

STUDIES ON POLY HERBAL POWDER SHAMPOO FOR THE TREATMENT OF *PEDICULOSIS CAPITIS* AND *PITYRIASIS CAPITIS* INFESTATIONS

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ABSTRACT

Objective: The main objective of this study was to the formulation containing polyherbal medicinal plants, which gives safety, and efficacy; rectify skin disease, scalp disorders and reducing the harmful effect from herbal anti-lice and dandruff shampoos for the treatment of *Pediculosis capitis* and *Pityriasis capitis* and to prevent hair fall.

Methods: The formulation of herbal shampoo with various herbal ingredients were dried, milled, sieved (120#) and mixed in geometrical order and evaluated their physicochemical characteristics. Furthermore, particle characters, organoleptic properties, foaming index, skin irritation study, and Anti-lice activity were performed.

Results: The prepared poly herbal powdered shampoo (PHPS) exhibits that was freely soluble, particle 20-25 µm size range and free-flowing powder. Least moisture content (2.5%), ash value, acid value and reduced surface tension of liquid are referred as an ideal candidate for foaming, anti-lice potential with no skin irritations.

Conclusion: Based on the evaluation parameters, the prepared powdered shampoo helps to remove hair grease, no hair fall and strengthen hair follicles. Preparation of PHPS formulation at laboratory scale and the compounding of several ingredients of herbal source have produced it possible to ensure safety, efficacy and secure highly effective PHPS.

Keywords: *Pediculosis capitis*, *Pityriasis capitis*, Polyherbal powder, Shampoo, Anti-lice activity

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INTRODUCTION

Pediculosis capitis and *Pityriasis capitis* (head lice) is one of the most common ecto-parasitic infestations. It is widely affected, with youngsters aged 6 to 13 y being the most prevalent sufferers. The youngster may experience significant social anguish, discomfort, parental anxiety, and humiliation as a result of *pediculosis capitis*. *Pityriasis capitis* is a common scalp disorder, and it is a chronic dermatitis of this condition and tendency to relapse makes it difficult to manage for people suffering from this fungal infection in the form of flaky white to Yellowish scales. Yeast is a kind of organism that lives *Malassezia furfur* is the principal dandruff-producing bacteria, and its lipase activity distributes free fatty acids into the skin, causing irritation and tissue damage [1].

Malassezia restricta and *Malassezia globosa* are fungi that produce *pityriasis capitis* (dandruff infestation). *Malassezia*, formerly known as *Pityrosporum*, is a yeast that causes skin and scalp infections [2].

The *Pediculosis capitis* and *Pityriasis capitis* are commonly afflicted with adolescents and the overall prevalence was 16.5% and 17.1%, respectively. The natural composition of the herbs has no negative effects on the human body but instead enriches it with nutrients and other beneficial minerals [3]. Present study is to examine the pediculicidal infestation like lice and dandruff in the scalp and the main objective was poly herbal powder shampoo (PHPS) containing shikakai, henna, reetha, Indian gooseberry, hibiscus, Avaram senna, vetiver roots, neem, curry leaves bringraj and rose flowers with on safety, efficacy which will rectify the problem of sebaceous disorders, skin-scaling disorders and economically reduce manufacturing cost. The Shikakai (*Acacia concinna linn*) is a medicinal plant; the fact; that the pods of this plant are known to contain many saponins based on acacia acid, prior chemical

examinations only resulted in the discovery of flavonoid and mono terpenoids for the Indian herbal sector [4].

The Henna (*Lawsonia inermis*) plants is useful to treat plant, animals and humans diseases from the ancient period and other herbal plants like Vetiver, curry leaves (*Murraya koenigil*), Bringraj (*Eclipta 127oliates127*) and Rose flowers (*Rosa Gallica offinalis*) which gives as strengthens hair follicles, coolant, conditioning and fragrance [5]. Reetha (*Sapindus 127oliates Linn, Sapindaceae*), which is known as soapnut and it is used as antibacterial, antifungal and insect repellent, etc. Amla, often known as Indian Gooseberry (*Emblica officinalis Gaertn, Euphorbiaceae*), is a traditional and neglected Indian fruit with enormous potential for marginal klaste land production.

The fruits are nutrient-dense and, after Barbados cheerful, the greatest source of vitamin C among fruits [6]. Methi (*Trigonella foenum-graecum l*) is a kind of fenugreek (*Trigonella foenum-graecum l*). It is a leguminous, herbaceous, rained crop and its use in the treatment of both internal and external swellings burns and prevents hair falling [7]. Hibiscus (*Hibiscus rosa sinensis, Malvaceae*) is helps in hair growth, soft and glossiness. The red flowered variety is preferred in medicine [8].

Avaram Senna (*Cassia auriculata linn*), commonly known as Tanner's Cassia is wild and perennial plant. Cassia species are well known for their laxative, purgative constituents and used for skin diseases [9]. Neem is a life-giving tree, especially in the arid coastal and southern areas, and it is used medicinally as an antibiotic, antiseptic, and to treat head lice. It also possesses insecticidal and spermicidal effects and hence kills a wide variety of organisms [10].

Based on the literature, out of 940 study subjects from govt. schools, aged between 8 and 3 y, 156 subjects (16.5%) were found

to be infested with head louse [11] relatively, Malaysian study reported that, among Hulu Langat school children aged 7–12 y were afflicted with *Pediculus capitis*, overall prevalence was 15.3%. The frequency of *pediculus capitis* was expressively developed among females (28.5%) than males (3.8%) [12]. In UAE study reported that, among 717 subjects, 328 subjects were afflicted with adolescent age and the overall prevalence was 46% having *Pityrosis capitis*. This prevalence was higher in males than females, as reported by Reza Ul Karim *et al.* and another study were reported that overall 17.1% (18–50) age people were affected with *Pityrosis* [13, 14].

MATERIALS AND METHODS

Collection of plant materials

Fresh parts shikakai, neem, curry leaves, rose flowers, henna leaves and reetha were collected from the medicinal garden, College of Pharmacy, Indra Ganesan Institute of Medical Sciences, Tamil Nadu, India. Remaining plant materials such as dried Indian gooseberry, fenugreek seeds, hibiscus and avaram senna were collected from Maisha Nursary Garden, Tiruchirappalli, India. Vetiver and Bringraj were purchased from Mufeez Ayurvedic store, Tiruchirappalli, India. List of ingredients was used in the preparation of PHPS shown in table 1.

Table 1: List of ingredients were used in the preparation of PHPS

S. No.	Ingredients	Botanical name	Medicinal use
1	Shikakai	Dried pods of <i>Acacia concinna</i> (<i>Mimosaceae</i>)	Pod extract is used to clean and manage dandruff in the hair.
2	Henna	Dried leaves of <i>Lawsonia inermis</i> (<i>Lythraceae</i>)	Nourishing and conditioning
3	Reetha	Dried fruits of <i>Sapindus mukorossi</i> (<i>Sapindaceae</i>)	Natural foam detergent
4	Indian Gooseberry	Dried ripe fruits of <i>Emblica officinalis</i> (<i>Euphorbiaceae</i>)	Prevents premature growing of hair
5	Fenugreek	Dried seeds of <i>Trigonella foenum-graecum</i> (<i>Leguminosae</i>)	Cure for only scalp and dermatitis
6	Hibiscus	Dried leaves of <i>Hibiscus roseus</i> (<i>Malvaceae</i>)	Hair growth
7	Avaram Senna	Dried flowers of <i>Senna auriculata</i>	Anti-Bacterial
8	Vetiver	Dried roots of <i>Zizanioides damascene</i>	Psoriasis and dandruff
9	Neem	Dried leaves of <i>Azadirachta indica</i> (<i>Meliaceae</i>)	Anti-lice and dandruff
10	Curry	<i>Murraya koenigil</i>	Strengthens hair follicles
11	Bringraj	<i>Eclipta Prostrata</i>	Strengthens hair follicles
12	Rose	<i>Rosa Gallica officinalis</i>	Flavouring and conditioning

Preparation of PHPS

Three formulations F1, F2 and F3 were prepared by different compositions at laboratory scale. All the formulations, herbal ingredients were individually dried in the shade, grinded and sieved (120#). The accurately weighed sufficient quantities of crude drugs were mixed in geometrical order, stored in a well-closed container and evaluate for further examination [15].

Evaluation of PHPS

Solubility

Accurately weighed 1g of shampoo powder and shifted into a beaker consist of 100 ml of water and solubilized in water. Slightly obtained residue weighed and recorded the residual amount. The organoleptic evaluation and visual appearance of formulated powder shampoo were measured parameters like colour, nature, odour and texture.

General characteristics of PHPS

Particle size determination was determined according to IP standard sieving method [16]. Angle of repose study was performed as per Indian Pharmacopoeia, the present study of the formulations was determined by glass funnel method. Weighed accurately and transferred in a funnel. The funnel's height (h) was adjusted to the point when the funnel's tip just touches the summit of the powder heap. The powder was able to flow freely through the funnel onto the surface. The diameter of the powder cone was measured and the following equation was used to determine it.

$$\theta = \tan^{-1} (h/r), \text{ Where } h = \text{Height of the pile formed, } r = \text{the radius of the base of pile.}$$

Bulk density

The bulk density (LBD) and tapped bulk density (TBD) of each formulation's powders were determined. A 100 ml graduated measuring cylinder was previously carefully shaken to shatter any agglomerates created [17]. After the initial volume was determined, the cylinder was allowed to fall from a height of 2.5 cm onto a hard surface under its own weight at 2-second intervals. The taps were kept going until there was no further fluctuation in loudness. The powder's weight Bulk density (pb) equals the powder's bulk volume. The powder's tapped density (p_t) equals the powder's tapped volume.

Physicochemical evaluation

The ash value was determined for quality and purity of herbal shampoo powder and to establish the identify it. The total ash was calculated by weighing 10 g of PHPS was transferred in tarred silica crucible and placed in a muffle furnace (Carbolite Gero Ltd, Hyderabad, India) at 1400 °C cooled until carbon-free, then computed the overall percentage of Ash.

$$\text{Total ash value of the powder shampoo} = 100(z-x)/y \%$$

Total ash was boiled for 5 min with 25 ml of 0.1N HCl, insoluble materials was kept on the filter paper, transferred to a grooch crucible, rinsed with hot water, ignited, and the percentage of total acid insoluble ash was computed [18].

$$\text{Acid-insoluble ash value of the powder shampoo} = 100 \times a/y \%$$

Moisture content, pH and washability

The 10 g of powder shampoo was transferred in a petri-dish and placed in Halogen Moisture Analyzer HX204 (shimazu, Jappan) for 300 °C for 15 min; after the time completion, loss on moisture has calculated the percentage of moisture content. The 10 % w/v shampoo solution pH was determined using digital pH Meter (Sigma, India). The ready-to-use formulations were applied to the skin/hair, and the ease and extent of water washing were manually assessed [19].

Foaming Index, hair shininess and Dirt dispersion

Foam stability test was used to compute the foaming index of the designed shampoos, which involved weighing 4g of shampoo powder with 100 ml water in a graduated cylinder for various time intervals and measuring the height of foam [20]. The nature of hair was evaluated by putting a tiny amount of herbal shampoo powder formulations to hair and then washing it. In a large test tube containing 10 ml of distilled water, two drops of each 1 percent herbal shampoo powder formulation were transferred [21]. After adding a drop of Indian ink, the test tubes were sealed and shook. The amount of ink in the foam was measured and classified as either none, moderate, or heavy.

Skin/eye irritation test and anti-lice activity

The skin/eye irritation tests exposed that the PHPS gives no side effect on the skin/eye. In many synthetic surfactants producing

irritation and causes itching to the skin/eye. All herbal substances collected naturally are used in the current study composition. As a result, it has no negative effects on the skin or eyes [22]. Anti-lice action was tested on all of the formulations by introducing fifteen live lice in Petri plates containing 1 ml of 10% of the formulation [23]. The time it took the final lice to die (death was defined as the lack of limbs and gut, as well as the inability to respond when the legs were stroked with forceps) was measured and recorded.

Solids contents and surface tension

Weighed 6g of powdered shampoo (semisolid content), transferred into clean dry evaporating dish, and placed into hot plate, evaporated and then dried. Retained sample was calculated of solid content of shampoo [24]. The surface tension of 10% V/V shampoo was evaluated using chromic acid and purified water in a staglomer. Because grease or other lubricants have a significant impact on surface tension [25]. The following equation was used to calculate the data:

$$\eta_2 = (W3-W1) N1 \times \eta_1 / (W2-W1) N2$$

Where W1 denotes the weight of an empty beaker, W2 is the weight of a beaker filled with distilled water, and W3 denotes the weight of

a beaker filled with a shampoo solution. N1 is the number of droplets of distilled water, whereas N2 denotes the number of drops of shampoo solution. The surface tension of distilled water at room temperature is one, whereas the surface tension of shampoo solution is two.

Stability studies

According to ICH guideline, PHPS was tested with required storage conditions of 25–30 °C with RH 60%. Their physical stability was inspected at every month intervals up to three months.

RESULTS AND DISCUSSION

Formulation of PHPS

Formulations (F1–F3) of PHPS were prepared by using different proportions (all required quantities for 100 g) of the plant ingredients (table 2). The evaluations of organoleptic properties were found brownish-green in colour; fine in powder, characteristic odour, smooth and soft texture. Powdered shampoo was freely soluble in water. This present study report was favorable with another Indian study by Muthu *et al.* 2019 [10]. Organoleptic evaluation study findings revealed that, brownish-green in colour, fine powder in nature, characteristic odour, smooth and soft texture.

Table 2: Preparation of different formulations were used in the PHPS

S. No.	Herbal components	F1 (%)	F2 (%)	F3 (%)
1	<i>Acacia Concinna</i>	34.4	39.3	-
2	<i>Lawsonia inermis</i>	11.0	14.0	22.5
3	<i>Sapindus mukorossi</i>	11.1	-	22.5
4	<i>Phyllanthus emblica</i>	5.2	8.4	15.8
5	<i>Trigonella foenumgraecum</i>	11.0	11.2	-
6	<i>Hibiscus rosea sinesis</i>	4.1	5.6	7.8
7	<i>Senna auriculata</i>	2.30	3.37	6.1
8	<i>Zizanioides damascene</i>	2.30	4.12	5.2
9	<i>Azadirachta indica</i>	3.40	3.37	-
10	<i>Murraya koenigil</i>	2.20	-	5.6
11	<i>Eclipta Prostrata</i>	11.0	6.74	8.9
12	<i>Rosa Gallicaoffinalis</i>	2.0	3.9	5.6

Table 3: Various evaluation parameters of PHPS

S. No.	Evaluation parameters	Formulations (Observation)		
		F1	F2	F3
1.	Solubility	Easy to dissolve in water	Easy to dissolve in water	Easy to dissolve in water
2.	Organoleptic Evaluation			
	Colour	Brownish Green	Brownish Green	Brownish Green
	Nature	Fine Powder	Fine Powder	Fine Powder
	Odour	Characteristic	Characteristic	Characteristic
	Texture	smooth	soft	Soft
3.	General Powder characteristics			
	Particle size (µm)	20-25	20-25	20-25
	Angle of Repose (°)	36.76	36.95	36.08
	Bulk density (g/cm ³)	0.3454	0.3319	0.3560
	Tapped density (g/cm ³)	0.3800	0.3714	0.4055
4.	Physicochemical evaluation			
	Ash value (% w/w)	4.5	3.0	3.2
	Acid insoluble Ash (% w/w)	1.87	1.0	1.4
	Moisture content (%)	2.5	3.5	3.2
	Solid content (%)	26.39	27.12	26.8
5.	pH	5.62±0.21	5.75±0.3	5.43±1.07
6.	Washability	25±0.22	29±0.10	31±0.31
7.	Foaming Index	Good	Moderate	Moderate
8.	Hair Conditioning/Nature	Soft	Manageable	Manageable
10.	Dirt dispersion	Good	Moderate	Moderate
11.	Surface tension (dyne. cm ⁻¹)	32.68±0.54	34.45±0.66	37.34±0.02

Physicochemical outcome

Total Ash value and acid-insoluble value for the formulations F1, F2, and F3 was exhibits as 4.5, 3.0 and 3.2 %w/w and 1.87, 1.0 %, and 1.4 % w/w, respectively. The moisture content was 2.5, 3.5, and 3.2 %, pH, and wash ability was determined as 5.6±1.5, 7±1.0 and 7±1.0 and 25±0.22, 29±0.10 and 31±0.31 for the formulations F1, F2, and

F3 respectively. These results was complied with the previously worked from Raffick *et al.* (2012) [20].

PHPS characteristics

The particle size was observed to be 20–25 µm of all the prepared formulations, the angle of repose F1, F2 and F3 was 36.76, 36.95 and

36.08 °respectively shows the good flow properties of PHPS. The bulk and tapped density was estimated to be 0.3444, 0.3319, and 0.3560 and 0.3800, 0.3710 and 0.4055 g/cm³ with the respective formulation F1–F3 (table 3). These study results was supported by Prashant (2015) reported that the active ingredients of these drugs like dried shikakai, hibiscus flowers and leaves, Avaram senna, vetiver, neem leaves, curry leaves, bhring raj and rose flowers of these drugs when integrated in shampoo producing with the better glossy beautifying properties [21]. It was produced for medicinal usage of foaming, hair growth, natural hair dye, good fragrance, conditioner and treatment for lice and *Pityrosis* (dandruff).

The moisture content was found to be range between 2.5 and 3.5% w/w for all the formulations, which is similar to the study conducted by Mohamed *et al.* (2012) and the average pH range found to be 5.8, but our findings are in contradiction with a study reported that 7.0±1.2 [26]. The resultant shampoo pH was reported to be

significant for more vigorous and raising the shinningness of hair, insignificant the irritation of the eyes and the restoration of the scalp's ecological balance. The finding of the solid content study shown that, formulated PHPS were using poly herbal extract was found to be having solid contents of 26.5% and it is significant that it can be washed out easily, Vasudevan *et al.* (2021) similarly (26.42%) reported and it was supported by our arguments [27].

Foaming Index and skin irritation study

The height of foaming capacity for F1, F2 and F3 had 185, 142 and 165 cm respectively with initial and end of 20 min shown in 153, 119, and 142 cm (table 4). The F1 shampoo powder having good foaming capacity, this is due to the presence of shikakai, reetha, fenugreek seed powder and hibiscus. Formulation F2 had moderate foaming capacity because absence of Reetha and F3 had better foaming capacity because presence of reetha and absence of shikakai and fenugreek seed powder.

Table 4: Foaming Index of PHPS with various time intervals

S. No.	Time (min)	Foam volume (in ml)		
		F1	F2	F3
1	0	185	142	165
2	1	181	140	162
3	2	177	138	159
4	3	175	133	157
5	4	172	132	154
6	5	160	126	153
7	10	157	122	148
8	20	153	119	142

Study findings shown in table 4, formulation F1 shampoo powder having good foaming capacity; this is due to the presence of shikakai, reetha, fenugreek seed powder and hibiscus. Those medicinal plants are having good foaming property naturally, which produces satisfactory results [28]. Formulation F2 had moderate foaming capacity because the absence of reetha and F3 had better foaming capacity because presence of reetha and absence of shikakai and fenugreek powder. Formulation F1 were found to be good foaming index and dirt dispersion. There was no eye irritation found for all the three formulations and remaining formulations F2 and F3 was found to be moderate foaming Index and dirt dispersion. After washes, nature of hair observed by volunteers responses and results were soft, manageable and no harmful effect on the skin and hair.

Anti-lice action

Examined by means of live lice and measured the fainting time. The formulations' fainting time was found to be 5 min, which was equivalent.

The time it took for the last lice to die was measured and recorded. Formulation (F1) were produced satisfactory consequence which is giving good aesthetic feel like effective, safety, dirt dispersion, no hair fall as well as surveillance study were conducted with 20 volunteers aged around 17–21 y, who affected with Head lice and dandruff, and 89% of participants hairs found to be the result was completely removed lice [29]. Dandruff cannot be totally eradicated, however, it may be properly managed and controlled.

Table 5: Data on the assessment of stability studies for PHPS formulation (F1)

Evaluation parameters	Initial	1 Mo	2 Mo	3 Mo
Colour	Brownish Green	Brownish Green	Brownish Green	Brownish Green
Odour	Pleasant	Pleasant	Pleasant	Pleasant
Transparency	Thick	Thick	Thick	Thick
pH	6.6±0.5	6.5±0.5	6.4±0.5	6.5±0.5
Solid content (%)	25.75±2	25.75±2	25.55±2	25.35±2
Foaming height (cm)	185	184	180	183
Surface tension (dyne. cm ⁻¹)	32.68±0.54	33.22±0.42	34.32±0.41	34.67±0.71

Stability of PHPS

Stability studies were tested for selected formulation (F1) PHPS only, because F1 gives good foaming Index and potential anti-lice activity. The findings suggested that they are chemically and physically stable over the storage period [30] and table 5 shows the stability of the PHPS formulation.

CONCLUSION

The prepared PHPS might be suitable for the treatment of *pediculosis capitis* and *pityriasis capitis* infestations. Based on the findings, the PHPS shown potential effective on anti-lice activity. The physicochemical evaluation concluded that the appropriate foaming properties and powder characteristics has been proven that the F1 preparation was ideal formulation throughout. Hence, usage of cleansing of prepared herbal cosmetics shampoo was not producing

any side effects and no hair fall. Medicinal plants were helps to cure skin disease, scalp disorders, glossiness and economically is better usage for all people.

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AUTHORS CONTRIBUTIONS

All the authors are contributed equally.

CONFLICTS OF INTERESTS

The authors declare that there are no conflicts of interest.

REFERENCES

- Nikam NR, Patil PR, Jadhav RP, Vakhariya RR, Magdum CS. Formulation and evaluation of herbal shampoo: a comparative study. *Res J Top Cosmet Sci.* 2019;10(2):61-4. doi: 10.5958/2321-5844.2019.00013.X.
- Shuster S. The aetiology of dandruff and the mode of action of therapeutic agents. *Br J Dermatol.* 1984;111(2):235-42. doi: 10.1111/j.1365-2133.1984.tb04050.x. PMID 6235835.
- Mohamed JMM, Alqahtani A, Ahmad F, Krishnaraju V, Kalpana K. Stoichiometrically governed curcumin solid dispersion and its cytotoxic evaluation on colorectal adenocarcinoma cells. *Drug Des Dev Ther.* 2020 Nov 2;14:4639-58. doi: 10.2147/DDDT.S273322. PMID 33173275, PMID 33173275, PMID 33173275.
- Victor AD, Prasad M, Mohanasundaram S. Biological active compounds with various medicinal values of strychnos nuxvomica—a pharmacological summary. *J Glob Trends Pharm Sci.* 2016;7(1):3044-7.
- Jamal Moideen MM, Alqahtani A, Venkatesan K, Ahmad F, Krishnaraju K, Gayasuddin M. Application of the Box-Behnken design for the production of soluble curcumin: skimmed milk powder inclusion complex for improving the treatment of colorectal cancer. *Food Sci Nutr.* 2020 Oct 30;8(12):6643-59. doi: 10.1002/fsn3.1957, PMID 33312548, PMID 33312548, PMID 33312548.
- Anil K, Ashatha S. Review on hibiscus rosa sinensis. *Int J Res Pharm Biomed Sci.* 2012;3(2):534-8.
- Mohamed JM, Alqahtani A, Ahmad F, Krishnaraju V, Kalpana K. Pectin co-functionalized dual layered solid lipid nanoparticle made by soluble curcumin for the targeted potential treatment of colorectal cancer. *Carbohydr Polym.* 2021 Jan 15;252:117180. doi: 10.1016/j.carbpol.2020.117180. PMID 33183627.
- Jaishetty N, Palanisamy K, Maruthapillai A. Enantiometric separation of sitagliptin in a fixed-dose combination formula of sitagliptin and metformin by a chiral liquid chromatographic method. *Int J Pharm Pharm Sci.* 2019;11(6):66-71. doi: 10.22159/ijpps.2019v11i6.22699.
- Jaishetty N, Palanisamy K, Maruthapillai A, Jaishetty R. Trace level quantification of the (-)-2-(2-amino-5-chlorophenyl)-4-cyclopropyl-1,1,1-trifluoro-3-butyn-2-ol genotoxic impurity in efavirenz drug substance and drug product using LC-MS/MS. *Sci Pharm.* 2015 Oct 18;84(3):456-66. doi: 10.3390/scipharm84030456, PMID 28117312, PMID 28117312, PMID 28117312.
- Bharathi P, Elavarasi N, Mohanasundaram S. Studies on rate of biodegradation of vegetable oil (Cocunut oil) by using *Pseudomonas* sp. *Int J Environ Biol.* 2012;2(2):12-9.
- Mohamed JMM, Alqahtani A, Al Fatease A, Alqahtani T, Khan BA, Ashmitha B. Human hair keratin composite scaffold: characterization and biocompatibility study on NIH 3T3 fibroblast cells. *Pharmaceuticals (Basel).* 2021 Aug 9;14(8):781. doi: 10.3390/ph14080781, PMID 34451878, PMID 34451878, PMID 34451878.
- Narendhiran S, Mohanasundaram S, Arun J, Saravanan L, Catherine L, Subathra M. Comparative study in larvicidal efficacy of medicinal plant extracts against *Culex quinquefasciatus*. *Int J Res Plant Sci.* 2014;4(1):22-5.
- Mohamed JMM, Alqahtani A, Khan BA, Al Fatease A, Alqahtani T, Venkatesan K. Preparation of a soluble complex of curcumin for the potential antagonistic effects on human colorectal adenocarcinoma cells. *Pharmaceuticals (Basel).* 2021 Sep 19;14(9):939. doi: 10.3390/ph14090939, PMID 34577638, PMID 34577638, PMID 34577638.
- Mohanasundaram S, Victor AD, Prasad M, Magesh R, Sivakumar K, Subathra M. Pharmacological analysis of a hydroethanolic extract of *Senna alata* (L.) for *in vitro* free radical scavenging and cytotoxic activities against Hep G2 cancer cell line. *Pak J Pharm Sci.* 2019;32(3):931-4.
- Mohamed JMM, Ahmad F, Alqahtani A, Alqahtani T, Raju VK, Anusuya M. Studies on preparation and evaluation of soluble 1:1 stoichiometric curcumin complex for colorectal cancer treatment. *Trends Sci.* 2021;18(24):1403. doi: 10.48048/tis.2021.1403.
- Nille GC, Mishra SK, Chaudhary AK, Reddy KRC. Ethnopharmacological, phytochemical, pharmacological, and toxicological review on *Senna auriculata* (L.) Roxb.: A special insight to antidiabetic property. *Front Pharmacol.* 2021 Aug 24;12:647887. doi: 10.3389/fphar.2021.647887, PMID 34504420, PMID 34504420, PMID 34504420.
- Mohanasundaram S, Rangarajan N, Sampath V, Porkodi K, Prakash MVD, Monicka N. GC-MS identification of anti-inflammatory and anticancer metabolites in edible milky white mushroom (*Calocybe indica*) against human breast cancer (MCF-7) cells. *Res J Pharm Technol.* 2021;14(8):4300-6.
- Muthu JM, Ahmad F, Kishore N, Al-Subaie AM. Soluble 1: 1 stoichiometry curcumin binary complex for potential apoptosis in human colorectal adenocarcinoma cells (SW480 and Caco-2 cells). *Res J Pharm Technol.* 2021;14(1):129-35. doi: 10.5958/0974-360X.2021.00023.8.
- Kumar JA, Ramkanth S, Prabu LS, Gopal V. Enhancement of saturation solubility and *in vitro* dissolution of carvedilol nanoparticles by high-pressure homogenization technique. *Int J Curr Pharm Rev Res.* 2015;6(6):269-73.
- Raffick MM, Mohamed JM, Vetrivelvan S, Vignesh M, Selvakumar K, Parkavi V. Preparation and evaluation of *in vitro* release kinetics of novel bilayer metoprolol succinate as sustained release and amlodipine besylate as immediate-release tablets. *Int J Biol Pharm Res.* 2012;3(2):285-97.
- Mohanasundaram S, Rangarajan N, Sampath V, Porkodi K, Pennarasi M. GC-MS and HPLC analysis of antiglycogenolytic and glycogenic compounds in kaempferol 3-O-gentiobioside containing *Senna alata* L leaves in experimental rats. *Transl Metab Syndr Res.* 2021;4:10-7. doi: 10.1016/j.tmsr.2021.07.001.
- Halith SM, Abirami A, Jayaprakash S, Chitra K, Pillai KK, Firthouse PU. Effects of *Ocimum sanctum* and *azadiracta indica* on the formulation of antidandruff herbal shampoo powder. *Pharm Lett.* 2009;1(2):68-76.
- Janakiraman AK, Sumathi B, Saleem TM, Ramkanth S, Kumar PO, Venkatachalam G. Design and evaluation of carvedilol nanocrystals sustained-release tablets. *J Appl Pharm Sci.* 2017;7(4):61-8.
- Victor AD, Mohanasundaram S, Prasad M. Analysis of hydroethanolic extract of *Senna alata* (L.) to screen bioactive compounds with inhibitory activity on lipid peroxidation, *in vitro* antibacterial and antidiabetic efficacy. *Int J Pharm Sci.* 2016;6(1):1360-6.
- Mainkar AR, Jolly CI. Evaluation of commercial herbal shampoos. *Int J Cosmet Sci.* 2000 Oct;22(5):385-91. doi: 10.1046/j.1467-2494.2000.00047.x. PMID 18503425.
- Mohamed JM, Bharathidasan P, Raffick MM. Preparation and development of curcumin magnetic nanopresuspension using magnetite (Fe₃O₄) and methylcellulose. *Int J Pharm Biol Sci.* 2012;3(4):419-32.
- Vasudevan K, Krishnapriya AS, Vijay VV, Thasny PPS. Formulation, evaluation, and comparison of polyherbal shampoo with commercial herbal shampoos. *Int J Pharm Res Appl.* 2021;6(1):137-45. doi: 10.35629/7781-0601137145.
- AlQuadeib BT, Eltahir EKD, Banafa RA, Al-Hadhairi LA. Pharmaceutical evaluation of different shampoo brands in local Saudi market. *Saudi Pharm J.* 2018 Jan;26(1):98-106. doi: 10.1016/j.jsps.2017.10.006. PMID 29379340, PMID 29379340, PMID 29379340.
- Rassami W, Soonwera M. *In vitro* pediculicidal activity of herbal shampoo base on Thai local plants against head louse (*Pediculus humanus capitis* De Geer). *Parasitol Res.* 2013 Apr;112(4):1411-6. doi: 10.1007/s00436-013-3292-8. PMID 23334727.
- Mohamed JMM, Alqahtani A, Kumar TVA, Fatease AA, Alqahtani T, Krishnaraju V. Superfast synthesis of stabilized silver nanoparticles using aqueous allium sativum (garlic) extract and isoniazid hydrazide conjugates: molecular docking and *in vitro* characterizations. *Molecules.* 2021 Dec 24;27(1):110. doi: 10.3390/molecules27010110, PMID 35011342, PMID 35011342, PMID 35011342.