarily prescribed liquid medications. [1] Syrups, suspensions, emulsions, elixirs, drops, and solutions are a few types of liquid dosage forms. Each variety is made and used differently. Liquid formulations are primarily created to make it easier to provide the correct dosage, enhance flavor, and speed up the medication's action. When a flexible dosage is required, liquid medications are often beneficial. Liquid formulations do have several drawbacks, too, including poor taste, decreased stability, and the potential for bacterial growth. Liquid formulations are primarily made to make it easier to provide the proper dosage, enhance flavor, and speed up the medication's action. In the pharmaceutical industry, liquid dosage forms are crucial. Both patients and manufacturers can gain greatly from it. The term "liquid dosage form" can also be defined as a type of pharmaceutical preparation in which the active drug ingredient is dissolved, suspended, or emulsified in a liquid vehicle, along with solvents, flavorings, sweeteners, and preservatives. In order to preserve stability and taste, a flavoring ingredient becomes necessary. [2]

Importance of liquid dosage forms

In the pharmaceutical and healthcare industries, liquid dosage forms are crucial. Their patient acceptance, quick absorption, adjustable dose, and convenience of administration make them popular. Liquid formulations are among the most popular dosage forms for patients of all ages due to these benefits. [3]

1. Administrative Easy
2. Quick action and rapid absorption
3. Accurate and adaptable dosage
4. Improved patient and test compliance
5. Fit for a variety of medications
6. A range of uses
7. Increased bioavailability
8. A high level of patient acceptance [4]

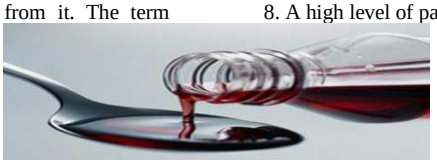

Fig: 1 Liquid syrup

*Correspondence
Dr.Nidhi Chaudhary
Associate Professor, School of Pharmaceutical Sciences
, Jigyasa University, Dehradun, Uttarakhand, India
E-Mail: nidhi.chaudhary@jigyasauniversity.edu.in.

Fig: 2 Advantages and disadvantages

Recent developments of liquid dosage forms

As technology has advanced, a number of innovative liquid medication delivery systems have been created to enhance the efficacy of traditional formulations. These include polymer-based liquid systems, liposomal dispersions, nanoemulsions, and microemulsions that improve the solubility, bioavailability, and controlled release of medications. These developments have created new opportunities for targeted drug delivery and extended the use of liquid dosage forms beyond conventional applications. [5]

Nanoemulsions are among the most important innovations. One kind of fine oil-in-water or water-in-oil dispersion is called a nanoemulsion. Additionally, the percentage of droplets in this are nanometer-sized. We employ nanoemulsions to make poorly water-soluble medications more soluble and absorbable so they can be administered orally, topically, intraocularly, and parenterally. They offer regulated release, bioavailability, and high stability because to their tiny particle size. For instance, compared to traditional dose forms, nanoemulsion formulations of antitubercular and anticancer medications have demonstrated superior therapeutic outcomes. [6]

The advent of complicated emulsions and multidrug delivery liquid systems is another recent development. For patients who need combination therapy, they enable the encapsulation of several medications in a single vehicle, offering a practical therapeutic choice. By carefully controlling droplet size and achieving uniform dispersion, modern microfluidic techniques increase production efficiency and reproducibility. [7]

Liposomal dispersions and polymer-based liquid systems have also gained attention in recent years. Liposomes are spherical vesicles composed of phospholipid bilayers that can encapsulate both hydrophilic and lipophilic drugs. They protect drugs from degradation and enable targeted and sustained drug release. Polymer-based liquid systems, on the other hand, use biocompatible polymers to modify drug release behavior and enhance stability.

These systems are ideal for controlled delivery in chronic diseases where prolonged action is desired.• The focus on patient-centric formulations is another key trend. Modern liquid dosage forms are being customized for pediatric and geriatric patients who often have difficulty swallowing solid forms. These formulations include taste-masked solutions, flavored syrups, and flexible dosing systems to improve patient compliance.[8]

Advanced liquid systems like nano emulsions and self-emulsifying formulations are becoming more and more in demand on an industrial level in the worldwide pharmaceutical business. Ongoing research keeps improving their safety, stability, and large-scale production despite obstacles like microbial contamination, physical instability, and regulatory barriers. [9]

History

Liquid dosage formulations have a long history. Since ancient times, this dose form has been in use. Liquid medications have been utilized since ancient times and are still often used today. Because it is simple to administer and acts more quickly than other dose forms, it is among the oldest. Liquid medications provide rapid relief and are simple to consume. They are therefore ideal for young people and the elderly. All things considered, the liquid dose form is among the best and most patient-friendly types of medication.

In Ancient time , people made remedies from natural materials such fruits, plants, and herbs. They produced a variety of liquids, including syrups, juices, and herbal teas (kaadha). These were applied to a number of health issues. Liquid medications were thought to be easier to use and more effective. They were more comfortable to take and aided in patients' quicker recovery. Numerous liquid medications, including Asava, Arishta, and Kashaya, were created in India under the Ayurvedic system. These were straightforward to make and administer to patients. These liquid medications were utilized more frequently than other types due to their ease of use and quick action.

During the Middle period, pharmacists began producing liquid medications such emulsions, tinctures, and elixirs. To extend the shelf life of the drugs, they employed honey or alcohol as a solvent. And the pharmacopoeia had instructions on how to make these.

Science started to advance dramatically in the 18th and 19th centuries, and people began to comprehend solubility and stability better. New liquid forms like solutions, suspensions, syrups, and emulsions were also developed at this time. Additionally, the pharmaceutical industry began producing these liquid formulations on a massive scale, paying close attention to sanitation and hygiene throughout the process.

The 20th century saw further advancements In technology. To safely store liquid medications, scientists developed novel packaging, such as glass and plastic bottles. Oral syrups, drips, injections, eye drops, and nasal sprays were among the various liquid formulations that were used. These produced quicker outcomes and were simple to use.

Liquid formulations have improved in the contemporary era. To increase the stability and efficacy of medications, new methods including emulsification and nanotechnology are employed. Researchers are now developing polymer-based suspensions, liposomal liquids, and nanoemulsions to improve the effectiveness and duration of medications in the body. additional advancements in liquid dosage forms in the present period. [10]

Classification of liquid dosage form

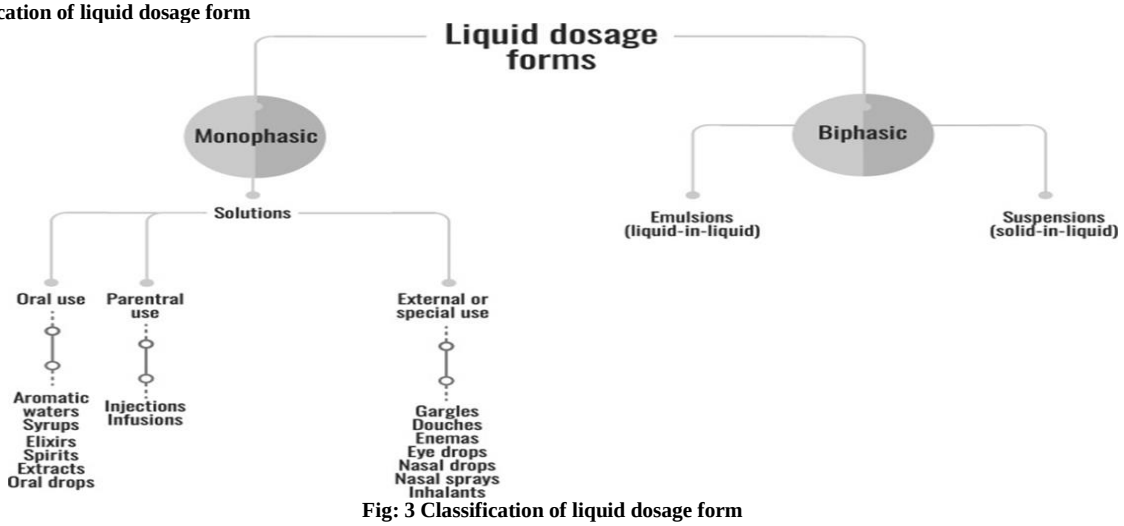

Fig: 3 Classification of liquid dosage form

Classification of liquid dosage forms based on route of administration

Oral liquid dosage form

A pharmaceutical oral liquid dose form is one in which our medication is suspended, emulsified, or dissolved in an appropriate liquid. In essence, an oral liquid dosage form is administered orally. Additionally, it can be used both with and without water. In the past, for instance, powder or granules were mixed with water to create this liquid dose form, which was then utilized right away. [11] Children, the elderly, and inpatients who have difficulty swallowing a tablet or capsule can benefit from this.

Oral liquid dose form classification

There are several categories of oral liquid drugs.

1) Syrups 2) Elixirs 3) Linctus 4) Blends
5) Oral remedies 6) Oral suspension 7) Oral emulsions 8) Oral drops [12]

1) Syrups: They are combined with water and sugar. One or more active medications are administered to the patient as part of this solution. Artificial thickeners and sweeteners are employed in sugarless syrup.

Fig:4 Syrup

2) Elixirs: Elixirs are liquid medications that are clear, sweet, and flavorful. In these, the medication is dissolved in a sugar and alcohol mixture. Alcohol and sugar are found in elixirs, which aid to stabilize the medication. [13]

Fig:5 Herbal elixir

3) Linctus: An oral liquid solution with one or more active pharmaceutical ingredients (API) that is viscous (thick). It is mostly used to relieve throat discomfort and coughing. To make linctuses, the medication is dissolved in a syrupy, sweet solution that typically contains sucrose or sugar derivatives. [14]

Fig: 6 Linctus

4) Mixtures: An oral liquid dosage form that has one or more active pharmaceutical ingredients (APIs) dissolved, suspended, or distributed in an appropriate medium is called a mixture. Mixtures are often made as aqueous solutions or suspensions and are meant to be taken orally. A mixture's solid particles may settle slowly while being stored, but they can be readily re-dispersed by shaking them before use. This guarantees that a consistent amount of the active ingredient is delivered with every dose. [15]

5) Oral solutions: An oral solution is a liquid dosage form that contains one or more fully dissolved active pharmaceutical ingredients (APIs) in an appropriate solvent vehicle, typically water [16]. It is intended to be taken orally, either straight or after dilution. [17]

6) Oral suspension: An oral suspension is a biphasic liquid dose form in which a drug's insoluble solid particles are evenly distributed throughout a liquid medium. After shaking the container to re-disperse the dispersed particles, it is meant to be taken oraly. [18]

Fig: 7Amoxicillin oral suspension

7) Oral emulsions: An oral emulsion is a biphasic liquid dosage form made up of two immiscible liquids, one of which is scattered throughout the other liquid in tiny droplets. Aqueous (water) and oily (oil) phases make up the majority of medicinal emulsions. Because oral emulsions are easier to swallow and more patient-acceptable, they are typically of the O/W type.

Fig:8Liquid paraffin and milk of magnesia Oral emulsion

8) Oral drops: Oral drops are liquid preparations that are meant to be given in tiny amounts using a dropper or other appropriate measurement tool. They are mostly used for young toddlers and newborns who have trouble swallowing tablets or capsules. [12]

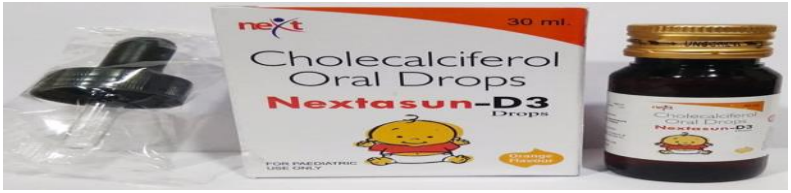

Fig:9 Cholecalciferol oral drops

2. Oral liquid dosage form universal test:

1. Assay for Physical Appearance Identification. 2. Contaminants [13]
3. Oral liquid quality control test
1. Visual examination . 2. Measurement of PH 3. Content uniformity
4. Phase separation. 5. Test for thermal stress. 6. Variation in weight

7. Rheology. 8. Test for antimicrobial efficacy

4. Advantages

1.Good taste 2.Ideal for newborns and children 3. Easy to administer

4. Flexible dose adjustment 5. Rapid absorption and accurate dosing.

5. Disadvantages

1.Risk of overdosing 2.Shorter shelf life 3.Difficulty in disguising the taste

2) Topical liquid dosage forms

One kind of formulation that is applied directly to the skin or mucous membranes is a topical liquid dose form. It is used directly for things like protection, cleaning, antibacterial effect, and relaxing. A common liquid dosage form's main function is to deliver the medication to the target location for a particular, localized action without causing it to spread throughout the body. They are mostly used to treat ailments like throat disorders, discomfort, inflammation, and skin infections.

1**.Classification of topical liquid dosage forms**

It is divided into several categories.

1) Lotion 2) Liniments 3) Paints 4) Gargles

5) Mouthwashes

1) Lotion: Lotions: Applied directly on the skin without rubbing, a lotion is a liquid preparation. It has a protecting and cooling effect. For instance, calamine lotion is used to relieve rashes and itching. Example: Calamine lotion.

2)Liniments: A liniment is a liquid or semi-solid solution that is rubbed onto the skin. It is used to treat inflammation or to relieve discomfort. Examples include iodine liniment and methyl salicylate liniment.

3)Paints: A paint is a thick liquid mixture that is applied with a brush to a small, targeted area. A thin, medicinal coating is left behind after it dries. For instance: Iodine-based throat paint.

Fig: 10 Mandl's paint

4)Gargles: A gargle is a liquid concoction that is spat out after being swished in the throat. They are used to clear the throat or treat infections. Antiseptic agents are the main ingredient in gargles. Povidone-iodine gargle, for instance.

Fig: 11 Providone iodine gargle

5)Mouthwashes: They are liquid preparations used for mouth freshness and oral hygiene. It is primarily used to protect the mouth from illness, kill oral bacteria, and freshen the mouth.

Fig: 12 Betadine Mouthwash gargle

2.Topic liquid dosage forms quality control test

Determining pH

Test for Viscosity
Examination of Physical Appearance
Drug Content/Assay Test.
A particular gravity test
Test for Uniformity
Test for Microbial Limit
Stability Test
Test for Irritation
Test for Spreadability

Advantages

1. It is simple to use
2. Prevents first-pass metabolism
3. Suitable for expansive surfaces
4. Fast relief and adaptable formulas
5. Beneficial under various circumstances

4. Disadvantages

Inaccurate dosage
short duration of action
allergy or irritation risk,
contamination risk [14]

Parenteral liquid dosage form

Liquid preparations that are injected directly into the body are known as parenteral liquid dose forms. These are administered via several ways, including intravenous (IV), intramuscular (IM), subcutaneous (SC), and intradermal (ID). Reaching the systemic circulation and demonstrating rapid impact are its primary goals.

Parenteral liquid dosage form classification

It is divided into several categories.

1) Injection 2) Infusion 3) Injection Powders
4) Concentrated Solutions for Dilution 5) Implants

1)Injection: This kind of liquid preparation is injected straight into the body. Injections of insulin and ceftriaxone are two examples.

2) Infusion: This is a gradual intravenous (IV) administration of a big volume fluid. It is mostly utilized for hydration or electrolyte balance. As an illustration, consider Amino Acid Infusion Normal saline (0.9% sodium chloride).

Fig: 13 Aminomit infusion

3)Injection powder: This is a sterile, dry powder that is dissolved in a solvent before being injected. Ampicillin powder for injection, for instance.

Fig: 14 Ampicillin powder injection

4)Concentration solution for dilution: This is a highly sterile concentrated solution that is injected after being diluted. For instance, potassium chloride injection concentrate

Implants: These are solid, sterile forms that are placed beneath the skin and gradually discharged. For instance, buprenorphine and leuprolide acetate implants

Fig: 15 Leuprorelin acetate implant

2. Parenteral liquid dose form quality control test

1. Sterility exam 2. Test of pyrogen 3. Test for particulate particles 4. Leak test 5. Clarity check 6. pH measurement 7. The active ingredient assay

Advantages

Accurate dose (no absorption variability like oral route)
Useful in emergency situations.
Quick onset of action.
Appropriate for medications that are poorly absorbed orally.
Helpful for patients who are unconscious or reluctant.

disadvantages

Expensive (needs sterile equipment and production).
Painful and requires trained staff.
Difficult to withdraw the medicine once injected.
In most circumstances.
not suitable for self-administration.

Ophthalmic liquid iquid dosage form

These are sterile formulations meant to be injected into the eye. They provide medications straight to the cornea or conjunctiva. These formulations are used to treat allergies, inflammation, and eye infections. [15]

Fig: 16Eye drops

1.Classification of ophthalmic dosage form

1) Eye drops 2) Eye lotion 3) Eye suspension 4) eye ointment

1)Eye drops: Eye drops are sterile, transparent aqueous fluids. This is frequently used when someone has glucoma.
2)Eye lotion: This is a sterile liquid preparation. Used to cleanse or irrigate the eyes and get rid of unwanted objects.
3)Eye suspension: This liquid ophthalmic preparation is sterile. carefully separated insoluble medications in a sterile container.
4)Eye ointment: These are sterile semisolid ophthalmic preparations. Allow for prolonged touch with the ocular tissues.

2.Tests for Quality Control

1) The sterility test 2) Test of clarity 3) Determining pH 4) Test for isotonicity

3.Advantages

1. Quick onset of effect.
2. Prevents first-pass metabolism.
3. Convenient and non-invasive. [16]

Disadvantages

1. Potential for nasal discomfort or damage.
2. Restricted dosage volume (0.1–0.2 mL).
3. Microbial contamination risk.[17]

5) Nasal liquid dosage forms

Sterile liquid solutions intended for delivery into the nasal cavity to produce local or systemic effects are known as nasal liquid dosage forms. They prevent first-pass metabolism and enable quick absorption through the nasal mucosa. They are used to treat nasal irritation, infection, and congestion. [18]

Fig: 17 Nasal spray

1.Classification of nasal dosage forms

1.Nasal Drops 2.Nasal Sprays
3.Nasal Inhalations 4.Nasal Washes

1. Nasal drops: they are local therapeutic action, little amounts of sterile aqueous or oily solutions or suspensions are injected into the nostrils.
2. Nasal sprays: These are metered-dose or pump-actuated devices that apply tiny droplets of medication to the nasal mucosa for both local and systemic effects.
3. Nasal inhalation: These liquid formulations, which are mostly used for respiratory or nasal problems, are transformed into aerosols or vapors for inhalation through the nose.
4. Nasal washes: These are medicated or sterile saline solutions. Extensively utilized for nasal cavity cleaning, moisturizing, or irritation removal.

2.Tests for quality control

1. The sterility test 2. Determining pH 3. Test for Viscosity

3. Advantages

1. Quick onset of effect.
2. Prevents first-pass metabolism.
3. Convenient and non-invasive.

4. Disadvantages

1. Potential for nasal discomfort or damage.
2. Restricted dosage volume (0.1–0.2 mL).
3. Microbial contamination risk [19]

6) Otic liquid dose forms

The sterile liquid formulations called otic liquid dosage forms are meant to be injected into the ear canal in order to treat localized infections, reduce inflammation, or soften earwax (cerumen). These preparations need to be clear, particle-free, isotonic, and sterile. Used to treat allergies, inflammation, and otic infections.

Fig:18 otic solution

1.Classification of Otic liquid dosage forms

1.otic solution 2.otic suspension 3.otic emulsion

1. Optic solution: A clear, sterile liquid with dissolved medications in an appropriate medium (aqueous or non-aqueous).
2. Otic suspensions: which are sterile liquids with finely divided medication particles scattered in an appropriate medium, need to be shaken before use. "Shake well before use" is also mentioned on the suspension container. [20]
3. Otic emulsion: These systems are two-phase (oil and water). Used for stability or solubility in a single phase is inadequate. Give longer-lasting effects and improved medication penetration.

2.Test for quality control

1) Sterility Test. 2) Clarity Test 3)Determination of pH
4)Test for Viscosity 5)Uniformity of Drug Content

3. Advantages

1.Quick relief from ear pain or infection.
2.Prevents systemic side effects.

4. Disadvantages

1. Potential irritation if pH or tonicity is not maintained .
2. Restricted to local use only.

3. Risk of contamination after opening.
4. Difficult administration in children.

7) Inhalation liquid dosage forms

These are sterile liquid formulations intended to have a local or systemic effect when inhaled through the respiratory system. Nebulizers, inhalers, and vaporizers are used to turn the liquid into aerosol. They are used to treat a variety of respiratory conditions, including asthma, bronchitis, lung infections, and COPD. These formulations offer quick action.

Fig:19 Inhaler

1.Classification of inhalation liquid dosage form

1. Nebulizer solutions 2. Metered-dose inhaler (MDI) solutions
3. Vapors/inhalation sprays

1. Nebulizer solution: The nebulizer transforms the aqueous solution into a fine mist. The medication is delivered straight to the lungs and airways. They work incredibly well.
2. Metered Dose Inhaler (MDI): A propellant-filled, pressurized canister containing a solution or suspension. It works quickly and is simple to use for a variety of respiratory system-related illnesses.
3. Vapor/Inhalation spray: These are volatile liquids that emit vapors for use in inhalation treatments. It produces fragrant fumes that aid in nasal passage opening. The underlying infection is not addressed.

2. Tests for Quality Control

1. The sterility test 2. pH measurement
3.Assay for active ingredient 4. Analysis of particle size

3. Advantages

1. Offers a quick start to action.
2. Prevents metabolism in the first pass.
3. Perfect for treating respiratory conditions including COPD and asthma.

4. Disadvantages

1. Needs costly and accurate inhaling equipment.
2. Dosage delivery is impacted by patient method.
3. Could induce coughing or irritate the airways

8)Mouthwash & Gargle Liquid Dosage Form

Aqueous preparations for cleaning, deodorizing, and medicating the mouth and throat include mouthwashes and gargles. Astringents, antiseptics, analgesics, anti-inflammatory, and deodorizing substances are all present in them. They prevent infection by maintaining good dental hygiene.

1.Classification of mouthwash and gargle liquid dosage forms

1. Aqueous mouthwash 2. Gargle solution

Fig:20 Mouthwash gargle

1.Aqueous mouthwash: It is a liquid preparation with a water base that is used for oral hygiene. It helps prevent dental plaque, freshen breath, and lower the microbial load. (For instance, mouthwash containing chlorhexidine).
2. Gargle solution: It is used to treat infections of the throat. These preparations are safe, simple to use, and useful for relieving symptoms. (Povidone-iodine gargle, for example).

2. Tests for quality control

1. Determining pH 2. Active ingredient assay
3. Test for microbial limits 4. Check for odor and appearance

3. Advantages

1. Quick local action and ease of use.
2. Assists in preventing mouth infections and tooth plaque.

4. Disadvantages

1.Short duration of action and not appropriate for systemic effect.
2. Certain formulations may cause tooth discoloration or irritate the mucosa. [20]

Conclusion

One of the most popular types of medications is liquid dose forms. Liquid formulations include oral, topical, ocular, nasal, otic, mouthwash and gargle, and parenteral. Drug distribution is made feasible by these many therapeutic pathways. and enhance patient adherence. Additionally, these formulations offer significant benefits such flexibility in dose adjustment, quick action, and ease of administration. Stability, contamination risk, and storage constraints are issues that must always be considered in these formulations. In liquid dosage forms, formulation science, excipient technology, and sterilizing techniques have all advanced significantly, improving stability, safety, and efficacy. As a result, the liquid formulation has been and will continue to be a crucial component of the contemporary drug delivery system.

References

1. Merisko Liversidge E., et al. “Nanosizing: a formulation approach for poorly-water-soluble compounds”. European Journal of Pharmaceutical Science 18 (2003): 113-120.
2. Blagden N., et al. “Crystal engineering of active pharmaceutical ingredients to improve solubility and dissolution rates”. Advanced Drug Delivery Review 59.7 (2007): 617-630.
3. Hu J., et al. “Nanoparticle engineering processes for enhancing the dissolution rates of poorly water soluble drugs”. Drug Development and Industrial Pharmacy 30.3 (2004): 233-245.
4. Nagarsenker MS and Garad, SD. “Physical characterization and optimization of dissolution parameters of prochlorperazine maleate co-evaporates”. International Journal of Pharmaceutics 160 (1998): 251-255.
5. Jalali MB., et al. “Enhancement of dissolution rate and anti inflammatory effects of piroxicam using solvent deposition technique”. Drug Development and Industrial Pharmacy 28 (2002): 681-686.

6. Cavallari C., et al. "Improved dissolution behaviour of steam granulated piroxicam". European Journal of Pharmaceutics and Biopharmaceutics 54 (2002): 65-73.
7. Mitchell SA., et al. "A compaction process to enhance dissolution of poorly water-soluble drugs using hydrxypropyl methylcellulose". International Journal of Pharmaceutics 250 (2003): 3-11.
8. Spireas S and Bolton M. "Liquisolid Systems and Methods of Preparing Same, U.S. Patent 5,968,550". (1999).
9. Karmarkar AB., et al. "Liquisolid Tablets: A Novel Approach for Drug Delivery". International Journal of Health Research 2.1 (2009): 45-53
10. Glenn EM and Nelson DH. "Chemical Method for the Determination of 17-Hydroxycorticosteroids and 17-Ketosteroids in Urine Following Hydrolysis With β-Glucuronidase". The Journal of Clinical Endocrinology and Metabolism 13 (1953): 911.
11. Nelson DH., et al. "Blood Levels of 17-Hydroxycorticosteroids Following the Administration of Adrenal Steroids and Their Relation to Levels of Circulating Leukocytes". Journal of Clinical Investigation 31 (1952): 843.
12. Tan E., et al. "Dosing information for paediatric patients: arethey really 'therapeutic orphans'?" Medical Journal of Australia179.4 (2003): 195-198.
13. Ekinci R and Kadakal C. "Determination of seven water-soluble vitamins in Tarhana, a traditional Turkish cereal food, by High-Performance Liquid Chromatography". Acta Chromatographica 15 (2005): 289-297.
14. Lee V H L and Robinson I R. "Ocuserts for improved drug delivery and better patient compliance". Journal of Pharmaceutical Sciences 68.1 (1979): 673.
15. Ancha MJ., et al. "Formulation and evaluation of pediatric azithromycin suspension". International Journal of Pharma and Bio Sciences 1 (2010): 1-2.
16. Marriott J., et al. "Pharmaceutical compounding and dispensing". 2nd ed. Pharmaceutical Press (2010).
17. "Remington: The Science and Practice of Pharmacy". London:Pharmaceutical Press (2012).
18. "The science of pharmaceutical compounding: non-sterile training". Montreal: LP3 Network Inc (2018).
19. DJ Burgess., et al. "Assuring quality and performance of sustained and controlled release parenteral". AAPS PharmSciTech 4 (2002): E7. Carstensen TJ. "Theory of Pharmaceutical systems". Academic press; NY, (1973): 59.
20. A Liberman., et al. "Gilbent's Pharmaceutical Dosage forms Dispersed systems". Marcel Dekker 2 (1996): 285.

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