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EVALUATION OF SELECTED PROPERTIES OF COMMERCIAL AND DEVELOPED LIQUID SOAPS

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Abstract

Background: *Frequent washing of hands is advisable by W.H.O (World Health Organization) to eradicate transmission of germs with suitable suds (soap). However, on frequent washing people experience dryness of hands in absence of proper quantity of humectant / lubricant in soap.*

Objective:
Inexpensive liquid soap is affordable and available to individuals of different financial le vels. Producing low-cost soap frequently demands fewer resources and energy. During this research authors tried to eliminate risks associated with use of more chemicals and evaluated formulations in terms of organoleptic properties.

Methods: *In present study two different formulations of liquid soaps are prepared by using castor oil and glycerin to avoid dryness. Comparison is made on selected parameters of liquid soaps with three commercially available similar products. The findings of this study revealed that customers have occasionally suffered unfavorable outcomes after consuming synthetic chemicals.*

Results: *Although properties of lab-made liquid soaps are not same as market soaps but some parameters including density (F1 is 0.830 and F2 is 0.821), acidity level (pH of F1 and F 2 is 5.4 and 4.9 respectively), spread ability, flow-ability and stability in volume of foam are comparable. Additionally, adjust pH roughly 5.5 to ensure skin safety and comfort. Finally, strive for viscosity that is appropriate for liquid soap, making it easy to dispense and apply. By harmonizing these critical criteria, an economical, good-quality liquid soap is developed that also matches requirements of consumers.*

Conclusion: *The conclusion of current study is to create cost-effective liquid soap with streamlined composition that promotes simplicity, efficacy, and skin safety. Formulation was focused to be developed with a minimum number of ingredients, utilizing affordable and commonly available components. Liquid soap should be highly effective while keeping skin soft.*

INTRODUCTION

Soap consists of two separate components, a lipophilic which is non-polar hydrocarbon end and a polar hydrophilic end. Non-polar end of soap dissolves non-polar molecules, while the polar end dissolves polar molecules. Soap is made by hydrolyzing triglyceride (fat or oil) with an alkaline solution, typically lye (chemically known as sodium hydroxide). Three long-chain aliphatic carboxylic acid chains joined to a single glycerol molecule make up triglycerides. Saponification is the term for the process that yields soap. Liquid soaps are available widely and frequently used for cleaning purposes. Liquid soaps can be used

cosmetically to provide clean and sanitized hands. They are not physiologically soaps, which are higher fatty acid salts created when hydroxides and triacylglycerol react to form hydrolytic saponification. Instead, they are often aqueous solutions of surfactants with various additions. Primary products used for the fresh skin of hands are liquid soaps. Repeated hand washing reduces risk of viral contamination but may harm the hydro-lipid layer of skin, causing different types of discomfort [1]. Scientifically, soap is interpreted as alkali (sodium or potassium salts) of fatty acids or similar products created by process of neutralization also known as saponification, in which fatty acids or triglycerides oils and fats are converted into compatible alkali salt mixtures of fatty acids using organic or inorganic bases [2]. Although the easiest, least expensive and most efficient strategy to lessen infections of skin is through frequent hand washing. But safety of products which are inclusive in hand skin is crucial for both antibacterial and conventional liquid soaps. Regular cleaning exposes hand skin to water and other chemicals or physical agents over extended periods of time. As a result, keratinocyte degeneration, activation of the skin immune system, epidermal barrier rupture, delayed-type hypersensitivity reactions and pro-inflammatory cytokine production are just a few of the pathophysiological changes. When soap chemicals are washed away into waste streams several ingredients have a potential adverse impact on both human and environment [3]. Sodium lauryl sulfate (SLS) which is an anionic surfactant, is commonly used as detergent in cleansing products like liquid face wash. High SLS concentration is harmful for eyes, leading to severe irritability and blindness. As a cleaning agent, fatty acid salts are chosen because they contain both hydrophilic and lipophilic groups [4]. Liquid soap is one of many varieties of soap available in the market with various forms and purposes. General public prefers liquid soap particularly for skin cleaning. It is a fact that liquid soaps specifically have benefits over other kinds of soaps. Whereas solid soaps are easier to store, more convenient, economical and hygienic, additionally provide appealing packaging [5]. Numerous studies have been done on the efficacy of different cleansers such as antibacterial soaps, regular soaps and alcohol-based hand rubs. The US Food and Drug Administration recently issued a final rule that prohibited marketing of over-the-counter consumer antiseptic wash products containing triclosan and triclocarban to avoid emergence of resistant bacteria [6]. To reduce the spread of potentially harmful bacteria, it is vital to wash hands with soap, however liquid soaps with refillable dispensers are more likely to become contaminated by external pathogens [7]. Usually, synthetic ingredients are used in the production of transparent soap. Therefore, natural ingredients must be used to optimize transparent soap composition. Essential oils are natural substitutes that can be employed [8]. Obligation to prevent and control infections necessitates paying close attention to various parts of biological risks and harmful environmental circumstances that must be addressed and managed. These include shortage of cleaning supplies, improper use of personal protective equipment, lack of routine for cleaning and disinfecting units and equipment used by everyone such as soap dispensers, flasks and improper disposal of contaminated clothing and materials among other things [9]. Cosmetic businesses sell a lot of detergents as being incredibly delicate products. However, there is no international consensus on standards for determining mildness of cleansers and several products have significant irritant effects specifically on sensitive skin. Medical professionals including dermatologists critically lack necessary chemical knowledge to evaluate composition of detergents. Even soaps for sensitive skin occasionally contain aggressive ingredients so doctors need to be aware of proper product recommendations to patients [10].

AIM OF STUDY

The aim of current study is to create cost-effective liquid soap with streamlined composition that promotes simplicity, efficacy, and skin safety. Formulation was focused to be developed with a minimum number of ingredients, utilizing affordable and commonly available components. Liquid soap should be highly effective while keeping skin soft. Additionally, adjust pH roughly 5.5 to ensure skin safety and comfort. Finally, strive for viscosity that is appropriate for liquid soap, making it easy to dispense and apply. By harmonizing these critical criteria, an economical, good-quality liquid soap is developed that also matches requirements of consumers.

MATERIAL AND METHOD

Castor oil, glycerin, sodium lauryl sulphate (SLS), carbomer and distilled water were ingredients employed in the study, all ingredients purchased from local market of Karachi. This experimental study intends to manufacture two liquid soap formulations using castor oil as emollient in formulation 1 and glycerin in formulation 2 as moisturizing agent. Other additives include carbomer as viscosity enhancer and SLS as surfactant within two compositions. Both composition shown in table-1. Equipment which were used included weighing balance Model BM-320/ Panther USA, stirrer Oni-lab MSPH, pH meter PHS-3C bench.

Table-1 Composition of Formulated liquid soap

Ingredients	Quantities	
	F 1	F 2
Castor oil (ml)	1	–
Glycerin(ml)	–	1
SLS (gm)	1	1
Carbomer (gm)	0.5	0.5
Distilled Water (q.s)	100	100

For formulation 1, One ml castor oil has been taken in a beaker then add 1 gm SLS in it. Mix it vigorously, on the other side take another beaker and soak 0.5 gm of carbomer in half quantity of water. When Carbomer swelled up properly then add it in castor oil mixture with continuous stirring. Finally make up the volume with remaining distill water. Same procedure was followed except addition of glycerin in place of castor oil for formulation 2.

ANALYSIS OF LIQUID SOAP FORMULATION PHYSICAL ATTRIBUTES AND VISUAL EXAMINATION

Developed composition was assessed for its capacity to produce foam, color, clarity, and odor [11]. Liquid soap samples were evaluated using physical parameter tests, which included density, cleaning effect, acidity level (pH), foam height, foam stability, and flowability. These values compared with three different commercially available liquid soaps.

ACIDITY LEVEL (pH) DETERMINATION

Degree of acidity or pH is one requirement of liquid hand wash formulation. In general hand wash products pH tends to be alkaline. It is because the basic ingredients of liquid soap are strong alkaline. Skin has a slightly acidic pH (4.6 to 5.8), which is necessary for effective antibacterial and antifungal treatments as well as for acting as a barrier and contributing to the stratum corneum's development and maturation [12]. Nine milliliters of distilled water were used to dissolve one gram of soap sample. The pH meter was calibrated using a pH-4 buffer, and the probe was cleaned with distilled water. The pH meter electrode is then inserted in a soap sample and reading was recorded [13].

DENSITY MEASUREMENT

By calculating specific gravity with the help of RD bottles, density can be measured. Using a pycnometer or density bottle, the density was determined. The weight of the empty bottle, the net weight of the water, and the net weight of the sample under investigation were measured using a once calibrated weighing balance. With the following formula, density was calculated as:

$$\boldsymbol{Density = \frac{Net\ weight\ of\ sample}{net\ weight\ of\ water} \times 0.99602}$$

Equation 1 [14]

FOAM HEIGHT AND STABILITY TEST

Nine milliliters of distilled water were used to dissolve one gram of soap sample. After sealing the reaction tube with a stopper, the sample was shaken for twenty minutes. The initial height of the foam was measured after shaking.. Additionally, the sample was left undisturbed for five minutes in order to quantify the ultimate foam height [15].

DIRT DISPERSION

Two drops of sample were added in a large test tube containing 10 ml of distilled water. One drop of India ink was added, a stopper was placed on the test tube and shaken for ten times. Amount of ink in foam was estimated as None, Light, Moderate, or Heavy.

CLEANING ACTION

Five grams of wool Yarn were placed in grease, after that it was kept in 200 ml of water containing 1 gram of liquid soap in flask. The temperature of the water was maintained at 35 °C. The flask was shaken fifty times per minute for four minutes. The sample was taken out, dried, and weighed after the solution was removed. Equation 2 was used to compute the amount of grease removed:

$$DP = 1001 - TC \quad \text{Equation 2}$$

Where,
DP = Percentage of Detergency power
T = Wool Weight of Formulated Preparation
C = Wool Weight of Marketed Preparation [16].

SPREADABILITY AND FLOWABILITY

Two glass slides were taken of known dimensions and excess of liquid soap under study was placed on the ground slide, diameter was noted by using measuring ruler. Liquid soap was then sandwiched between, then replaced top slide and again measured the diameter [17]. Flowability of liquid soap was measured by pouring 10 ml liquid soap from one cylinder to another and its time of pouring was observed.

SKIN TEST

Specific amount of sample was applied on skin and observed any irritancy or allergy [18].

RESULTS

This research was based on preparing liquid hand wash/ liquid soap by using castor oil, glycerin, with SLS concentrations of 1 %. Results of tests were carried out by different methods, described as below.

ACIDITY LEVEL (pH) DETERMINATION

Formulations 1 and 2 have pH values of 5.4 and 4.90, respectively. Marketed products have pH 4.53, 6.54 and 8.74. Observations are listed (Table-2&6). According to which pH of formulation 1 was found to be the best for liquid hand wash. As per SNI 06-4085-1996, a pH of no more than 8 to 11 is advised. Because of the large concentration of free alkali, high pH might irritate skin [19].

DENSITY MEASUREMENT

Density of prepared formulation is 0.830 to 0.821 g/mL and meets the range (from 1.010 to 1.100 g / mL) [20]. Value of material density is influenced by constituents, concentration and physical properties. Results presented in (Table- 3&6).

DIRT DISPERSION

The fact that none of the formulations retained ink in the foam suggests that they are all capable of effectively eliminating dirt. Since producing cleaning action is the main objective of any hand wash preparation, formulation results showed 29% Detergency Power, which is efficient against substances like dirt and grease [21].
Test mixture for dirt dispersion should not cause ink to concentrate in foam; dirt should remain in water; grime that remains in foam will be challenging to rinse away. Therefore, findings of formulation evaluation revealed that there was no dirt in foam (Table-4&6).

CLEANING ACTION

After calculating, the cleaning effect of formulation 1 is 25.4% and formulation 2 is 33.3% (Figure-1, Table-5&6).

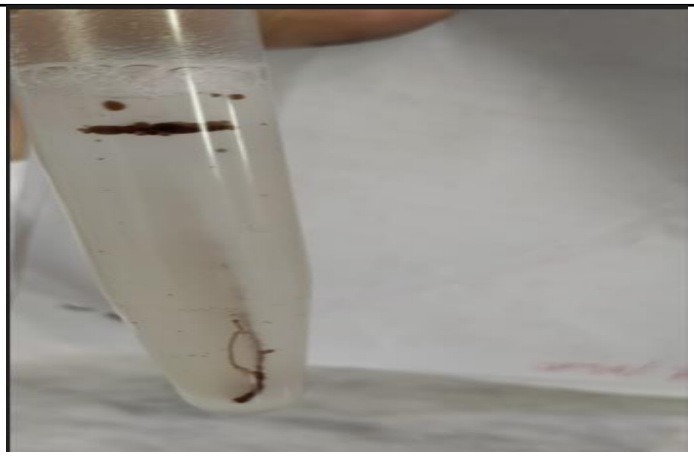

Figure. 1: Cleaning effect on yarn with grease, (Source: Self elaboration)

Table-2 pH Measurement of Liquid Soaps

Hand wash	pH			
	Sample 1	Sample 2	Sample 3	Mean
A	4.53	4.82	4.64	4.66
B	6.54	6.12	6.36	6.34
C	8.74	8.91	8.95	8.866
Formulation 1	5.4	5.9	5.2	5.5
Formulation 2	4.90	4.85	4.67	4.806

Table-3: Density Measurement of Liquid Soaps

Hand wash	Density (g/ml)			
	Sample 1	Sample 2	Sample 3	Mean
A	1.0988	1.0812	1.0915	1.0905
B	1.0713	1.0794	1.0768	1.0813
C	1.3255	1.3341	1.3945	1.3513
Formulation 1	0.830	0.883	0.847	0.853
Formulation 2	0.821	0.739	0.846	0.802

Table-4: Dirt Dispersion Measurement of Liquid Soaps

Hand wash	Dirt dispersion		
	Sample 1	Sample 2	Sample 3
A	None	None	None
B	None	None	None
C	None	None	None
Formulation 1	Light	Light	Light
Formulation 2	Light	Light	Light

Table-5: Cleaning % Measurement of Liquid Soaps

Hand wash	Cleaning %			
	Sample 1	Sample 2	Sample 3	Mean
A	35.5	39.8	42.1	39.133
B	31.8	40.7	45.3	39.266
C	28.6	19.9	32.4	26.96
Formulation 1	25.4	31.8	16.7	24.63
Formulation 2	33.3	39.4	28.6	33.76

Table-6: Mean Values of Density, pH, Cleaning Effect and Dirt Dispersion of Liquid Soaps

Hand wash	pH (Mean)	Density (g/ml) (Mean)	Cleaning % (Mean)	Dirt dispersion (Mean)
A	4.66	1.0905	39.133	None
B	6.34	1.0813	39.266	None
C	8.866	1.3513	26.96	None
Formulation 1	5.5	0.853	24.63	Light
Formulation 2	4.806	0.802	33.76	Light

SPREAD ABILITY AND FLOW ABILITY

Results showed that Formulation 2 has good spread ability as compared to Formulation 1, which represents its less-water-absorbing capacity. Shorter intervals indicate better spread ability.Results of spread ability and flowability tests have been shown in (Table-7, fig- 2). Results of foam stability test have been presented in (Table-7). Commercial hand washes have been tagged as A, B and C.

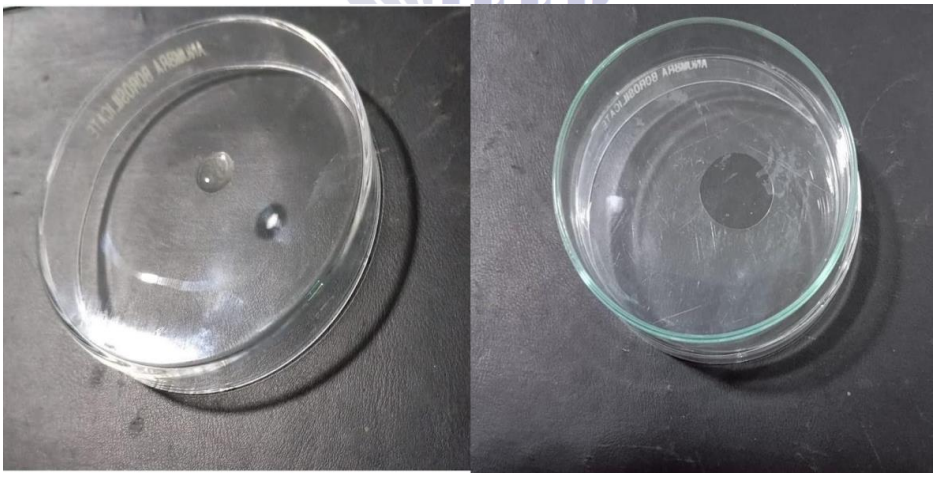

Figure 2: Spread ability of samples, (Source: Own elaboration)

Table-7 Spread ability and Flowability with Flow rate determination

Hand wash	Spread ability		Flow rate (ml/min.)
	Diameter before spread (cm)	Diameter after spread (cm)	
A	1	2.7	0.837
B	1.5	3.16	0.893
C	1	2.73	0.803
Formulation 1	1.5	7	0.809
Formulation 2	1.5	5.5	0.829

FOAM HEIGHT AND STABILITY TEST

Liquid soap contains sodium lauryl sulfate (SLS) which act as foam enhancer. SLS is surfactant, commonly used in manufacturing of liquid soap and its large concentrations can irritate the skin. Samples were taken about 1 mL, kept stand till aqueous volume measured up to 9 ml after 25 strokes & measured the foam height, above the aqueous volume. Since foam height of formulation-2 was almost stable for 5 min thus it was best to be used as liquid hand wash. (Figure 3, Table-8) shows foam height of formulations across various time periods.

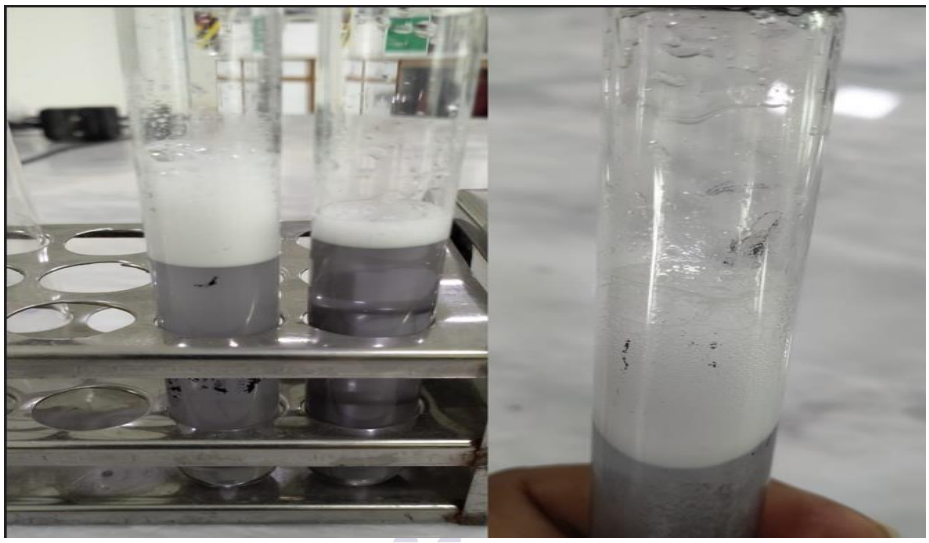

Figure 3: Foam height and stability of Samples, (Source: Own elaboration)

Table – 8 Foam Height and Stability

Hand wash	Height of foam in water (mm)			
	At 5 min	At 10 min	At 15 min	At 20 min
	Liquid + Foam			
	Mean (S.D)			
A	7.1 (0.360555128)	5.5 (0.5)	5.1 (0.360555128)	4.5 (4.5)
B	3.5 (0.5)	2.4166 (0.38188)	1.58333 (0.52041)	1.5 (0.5)
C	4.75 (0.25)	4.41666 (0.38188)	2.75 (0.25)	3 (0.5)
Formulation 1	3.5 (0.5)	5 (0.5)	4.5 (0.5)	3 (0.5)
Formulation 2	6 (0.5)	4.83333 (0.7637)	5 (0.5)	3.5 (0.5)

DISCUSSION & CONCLUSION

Soap is an ingredient needed to wash hands, and with most people's high levels of activity, they prefer soap that is more practical and portable. Among different types of soaps, liquid soap is more portable and hygienic than bar soap. Liquid soap acts as cleanser and inhibits growth of bacteria on skin which is crucial for lowering risk of infection and onset of disease. In the present study two types of liquid soaps have been made and only three ingredients were used. In formulation 1, castor oil was used as moisturizer, SLS as foaming/cleaning agent and carbomer as thickening agent. In formulation 2, castor oil was replaced with glycerin and other ingredients were same. After preparing two formulations of liquid soap with least ingredients, its parameters like pH, dirt dispersion, cleaning effect, density, spread ability, flow ability and foam stability were compared with three commercially prepared liquid soaps in the laboratory. When preparing liquid soap, pH is a crucial factor. Because the pH of normal skin is slightly acidic, an extremely alkaline pH can harm the acid mantle, which serves as an antibacterial barrier. Extremely alkaline pH can also damage the epidermis' lipid

lamellae, which can lead to dry skin from increased transepidermal water loss (TEWL) and the introduction of allergens and irritants [22].

The preparations, Hand washes (A, B, C, Formulation 1, Formulation 2) were undergone several quality tests, that were included as acidity level (pH) test with three readings (Table-2) & mean pH value of Formulation 1 is 5.5 and Formulation 2 is 4.806 (Table-2&6), density measurement was performed in (g/ml) and calculated mean value was obtained as 0.853 for Formulation 1 and 0.802 for Formulation 2 (Table-3&6), dirt dispersion showed light results for both Formulation 1 and 2 (Table- 4&6), cleaning action was calculated in percentage and mean value was obtained for Formulation 1 was 24.63 and Formulation 2 was 33.76 (Figure-1, Table-5&6), spread ability test was performed by measuring diameter in centimeters. Formulation 1 had 1.5 cm diameter before spread and 7 cm after spread and flow rate (flow ability test) 0.809 ml/min was observed, whereas Formulation 2 diameter was 1.5cm before spread and 5.5 cm after spread, Formulation 2 showed good spread ability than Formulation 1 (Figure-2, Table-7), foam height in millimeter was measured and it was 3.5mm, 5.5mm, 5mm, 3mm for Formulation 1 and Formulation 2 was 6.5mm, 5mm ,5mm, 3.5mm at 5, 10, 15 and 20 minutes of time intervals, time interval showed the foam stability test, Formulation 2 had more foam height and more foam stable at 5 minutes of time (Figure-3, Table-8). pH testing is one of the standards for excellent liquid soap. Because liquid soap comes into close touch with the skin, it can cause irritation if the pH does not match. When the pH of liquid soap in each formula is measured, the results are quite similar, falling between 4 and 8. The pH of liquid soap products is frequently alkaline. The basic ingredients in liquid soap are culpable for this. The liquid soap formulation that has been developed shows considerable potential in terms of compatibility with commercially available liquid soap. Lab-developed formulas strike a balance between powerful cleaning and delicate skin care. The surfactant SLS produces thick, creamy lather while remaining gentle. Glycerin as moisturizer improves skin feel without sacrificing washing power, while in formulation- 2, castor oil as moisturizer may have an effect on cleaning power. Comparative testing with commercial liquid soaps will yield useful information for future development.

Most consumers like cleaning supplies with a lot of foam, but the amount of foam in cleaning products is attributable to the surfactant sodium lauryl sulphate (SLS), which can cause skin irritation. A good foam stability criterion is a foam stability range of 60-70% within the first 5 minutes. Foam height testing was allowing it to clear dirt. From present study the measurement is consistent with the needed value, indicating that the foam remains stable.

Good spread ability means that soap covers the skin evenly and effectively removes dirt and bacteria. Proper spread ability allows soap to reach all parts of the skin, avoiding uneven washing. Spread ability influences lather development, which aids in dirt removal and skin cleaning. Easy-to-spread soap improves the user experience, making washing more comfortable and efficient. In present study the value of spread ability after measurement is 70 mm in formulation- 1 and 55 mm of formulation - 2.

The fundamental ingredients of all soaps, liquid or bar are alkali salts of fatty acids, which have detergent qualities and stop the growth of bacteria and germs. Liquid soap will produce richer and more moisturizing lather. Liquid soap is the perfect blend of ingredients, making it perfect for hand care and cleanliness. It guarantees to eradicate the majority of common skin bacteria and offers long-term protection. Overall current formulations show significant economic viability and with focused tweaks, a competitive product that matches consumer expectations can be created.

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