

Original Research Article

Herbal conjugation for increased binding of zinc pyrithione on hair: new treatment approach

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ABSTRACT

Background: Fungal infections of scalp and hair are common now-a-days and emerging. There are various medicaments for scalp mycosis. Shampoos attained importance due ease of use. But they underperform or perform poorly due to the likely short contact time as most of them are wash off products. Selective binding of the anti-fungal agents over hair in short contact time alone can address the problem of scalp mycosis.

Methods: AAS was done to establish the adhesion of anti-fungal agents over hair and the rate of fungal colonization over hair and the extent of hair perforation were used to establish the effect of herbal conjugation in providing anti-fungal activity and blocking the parasitic conversion of fungi.

Results: Zinc adhesion was significant in Verdura anti scaling scalp shampoo and zinc pyrithione treated and no colonization and perforation was observed in Verdura anti scaling scalp shampoo and zinc pyrithione treated hair samples.

Conclusions: Present study deals with the importance of herbal conjugation technology in enhancing the targeted delivery of zinc pyrithione over hair. The present technology is important for achieving greater anti-fungal benefits from wide range of toiletry preparations due to their short contact time.

Keywords: Dandruff, Zinc pyrithione, Hair perforation test, Fungal colonization, Herbal, Fungal infections, Anti-dandruff shampoo

INTRODUCTION

Fungal infections of scalp and hair are emerging globally due to the upsweep change in the lifestyle, scalp care, pollution burden in the ecosystem and the use of various hair care products.¹ The anti-fungal drug resistance also contributes to the above problem.²

Among the various fungal infections of the scalp, the prevalence of dandruff and dermatophytosis are reported to be on increase irrespective of the gender and age.³ Several anti-fungal preparations are available for the

scalp mycosis. Among various medicaments, anti-fungal scalp lotions and shampoos have attained greater importance due to the usage convenience of these products. Although such preparations are loaded with high dose of anti-fungal drugs but still many such products underperform or perform poorly due to the likely short contact time as most of them are wash off products.⁴

Selective binding of the anti-fungal agents over hair in short contact time alone can address the problem of scalp mycosis. To ensure the above possibility the formulation engineering needs to be innovative and robust.

Verdura anti-scaling scalp shampoo has employed a novel trajectory to shoot and scoot the anti-fungal agents over the hair in short time.

To develop a novel trajectory to shoot and scoot the anti-fungal agents over the hair in short time and to evaluate the adhesion of actives and efficacy current study was done.

METHODS

Study period: April 2017- May 2017

Details of the test product: Verdura anti-scaling scalp shampoo

The above test product is the proprietary cosmetic formulation of Dr. JRK's Research and Pharmaceuticals Pvt Ltd, Chennai.

The formulation contains zinc pyrithione as major anti-fungal agent. The formulation also contains the extracts of *Wrightia tinctoria*, *Aloe vera* and *Cassia alata* as coupler to shoot the anti-dandruff agent over the hair and scalp.

Estimation of zinc in pretreated hair⁵

10 gm of healthy human hair (10 cm) was collected and washed thoroughly using distilled water. After drying 0.5 gm of hair was collected and was cut into small pieces. The hair pieces were subjected to acid digestion i.e. by treating in a solution containing 10 ml of conc. HNO₃, 3 ml of H₂O₂ and 5 ml of HCl. After which the solution was filtered and the filtrate was made up to 50 ml with distilled water and then it was sent to A To Z Pharmaceuticals Private Limited, Chennai for the estimation of zinc by AAS.

Treatment of hair with zinc pyrithione

0.5 gm of hair was taken and was washed with 0.5 gm of zinc pyrithione by allowing the contact time of 1 min. After which the hair was washed thoroughly with distilled water and dried and then subjected to acid

digestion as described above. The final filtrate was made up to 50 ml with water and sent to A To Z Pharmaceuticals Private Limited, Chennai for the estimation of zinc by AAS.

Treatment of hair with Verdura anti-scaling scalp shampoo

0.5 gm of hair was taken and was washed with 0.5 gm of Verdura anti-scaling scalp shampoo by allowing the contact time of 1 min. After which the hair was washed thoroughly with distilled water and dried and then subjected to acid digestion as described above. The final filtrate was made up to 50 ml with water and sent to A to Z Pharmaceuticals Private Limited, Chennai for the estimation of Zinc by AAS.

Fungal colonization over hair by hair perforation test⁶

The above pretreated hair samples (after washing but before acid digestion) viz.,

- Untreated hair
- Zinc pyrithione treated hair
- Verdura anti-scaling scalp shampoo treated hair

They were taken and placed in 1% yeast extract in a petri dish and were inoculated separately with the culture of *Trichophyton mentagrophytes* (granular form). The plates were incubated for 13 days and after which the hair sample were examined under microscope for the presence of wedge shaped perforations.

RESULTS

It was estimated that 1.2 mg of zinc was present in untreated 0.5 gm of hair (table-1). The zinc pyrithione treated hair shown greater level of zinc when compared to Verdura anti-scaling scalp shampoo (Table 1).

Neither the fungal colonization nor the perforation of hair was seen in the hair samples treated either with zinc pyrithione or Verdura anti-scaling scalp shampoo (table-2). Whereas the untreated hair showed high level of perforation and fungal colonization (Table 2).

Table 1: Estimation of Zinc by AAS.

S. No	Test products	Zinc in 0.5 gm of hair	Zinc quantity (mg/lit)
1	Untreated hair	1.2 mg	24.2
2	Zinc pyrithione treated hair	1.55 mg	31.03
3	Verdura anti-scaling scalp shampoo treated hair	1.36 mg	27.29

Table 2: Fungal colonization over hair by hair perforation test.

S. No	Test products	No. of perforations per hair/field
1	Untreated hair	8±1.3
2	Zinc pyrithione treated hair	Nil
3	Verdura anti-scaling scalp shampoo treated hair	Nil

DISCUSSION

The herbal conjugation technology adopted for shooting zinc pyrithione over hair has indeed shown greater binding of zinc pyrithione on the hair. In our previous study we have clearly demonstrated that the binding of the above anti-dandruff agent on the hair in the absence of *Wrightia tinctoria*, *Aloe vera* and *Cassia alata* complex was poor. This strongly suggests that the conjugation technology using some select herbs has a significant role in the delivery of zinc pyrithione. We are unsure of the exact mechanism that is responsible for such possibility. However, our study finding has clearly shown the imminent role of the herbs in such dramatic wonder.

The zinc estimation by AAS has clearly substantiated the above possibility. Our study also has established that herbal conjugation technology in shooting zinc pyrithione over hair is not a mere mechanical or physical phenomenon but it also translates to the anti-fungal benefit.

One-minute treatment of the hair with Verdura anti-scaling scalp shampoo was sufficient to offer complete protection from *Trichophyton mentagrophytes* as we could not find any fungal colonization or hair perforation. This strongly suggests that the micro adhesion of zinc pyrithione in the hair cuticle would have certainly limited the fungal colonization.

On the contrary, the hair that was not treated by Verdura anti-scaling scalp shampoo showed high level of characteristic wedge shaped perforation due to *Trichophyton mentagrophytes*. This might be due to the fact that the hair had not obtained the anti-fungal protection as they were not treated by Verdura anti-scaling scalp shampoo.

Hair perforation test assumes great importance as it denotes the parasitic behavior of the organism. In minimal essential medium when the dermatophytes is grown along with hair, certain species of dermatophytes produce perforating organs and would cause wedge shaped perforation in the hair.⁷ Largely the hair perforation test is used for species identification but it can also be stretched for studying the parasitic ability of dermatophytes.¹¹ The dermatophytes could not perforate Verdura anti scaling scalp shampoo treated hair which strongly suggests that the herbal conjugation technology besides exhibiting anti-fungal activity also may be affecting the parasitic conversion of dermatophytes. The above dual target mechanism of Verdura anti scaling scalp shampoo gains greater scientific importance in the context of the product being toiletry with very short contact time with hair and scalp.

In our separate experiment we have already established that Verdura anti-scaling scalp shampoo without the herbal actives such as *Wrightia tinctoria*, *Aloe vera* and *Cassia alata* did not offer protection to the hair during

perforation experiment. When the treatment time was increased to 15 min instead of one minute, the hair showed fungal resistance despite the Verdura anti-scaling scalp shampoo devoid of any herbal actives. In the absence of the above herbs, longer exposure time is required whereas when herbs are present such benefit could be achieved with short exposure time. This clearly reveals the importance of herbal conjugation technology in drug delivery.

In the present study we have estimated the presence of zinc as an indicator to establish the presence of zinc pyrithione. Every zinc molecule is conjugated with 2 pyrithione molecules. Therefore, the detection of every zinc molecule corresponds to the presence of two additional pyrithione molecules. It means the adhesion of the anti-fungal pyrithione molecule is likely to be two fold higher than the level of zinc molecule.^{8,9} How the herbal conjugation acts upon the complex zinc pyrithione is unclear. Whether it acts upon the zinc molecule or in the pyrithione ring we have not yet established in the present study.

It is already known that the herbs do chelate metals and inactivates several drugs.^{10,11} when such possibility is known, the scope of certain herbs potentiating the therapeutics of several molecules in enhancing their competitive binding onto the receptor site cannot be discounted.

CONCLUSION

The present study clearly shows the intelligent formulation engineering and wise selection of herbs such as *Wrightia tinctoria*, *Aloe vera* and *Cassia alata* has significantly increased the efficacy of zinc pyrithione. All these herbs are known to have enormous medicinal values and which are well documented in the sacred scriptures of Indian system of medicine. Further the stand alone anti-fungal benefits of these herbs and the possible synergistic potentiation of the efficacy between the herbs and zinc pyrithione also cannot be ruled out.

The study findings reiterate that the competitive binding of the actives on the target site is more important to achieve the treatment success than the concentration or the drug combination. Verdura anti scaling scalp shampoo is the best testimony to the above research extravaganza.

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Ethical approval: The study was approved by the institutional ethics committee

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