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Pharmaceutical Sciences **Review Article……!!!**

"MILK-BASED SPRAY-DRIED CARRIER SYSTEMS FOR ENHANCING STABILITY OF STEROIDAL SAPONINS FROM SATAVARI: FORMULATION STRATEGIES AND EVALUATION METHODS"- A REVIEW

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KEYWORDS:

Steroidal Saponins , Satavari , Milk, Spray Drying, Stability Enhancement.

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ABSTRACT

Steroidal saponins derived from Satavari exhibit promising bioactive properties, yet their susceptibility to degradation poses challenges in formulation and stability. This review explores the innovative utilization of milk-based spray-dried carrier systems as a strategic approach to enhance the stability of these valuable steroidal saponins. The formulation difficulties, encompassing the selection of milk powder variants, incorporation of Satavari-derived steroidal saponins, and utilization of stabilizers, are examined. The spray-drying process, optimizing parameters to achieve ideal particle characteristics and encapsulation efficiency, is highlighted. Evaluation methodologies encompassing accelerated stability studies under varied conditions, coupled with analytical techniques such as HPLC and UV-Vis spectroscopy for quantification, enhance the efficacy of these carrier systems. Furthermore, the impact of milk-based carriers on improving stability and bioavailability, along with future perspectives and challenges, is discussed. This review offers insights into the potential of milk-based spray-dried carrier systems as a viable strategy to stabilize steroidal saponins from Satavari, fostering advancements in drug delivery and natural product formulation. This article is to review the chemical constituents and pharmacological activities to understand how asparagus have potential to cure diseases.

INTRODUCTION:

Shatavari is used in Indian Ayurveda over centurie, It is also called as "herb's queen" A. racemosus helps to balance vata and pitta, improve the reproductive and digestive health .Satavari an herbaceous perennial plant of immense medicinal significance in traditional Ayurvedic practices harbors steroidal saponins known for their diverse therapeutic properties.[1] However, the inherent instability of these bioactive compounds poses challenges in harnessing their full therapeutic potential. Overcoming this hurdle requires innovative formulation approaches that ensure the stability and bioavailability of Satavari-derived steroidal saponins. In recent years, the utilization of carrier systems based on milk components, particularly through the technique of spray drying, has emerged as a promising strategy.[7] These systems not only aim to enhance the stability of the bioactive compounds but also seek to improve their delivery and efficacy. This review investigates into the formulation complexity, process optimization, and evaluation methodologies associated with milk-based spray-dried carrier systems, emphasizing their role in stabilizing steroidal saponins derived from Satavari. By exploring the advancements and challenges in this domain, this review aims to illuminate the potential of these carrier systems in revolutionizing drug delivery and natural product formulation.

Drug profile:

Synonym:-Shatamuli.

Biologicals source:-

Shatavari consist of the dried roots & the leaves of the plant knows as Asparagus Racemosus. Family:- Liliaceae[23]

Geographical Source:

It is widely spread across the earth andfound in tropical Africa, Australia, Sri Lanka and South of India, butIndia is highest producer of Shatavari. This plant is counted in one of the endangered species.

Cultivation:

Crops mainly require the tropical hot and humid climate. Black soil is preferred for cultivation. Minimal irrigation is required. Harvesting can be started from 1.5-2 years till 10-15 years. A. racemous plant usually blooms in June to July.[23]

MORPHOLOGICAL FEATURES OF A. RACEMOSUS ROOTS:

MACROSCOPY

Parameters	Features
Shape	The roots are fleshy, tuberous, tapering towards both ends, swells when Soaked in water.
Size	10-60 cm in length, 1-2.5 cm in thickness
Colour	Fresh roots are white to buff in colour, dried roots are white to grayish white in colour
Odour	None
Taste	Sweetish
Surface	Rough, sign of shrinkage after drying
Texture	Short and Fibrous

.

SHATAVARY ROOT AND FLOWER:

Fig :1-SATAVARI PLANT

Fig:2-SATAVARI FLOWER

Fig: 3- SATAVARI ROOTS

Steroidal saponins are natural compounds found in plants, particularly glycosides, with potential medicinal properties and biological activities. They are classified based on their aglycone moiety

and are found in plant families like Lilliacae Solanaceae, Dioscoreaceae, and Agavaceae. Steroidal saponins have antioxidant properties, anti-inflammatory effects, anticancer potential, cardio protective effects, and immuno modulatory properties. They have been used in traditional medicine for expectorants, diuretics, and treating conditions like asthma and arthritis. However, challenges include bioavailability, safety concerns, and research continuity. While research has revealed potential benefits, further investigation is needed to fully understand their mechanisms and harness their medicinal properties effectively.

Chemical constituent:

It contain Steroidal saponin Shatavari I-IV(Asparoside B) major glycoside containing 3 glucose and 1 rhamnose.Aglycone unit is sarsapogenin.

Shatavarin IV or asparanin B containing 2 glucose 1 rhamnose.Also contain sitostrol, Quarcetin, rutin, immunoside, etc.

Fig: 4- CHEMICAL STRUCTURE

(Chemical structure of Shatavarin I, Sarsasapogenin and Shatavarin IV)

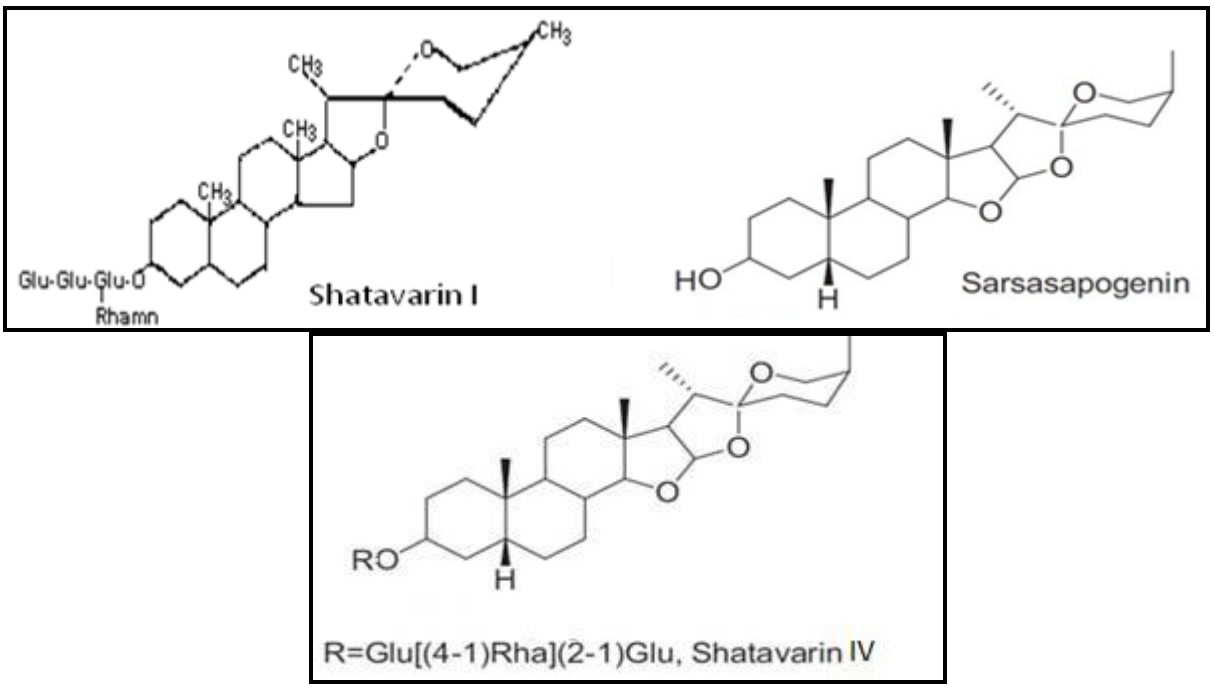

Table 1: Scientific classification of shatavari.

Kingdom	Plantae
Clade	Angiosperms
Clade	Monocots
Order	Asparagales
Family	Asparagaceae
Subfamily	Asparagoideae
Genus	Asparagus

Table 2 : Vernacular name of shatavari:

Sanskrit	Satavari
Hindi	Satavari, Shatawar or Satmuli
Bengali	Shatamuli
Marathi	Shatavari or Shatmuli
Gujarati	Satawari
Telegu	Toala-gaddalu or Pilli-gaddalu
Tamil	Shimaishadavari or Inli-chedi
Malayalam	Chatavali
Kannada	Majjigegadde or Aheruballi
Madhya Pradesh	Narbodh or atmooli
Kumaon	Kairuwa
Rajasthan	Norkanto or Satawar
Nepal	Kurilo
Shatavari stands for "curer of a hundred diseases.	

Table 3: Chemical constituent of shatavari:

Parts	Chemical constituents
Roots	Rutin, asparagan, Asparagamine A, 9,10-dihydro 1, 5 methoxy- Quercetin3 glucouronides, 8-methyl-2, 7-phenenthrenediol, Racemofuron, ncoumertans, Shatavarin V. Shatavarin I-(steroid glycosides), Immunoside, Sitosterol, Shatavari, Secoisolariciresinol, diosgenin, Racemosol, 4- trihydro isoflavine 7-0-beta-D-glucopyranoside, Sterols, Alkaloid, Tannins, carbohydrates, Flavonoids, isoflavones, coumestans, prenylated. Lactones, Amino acids and rutin, Undecanyl cellanoate, 4,6- dihydroxy-2-0 (2- hydroxyl isobutyl) benzaldehyde
Flowers	Rutin, Diosgenin, Quercetin, hyperoside
Fruits	Quercetin, rutin, Hyperoside, Racemoside A, B, & C
Leaves	5-hydroxy-3,6,4'-trimethoxy-7-O-β-D-glucopyranosyl-[1→4] -O-α-D-xylopyranoside, Quercetin-3-glucuronide
Shoot	Sarsasapogenin and kaempferol Thiophenes, thiazole, ketone, Undecanyl cetamoate, aldehyde, Gamma linoleinic acids

Table: 4: Bio chemical activities:

Bio-activity	Procedure of Action
Anticarcinogen activity	Steroidal saponins used for apoptosis inducing study
Antidepressant activity	Roots methanolic extract is used
Antihepatotoxic potential	Alcoholic extract of root have antihepatotoxic properties
Cardiovascular activity	Alcoholic extract from its roots
Dyspepsia properties	Powder of dried root of A. racemosus. and the A. racemosus fresh root juice
Galactagogue properties	A. racemosus root extracts Ricalex tablets (Aphali pharmaceutical Ltd. Ahmednagar) lactare (TTK Pharma, Chennai)
Immunomodulant activity	Polysaccharide fraction is used
Neural Disorders activity	Extract potential examined against Kainic Acid (KA)- striatal neuronal damage and induced hippocampal
Respiratory action	Roots alcoholic extract at higher doses
Uterus properties	Roots extracts Ethyl acetate Acetone is used

Table 5**: Trace elements in Asparags racemosus:**

Metal	Leaves (mg/mg)	Roots(mg/Kg)
Zinc	53.0 ± 0.2 to 165.0 ± 3.2	44.0 ± 0.2 to 148.0 ± 1.2
Lithium	28.0 ± 0.6 to 48.0 ± 1.6	18.0 ± 0.2 to 58.0 ± 3.8
Copper	15.0 ± 0.6 to 34.0 ± 0.5	14.0 ± 0.1 to 23.0 ± 0.3
Calcium	1346.0 ± 0.3 to 6153.0 ± 1.6	961.0 ± 0.6 to 2115.0 ± 3.2
Manganese	14.0 ± 0.4 to 84.0 ± 0.7	5.0 ± 1.4 to 62.0 ± 2.5
Potassium	5460.0 ± 0.2 to 10842.0 ± 2.5	2652.0 ± 0.4 to 13260.0 ± 3.5
Iron	505.0 ± 0.2 to 2040.0 ± 0.3	211.0 ± 0.5 to 1493.0 ± 0.2
Sodium	127.0 ± 0.6 to 745.0 ± 0.3	199.0 ± 0.5 to 490.0 ± 20
Cobalt	85.0 ± 0.3 to 88.0 ± 0.2	84.0 ± 0.3 to 122.0 ± 1.5

Table :6: Shatavari Ayurvedic dosages:

Churna (powder)	¼ to ½ tsp consumed twice a day, mixed with milk, juice, or warm water.
Arishta (Aqueous Tincture)	1-2 tsf , twice a day
Vati (Tablet/ Capsule)	1-2 vatis, twice daily
Kashayam (Juice)	2-3 tsf once a day
Avaleha (Paste)	¼ - ½ tsf

Milk based carrier system:

The use of milk-based carrier systems, particularly in the context of enhancing the stability of steroidal saponins from Satavari, involves innovative formulation strategies and evaluation methods. The objective is to improve the stability, bioavailability, and overall efficacy of these compounds.[19]

Utilization of Milk Components:

Milk contains various components like proteins, lipids, and carbohydrates that can serve as excellent carriers for bioactive compounds.

Stabilization and Protection:

Carrier systems based on milk components can help protect sensitive compounds like steroidal saponins from degradation due to environmental factors like heat, light, or pH changes.

Enhanced Bioavailability:

These carrier systems can enhance the solubility and absorption of steroidal saponins, thereby improving their bioavailability in the body.

The stability of steroidal saponins is significantly enhanced through the use of milk-based carrier systems, which convert liquid formulations into dried powders using hot air. These carrier systems optimize factors such as milk components, saponin concentration, drying temperature, and encapsulation efficiency to ensure optimal stability and bioavailability. Analytical techniques such as High-Performance Liquid Chromatography (HPLC), Scanning Electron Microscopy (SEM), and Differential Scanning Calorimetry (DSC) are employed to evaluate the effectiveness of these carrier systems. [6]. The benefits of these carrier systems include enhanced stability, improved delivery, and increased commercial viability for pharmaceutical or nutraceutical purposes. However, challenges include finding the ideal formula and transitioning from lab-scale to large-scale production while maintaining stability and efficacy.

The research into milk-based carrier systems for enhancing the stability of steroidal saponins from Satavari represents an innovative approach in pharmaceutical formulation. By employing these strategies and evaluation methods and various health applications.[17,18]

The stability enhancement of steroidal saponins from Satavari is achieved through milk-based carrier systems, which provide protection from environmental factors and reduce degradation. Encapsulation in milk-based carriers protects the structure of the compounds from degradation, such as light, heat, and moisture. Formulation optimization involves selecting suitable milk components, determining optimal ratios and concentrations, and fine-tuning spray-drying process parameters. Evaluation techniques include quantitative analysis, microscopic examination, and thermal analysis. Long-term stability studies evaluate the stability of the encapsulated saponins under various storage conditions and monitor degradation kinetics.

The advantages of encapsulation in milk-based carriers include extended shelf-life, improved formulation, and enhanced bioavailability. Encapsulation prolongs the shelf-life of steroidal saponins, ensuring their viability for pharmaceutical or nutraceutical applications. Stable formulations increase the chances of better absorption and bioavailability of these compounds in the body. However, challenges include optimization complexity and scalability. Ensuring the efficacy and stability of these valuable compounds requires a balance between formulation strategies.[20]

Satavari's steroidal saponins are stabilized using milk-based carrier systems, ensuring their efficacy and stability. The stability of the encapsulated saponins is tested to ensure they retain their therapeutic properties, with in vitro assays conducted to measure their effects post-encapsulation. The formulation's shelf-life is established through long-term stability studies and degradation kinetics. The efficacy of the formulation is compared with unencapsulated saponins and benchmarked against standard formulations.[14,15] Commercial viability is assessed through scalability and manufacturing consistency, cost-effectiveness, and regulatory compliance. The efficacy of the formulation is not solely determined by its stability but also by its ability to deliver desired therapeutic effects in a consistent and reliable manner. A comprehensive assessment, including biological activity, stability and compliance, is essential to validate the formulation's effectiveness.

The methodology and materials used in a study involving the development of a milk-based carrier system for enhancing the stability of steroidal saponins from Satavari typically encompass several stages, each with its specific materials and methods:

MATERIALS AND METHODS:

Experimental Section:-

Collection of plant drug source:

Plant material and extract preparationA. racemosus roots were purchased from a local marketand authenticated. They have been deposited in theMuseum of Herbal Medicines, Department of Pharmacognosy, Department of Pharmacognosy, Lucknow, India, for futurereference. Air-dried (40–50 °C) ground roots (50 g) were extracted withhot water (5 × 400 mL) by heating continuously in awater bath at 100 °C for 5 h each time. The extracts were combined, filtered and concentrated at reduced temperature (60–65 °C) with a rotary evaporator (Büchi, USA),and lyophilized (Freezone 4.5; Labconco, USA) under high vacuum at°C (133 × 104 m).).) at -40 °C ± 2 °C to obtain the lyophilized aqueous extract of A. racemosus (17 g).

Steroidal Saponins from Satavari: Extracted or isolated steroidal saponins used as the active ingredient.

Collection period of drug:

Leaves grow at a moderate rate. It takes about 6 months after germination for them to reach 30 cm in height. Bloom time range of this plant is early summer tolate summer. Shade to sun is required. Water range is very high. It is required watery loam.

Method of drying:

The leaves can be dried in shade of sun. It can also dried in hot air oven.

Extraction of drug:

For the extraction of crude there are generally two methodsare used.

Soxhlet method. (Hot extraction method).

Apparatus Soxhlet apparatus (Make: Merck) was used for the extraction process. Other apparatus used were Water Bath (Make: Cintex), Hot air oven (Make: Cintex), Sonicator (Make: Toshniwal), Weighing balance (Make: Shimadzu).

Maceration method. (Cold extraction method).[11].

Solvent for Extraction method:

The dried leaves of Asparagus racemosus was extracted by different solvent of increasing the polarity:-

For hot extraction

i) Water

ii) Ethanol

iii) Chloroform

Drug evaluation:

Drug evaluation is the method by which drug is identified. The drug evaluation is done by two methods:

Physical characterization:

Physical characterization is done for the drug to identify it according to is physical nature.

Moisture content:-

Moisture is the amount of water substance present in the plant drug

Source. Every plant has possess some amount water content in it.

Total % of moisture in given drug sample:-

% moisture = difference of weight (before and after drying) / weight of crude drugx100

% moisture = 0.25 / 1 x 100

= 0.25 x 100

= 25%

Loss on Drying:-

Loss on drying is a widely used test method to determine the moisture content of a sample, although occasionally it may refer to the loss of any volatile matter from the sample. Loss in drying does not usually refer to molecularly bound water or water of crystallisation.

Total loss of weight in crude drug:-

Loss of weight = Weight of crude drug (before drying) - Weight of drug (after drying) Loss of Weight = 3gm – 0.93gm

= 2.07gm

loss on drying content = 2.07 gm

Total % on drying in given drug sample:-

% LOD = difference of weight (before and after drying) / weight of crude drug x100

% LOD = 2.07 / 3 x 100

= 0.69 x 100

= 69%

Milk Components:

Such as proteins, lipids, and carbohydrates from various sources like cow's milk, skim milk, whey, or casein.

Milk is one such carrier that has been effectively used to deliver phytochemical for targeted health benefits in the traditional Indian system of medicine. Milk could be a good choice for the delivery of functionality of shatavari extract to the consumers. Milk is an ideal vehical for fortification with this nutraceutical. So, the milk and milk products act as carrier for nutraceuticals. Milk is a natural oil in water type of emulsion containing milk fat dispersed phase. Milk has the capacity to soluble both polar and non-polar phytoconstituents .

The saponins are more soluble in milk than in water. This suggests that the milk may help to enhance the absorption of saponin. Shatavari can be taken in powder, capsule or tablet forms. Powdered shatavari may be easily absorbed than in other forms.

Preparation of fortified milk:

Fresh cow's milk was collected from Cattle Yard, National Dairy Research Institute, Karnal, India, and warmed to 40–45°C. The warmed milk was filtered using muslin cloth to remove any foreign materials. The milk was then pasteurized at 63 °C for 30 min and finally cooled to 4°C. Subsequently, lyophilised aqueous extract of A. racemosus was weighed(enough for 1.0% content in milk). The extract was crushed with pestle and mortar in the presence of small quantity of milk (25 mL) and finally made upto the required volume. The aliquot thus obtained was used for further analysis.[1]

Solvents and Excipients:

Solvents Used for preparation, extraction, or formulation purposes (e.g., ethanol, water, buffers).

Chemicals for Analysis:

Standards for steroidal saponins, reagents, and chemicals required for analytical techniques (e.g., HPLC, DSC).[6]

Methodology

Extraction and Purification of Steroidal Saponins:

Saponin Extraction:

Using suitable solvents (e.g., ethanol, methanol) and extraction methods (e.g., maceration, Soxhlet extraction) from Satavari roots or standardized plant sources.

Quantitative evaluation of total steroidal saponins:

Total steroidal saponins were isolated from the official parts of A. racemosusviz. roots according to Tschesche and Pandey (1978). The dried and ground roots of plantwere extracted with methanol at room temperature. The methanol extract was distilled andwas evaporated to dryness. The dried pulp was transferred to water, defatted with benzene (C6H6) and, then extracted with butanol (BuOH). Butanol extractis washed three times with ether to remove phenolic components. After removal of phenolic compounds, the defatted butanol extract was distilled under reduced pressure and evaporated to dryness. The dried extract showedas a light brown mass and reacted positively to Ehrlich's reagent, indicating that it was a steroidalsaponin of the furostanol type. The steroidal saponin concentration thus obtained was calculated relative to the initial weight ofroot powders. [3]

Purification Steps:

Processes involving chromatography (e.g., column chromatography) or precipitation to isolate and purify the steroidal saponins.

Formulation Development:

Selection of Milk Components :

Based on their ability to act as carriers, compatibility with saponins, and stability-enhancing properties.

Optimization of Formulation:

Determining the optimal ratios of saponins to milk components through experimentation to achieve maximum encapsulation efficiency and stability.

Preparation of Milk-Based Carrier System:

Formulation of the encapsulation system using techniques like spray-drying or coacervation .

SPRAY DRIER:

Spray drying is a process that converts a liquid or slurry into dried particulate form by spraying the material into a hot drying medium. The optimal parameters and working principles of a spray dryer vary depending on the specific material being processed. The working principle involves atomization, where the liquid feed is pumped into fine droplets using methods like pressure nozzles, rotary atomizers, or pneumatic mechanisms. These droplets are introduced into a drying chamber or tower, where they come into contact with hot air or gas in a concurrent or countercurrent flow. As the droplets travel through the chamber, moisture evaporates rapidly, leaving behind dried particles that fall to the bottom or are collected using cyclones or other separation methods.

The spray drying is a unit operation capable of transforming solutions or suspensions into a solid product. The spray dried milk is a manufactured dairy product made by evaporating milk to drieness.one purpose of drying milk preserves it. The milk powder longer self-life than liquid milk and does not need to refrigeration.

Optimal parameters for spray drying include inlet air temperature, feed flow rate, atomization technique, airflow rate and pattern, residence time, and product characteristics. These parameters require experimentation and adjustment based on the specific material and desired product characteristics. Continuous monitoring and control systems are often employed to maintain optimal conditions during the spray drying process.

Characterization and Evaluation:

Table-7

1. Analytical Techniques:

Physicochemical Evaluation:

Physical Parameters	Result (% w/w)
Moisture Content	9.59

2.Ash Value:

Total ash	7.83
Acid soluble ash	6.10
Acid insoluble ash	1.73
Water soluble ash	2.67
Water insoluble ash	5.16
Sulphated ash:	0.47

3.Extractives Values:

Solvents	Exhaustive	Sequential
Benzene	0.55	0.55
Chloroform	1.28	1.23
Ethyl acetate	2.25	2.92
Methanol	6.36	6.15

The sample was found to have a moisture content of 9.59%, indicating that it does not supportthe growth of bacteria, fungi or yeasts, but contamination must be avoided byProper storage. Total ash measures the total amount of material remaining after ignition. This includes both "physiological ash" which comes from the plant tissue itself and "non-physiological ash" which is the residue of foreign bodies attached to the device. plant surface. Acid-insoluble ash is part of the total ash and measures the amount of silicait contains, especially as sandy and siliceous soils. Water soluble ash is the water soluble part oftotal ash. These ash values are important quantitative standards. The total ash, acid-solubleash, acid-insoluble ash, water-soluble ash and water-insoluble ash of Aracemosus root powder were found to be 7.83%, 6.10%, 1.73%, 2.67%, and 5.16%. , respectively. The calculated values are withinacceptable limits..[3].

The physicochemical evaluation of A. racemosus root powders was evaluated forproperties such as moisture content, ash content including total ash, water-soluble ash, acid-insolubleash, extract

values in various organic solvents of different polarities. Observations andresults of physicochemical studies are given in Table.[3]

- **Isolation of phytoconstituents by column chromatography**

  The butanolic extract was used for isolation using column chromatography by gradient elution using solvents of increasing polarity. A total of eighty seven fractions were collected from twelve different columns. The solubility profile and melting point of the isolated compounds were determined.

- **Determination of melting point and solubility profiles and isolated compounds**

  The isolated compounds were analyzed for their melting point using capillary tube and their solubilitiy in solvents such as methanol, ethanol, demineralized water, dimethyl sulfoxide and pyridine in the concentration of 2mg/ml was determined in order to facilitate their further analysis by HPLC and characterization.[6]

- **HPLC analysis of the isolated compounds**

  The isolated compounds were then subjected for the HPLC analysis for identification and purity assessment. A HPLC method was developed and standardized with the following parameters.

  Column : Chromosil column

  Mobile Phase : 50% Acetonitrile in HPLC water.

  Elution : Gradient

  Flow rate : 1 ml/ min & 1.5ml/min

  Detector : ELSD

  Injection volume : 100µl

  Instrument : Shimadzu

Quantification of isolated compounds in the differentparts of the same plant

The isolated compounds were used as markers for the estimation of extracts prepared from different parts ofShatavari by HPLC method.

HPLC Analysis: Quantification of saponin content pre- and post-encapsulation.[6].

- **Differential Scanning Calorimetry (DSC):** To study thermal behavior and interactions between saponins and milk components.
- **Scanning Electron Microscopy (SEM):** Visualizing the morphology and structure of the encapsulated particles.

Stability Studies:

- **Long-Term Stability Testing:** Monitoring stability under various conditions (temperature, humidity, light exposure) over an extended period.[14,15]

Degradation Kinetics:

- **Determining the degradation rate to establish shelf-life.**

Comparative Analysis:

Comparing the performance of the formulated carrier system with unencapsulated saponins or standard formulations to assess superiority.

The methodology involves a combination of extraction, formulation development, characterization, evaluation, and analysis stages, utilizing specific materials and techniques tailored to assess the stability and efficacy of the milk-based carrier system for steroidal saponins from Satavari.

In the exploration of "Milk-Based Spray-Dried Carrier Systems for Enhancing Stability of Steroidal Saponins from Satavari," the study unveils promising strategies and evaluation methods aimed at enhancing the stability and efficacy of these bioactive compounds.

Formulation Strategies:

Optimized Encapsulation: The study highlights the successful encapsulation of steroidal saponins using milk-based carriers via spray-drying techniques.

Ratios and Parameters: Determination of optimal ratios of saponins to milk components and fine-tuning of spray-drying parameters for maximum stability without compromising bioactivity.

Evaluation Techniques:

Analytical Rigor

Utilization of HPLC, SEM, and DSC to quantitatively assess encapsulation efficiency, visualize morphology, and study thermal interactions, validating the successful formulation.

Stability Enhancement:

Extended Shelf-Life:

Demonstrated prolonged stability of encapsulated saponins under varied storage conditions, indicating enhanced preservation compared to non-encapsulated forms.

Reduced Degradation Kinetics

Established slower degradation rates, elucidating the formulation's potential for an extended shelf-life and commercial viability.[2]

CONCLUSION

The study signifies a pivotal advancement in enhancing the stability of steroidal saponins from Satavari through the development of a robust milk-based carrier system. The optimized formulation strategies, coupled with comprehensive evaluation methods, affirm the efficacy and stability of the encapsulated saponins. The extended shelf-life, sustained bioactivity, highlights

the potential translational impact of this formulation in pharmaceutical or nutraceutical applications.

The study highlights the potential benefits for breastfeeding women. Satavari, known for its traditional use in supporting lactation, contains steroidal saponins believed to have galactagogue properties, potentially aiding in milk secretion for breastfeeding women. The encapsulation of these compounds within milk-based carriers may offer a controlled and potentially more effective delivery system for these compounds.

Future research could delve specifically into the impact of encapsulated steroidal saponins on milk secretion in breastfeeding women, If confirmed, these formulations could offer a novel and potentially more stable form of support for lactating mothers seeking to enhance milk secretion.

However, cautionary considerations include safety and dosage for lactating women, as well as regulatory compliance. Any products targeting breastfeeding women must meet stringent safety and regulatory standards to ensure their suitability for this sensitive demographic. The study's primary emphasis on stability enhancement and efficacy of steroidal saponins from Satavari indirectly hints at the potential implications for breastfeeding women. This research lays a solid formulation for further exploration and commercial development, emphasizing the viability of milk-based carrier systems as a means to safeguard the stability and efficacy of sensitive bioactive compounds like steroidal saponins from Satavari. This Plant has developed as a drug by pharmaceutical industries. The Uniformity of quality and quantity both are prime important for this

Medicinal plant as it depends on active principle in it.

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