

## FORMULATION AND EVALUATION OF THE CHEMICAL STABILITY OF POVIDONE-IODINE IN SOME TRADEMARKS CLEANING FORMULATIONS

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### ABSTRACT

**Purpose:** The aim of this study is to evaluate the chemical stability of Povidone-Iodine (PVP-I) after its incorporation into commercial cleaning formulations.

**Method:** PVP-I was incorporated into five different trademarks of cleaning formulation designated F1 through F5. Chemical stability of PVP-I on months 0,1,2,3 and 4 was checked. pH, color, smell, and foam properties of the obtained cleaning formulations were tested.

**Results:** PVP-I in Shampoo (F1) and hair & body wash (F2) was stable for more than 4 months, while in the shower gel (F3) and liquid soap (F4) was stable within the limit period of three month. The body wash (F5) was stable for only one month. The pH of the formulations remains constant during the entire period of the study. The foam volume and stability was comparable to that obtained from the starting trademarks. No change in smell or color of the cleaning formulations was observed. No sign of precipitate was observed within the entire period of study.

**Conclusion:** Compounding PVP-I into cleaning trademarks in order to achieve disinfection and medical benefits can be followed. Cleaner industries should take seriously in consideration this issue to improve their selling.

**Keywords:** Povidone Iodine, Shampoo, Stability, Disinfection.

### INTRODUCTION

Several antiseptic agents are available in the pharmaceutical market and many others are under development due to the capacity of many microorganisms to develop resistance against these antiseptic agents [1,2]. Povidone-iodine (PVP-I) is a stable chemical complex of polyvinylpyrrolidone and elemental iodine (figure 1). It contains from 9.0% to 12.0% available iodine, calculated on a dry basis [1]. It has been demonstrated that bacteria do not develop resistance to PVP-I [2, 3]. Consequently, PVP-I has found broad application in medicine and so it has been formulated at concentrations of 7.5–10.0% in solution, spray, surgical scrub, ointment, and swab dosage forms for pre- and post-operative skin cleansing for the treatment and prevention of infections in wounds, ulcers, cuts and burns; in gynecology for vaginitis associated with candidal, trichomonal or mixed infections. Also, the utilization of PVP-I is potentially beneficial in the management of some periodontal diseases [4,5]. Povidone-iodine 1.25% ophthalmic solution is also effective in treating bacterial conjunctivitis [6]. Recently povidone-iodine has been incorporated into the field of nanotechnology as a wound-healing application [7, 8]. Furthermore, PVP-I has demonstrated its efficacy as potent antiviral agent. Indeed, PVP-I products have been found to be effective in inactivating a variety of viruses, such as polio, herpes simplex, herpes zoster, and human immune deficiency viruses [9,10,11,12]. Anti-influenza virus activity of PVP-I also has been reported recently [13,14,15]. Pretreatment of avian influenza H5N1, H5N3, H7N7 and H9N2 viruses with PVP-I products, such as solution, scrub, gargle and throat spray, in the range of 0.23–2%, reduced viral infectious titers to undetectable values [14]. Therefore the formulation of PVP-I into shampoo or hair and body liquid shower will be a good tool for personal hygiene and protection from contamination of several pathogenic microorganisms' especially avian influenza viruses. In fact, from hygiene point of view the availability in the cleaners market of such formulations offers further interesting products which should be used for personal hygiene especially in these days when the media of all parts of the globe talk continuously about the swine influenza and the best methods of decreasing its spreading. Unfortunately, PVP-I formulated in cleaning formulations such as: soap, shampoo, and body wash are not available as cosmetic trademarks. Therefore, it would be interesting if the pharmacist mix or reformulate this potent antiseptic into the personal shampoo or liquid soap of the customer in order to encourage him to achieve this

personal hygiene, especially against the avian viruses. This study aims to reformulate and evaluates the chemical stability of PVP-I after its reformulation into some trademarks cleaning formulations.

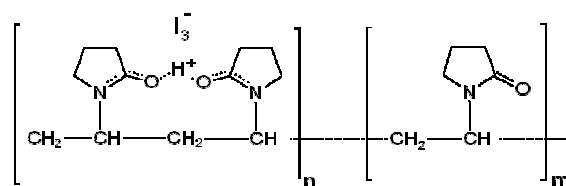


Fig. 1: Chemical structure of PovidoneIodine

### MATERIALS AND METHODS

#### Chemicals

All chemicals and reagents were USP/NF or ACS grade and were used without further purification. PovidoneIodine powder was purchased from Medichem (Xuchang, China), sodium thiosulfate was obtained from Riedel-de Haen(Ag, Germany). All cleaning formulations were imported by Palestinian agents. The cleaning formulations were bought from community pharmacy and supermarkets. The expiration date of each of the product was still valid for at least one year. They were designated as F1 for shampoo, F2 for hair and bodywash, F3 for shower gel, F4 for liquid soap and F5body wash (Table 1).

#### Equipment

All pH values were measured with a pH 211 microprocessor pH meter from Hanna Instruments ( Woonsocket, Rhode Island), an electrical Laboratory balance (Type AEy-20G Shimidazu Corp. Japan). For purified and distilled water a Reverse Osmosis (R.O.) water system (model HP-300 Cuno/ water factory system / USA) was used.)

#### Preparation of formulations

Sample preparations for stability studies were prepared according to the following method:

1. Suspend 10 grams of PVP-I in 4 grams of polyethylene glycol 400 (PEG 400) at room temperature until obtaining a homogenous mixture (Mixtures I).

- Add about 14 grams of the desired cleaning trade mark to mixture I and mix slowly until obtaining a homogenous solution (solution II).
- Add about 24 grams of the same cleaning trade mark to solution II and repeat the mixing.
- Add the remaining portion of cleaning trade mark to obtain 100 gram of final formulation.
- Fill in an opaque plastic bottle. All blank and active drug formulations were prepared in duplicate and stored in 100 cc opaque plastic bottles.

Preparations were stored at 25 °C (room temperature). Each cleaning formulation containing PVP-I was visually assessed for color and clarity before it was poured into the bottles. Approximately 5 grams of cleaning formulation was removed for chemical analysis and apparent pH measurement from each of the bottles, which were labeled 10% shampoo (F1), 10% hair & body wash (F2), 10% shower gel (F3), 10% liquid soap and blank solution. The preparations were sampled at 0, 1, 2, 3 and 4 months. All samples were tested for, pH and analyzed for PVP-I concentration. Samples for foam volume and stability of foam were also taken.

#### Preparation of blank solutions

Blank solutions were prepared in the same manner as described in table 1, but without the use of PVP-I. Blank solutions were labeled as blank solutions.

#### Analytical Method

##### Assay analysis of available iodine

To establish the PVP-I content in the prepared formulations, standard and samples were analyzed using the official analytical method of the USP [1].

#### Titration conditions

The 0.02 N VS sodium thiosulfate was prepared by dissolving 3.16 g of sodium thiosulfate in 1000 ml distilled water. PVP-I concentrations were determined using the titration method described in the USP as follow:

- Transfer an accurately weighed quantity of shampoo or hair and body shower, equivalent to 50 mg of iodine, to a 100-ml beaker.
- Add water to make a total volume of not less than 30 ml, and stir until the complete dissolution of the formulations.
- Titrate immediately with 0.02 N sodium thiosulfate VS, determining the end point visually, using a platinum-calomel electrode system.
- Perform a blank determination, and make any required correction.

Each ml of 0.02N sodium thiosulfate is equivalent to 2.538. The color of the solution at the end point is that of the blank solution. Another analytical method reported by JayarajKumar was also used to confirm the obtained data [15]. This method is also based on the titration procedure reported by the USP except per the end point which was determined visually by the use of starch solution as indicator. No differences were obtained between the two methods.

#### Foam volume and foam stability

The Ross-Miles foam column method used to measure foam height and stability. In this test 200 ml of 0.2% liquid shampoo solution falls through an orifice into a glass column containing 500 ml of the same solution. After a specified period of time at once and after five minutes, the height of foam was taken.

## RESULTS

#### Chemical Stability

The assay method used for this study was reported by the USP. The same method was also conducted with a variation in the determination of the end point of the titration [15]. In this last modification starch solution

was used for the determination of the end point. No differences in the assay were observed between the two methods. This suggests the use of this last method in pharmacy if the potentiometer is not available. The chemical stability of PVP-I 10% shampoo, hair and body shower stored in opaque plastic bottles at room temperature is summarized in table 1. As expected the rate of degradation of PVP-I in the above three cleaning formulations was different due to the different components present in each trade mark. After 4 months the available iodine in the shampoo (F1), and hair and body shower (F2) was within the accepted range of the USP for PVP-I for cleansing solution (85-120) [1]. While PVP-I in the shower gel (F3) and in the liquid soap (F4) was chemically stable till the end of the third month of storage as reported in table 1. The last one, body wash (F5) was stable till the end of the first month of study. Therefore, these formulations could be recommended within this time limit. The selected cleaning preparations and PEG 400 (F1, F2, F3) offer a good co-solvent system for PVP-I. This solvent system is chemically compatible with PVP-I within the reported time limits for each formula. Moreover, the preparation of these formulations with a concentration of PVP-I close to 120% may prolong the shelf life of the prepared preparations.

**Table 1: Percentage of assay of Povidone-Iodine after its reformulation into different trademarks cleaning Formulations and storage at room temperature**

Date of analysis (month)	F1	F2	F3	F4	F5
1	101.3	100.6	101.2	100.8	101.5
2	100.2	99.5	96	95.4	85.2
3	99	98.2	89.1	90	a
4	98.1	97.3	85.2	86	a
5	97.1	96	a	a	a
r <sup>2</sup>	0.9976	0.9975	0.99	0.9953	1

a = analysis not performed at this period

#### Apparent pH and physical appearance

The pH of the prepared cleaning formulations were within the accepted range described in the USP for PVP-I solution (1.5-6.5). These pH values remain constant within the entire period of stability study for all formulations. Concerning the appearance of the re-compounded PVP-I cleaning formulations, no detectable change in the obtained odor, color or precipitate was observed at the end of the study.

#### Foam volume & foam stability

Concerning the foam volume and stability of the PVP-I cleaning formulations, no detectable differences in the foam density and volume of foam were observed between the produced cleaning formulations and the starting commercial trademarks cleaning preparations.

## DISCUSSION

As expected from the obtained results, the compounded PVP-I, 10% cleaning formulations, prepared and stored at room temperature, have different rate of degradation for PVP-I. In fact, F1 and F2 were chemically stable for more than 4 months, while PVP I in the shower gel (F3) and liquid soap (F4) was chemically stable only for three months when stored at the same conditions. The last one, body wash was stable for only one month when stored at the same conditions. These results were expected since; these formulations are different formulations and may contain different components. This suggests that these formulations can be suitable for preparing PVP-I into personal cleaning formulation for cosmeceutical purposes, but attention should be made to determine the exact and true expiry date beyond which the consumer should discharge the remaining amount of the compounded formulation. This may encourage customers to use this potent antiseptic for personal cleaning and disinfection especially when the expiry date of the obtained formulation is long as the case of the first two cleaning formulations (F1 and F2). In this contest, this type of compounding formulations will be very useful especially in hospitals and clinical settings as potent antiseptic cleaners for hospital tools and employee. Also the field of cleaners should pay attention to this study since it should offer another important market option for these industries. In fact

these industries may add PVP-I to their cleaning trademarks or produce new suitable cleaning formulations containing this potent antiseptic for hospital and personnel hygiene use. Furthermore, the community pharmacists may gain an important advantage from these results, since it can formulate PVP-I in an existing shampoo or cleaning agent to meet the customer desire who is not willing to change his personnel cleaning trademark but still looking for the ideal antiseptic to defend himself from swine influenza or any other type of contaminating microorganisms. In this contest the pharmacist could search for a stable PVP-I shampoo or liquid soap not only for personal hygiene as previously mentioned, but also for patients having PVP-I sensitive infections in the body or hair scalp. This last point will achieve high patient compliance since again the patient found his personal cleaning formulation provided with a suitable antiseptic agent.

#### CONCLUSIONS

The practice of compounding PVP-I in various trademarks cleaning formulations in order to achieve clinical and disinfection benefits can be followed in community pharmacy, hospital pharmacies and clinical settings. But attention should be taken to evaluate the correct shelf life of the obtained formulations. In the future further study should be recommended to extend this study on other cleansing cosmetics and to examine the stability of these formulations at room temperature for long period of time which should return in good economic benefit in pharmacy and industries alike. Cleaner industries should produce new suitable and stable cleaning trademarks containing this potent antiseptic.

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