# GLUCOSAMINE HYDROCHLORIDE ORAL LIQUID SOLUTION

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**ABSTRACT:** In terms of arthritis prevalence, osteoarthritis (OA) ranks high globally. Glucosamine is researched as a supplement for osteoarthritis. Glucosamine, which is found in the matrix of joint tissues, can help alleviate symptoms of osteoarthritis (OA) by stimulating the regeneration of cartilage. One way to take glucosamine hydrochloride is in a liquid form that can be swallowed. Any patient, whatever age, can take it without any problems. This glucosamine hydrochloride fluid formulation is perfect for the elderly who struggle with swallowing. Recommend that the elderly take glucosamine hydrochloride solution in addition to their other medications for the best possible therapeutic improvement. The materials used include glucosamine hydrochloride, sorbitol, xanthan gum, propylene glycol, glycerine, simethicone liquid, and sodium benzoate. Components include sodium edetate, menthol, sucralose, and anhydrous citric acid. Sweet orange, booster orange. Sunset Yellow Supra and Purified water. Formulating and stabilizing 500mg/10ml glucosamine oral solution is the biggest issue. Aqueous glucosamine is unstable. Alkaline pH destabilizes glutamine. It is robust in pH imbalances and with proper oxidizers. We adjusted the formula with xanthan gum, the main stabilizing agent that prevents Glucosamine Hydrochloride Formulation

deterioration. The pH is adjusted to 3.86 using citric acid anhydrous to improve stability, with a limit of 3.5-5.0. The formulation was held on Accelerated stability for 3 months to confirm stability. HPLC evaluation of Glucosamine hydrochloride oral liquid formulations and conventional permits qualitative and quantitative component evaluation and indicates the amount of drug. A 400C/75%RH stability study was performed on the adjusted formulations. Physical traits were unchanged. It is intriguing because it may administer the right amount of drug to the body and the full drug to the location of interest, improving patient therapy.

**Keywords:** Osteoarthritis, Glucosamine hydrochloride, Oral liquid formulations, Elderly, Medications

## INTRODUCTION:

**OSTEOARTHRITIS (OA):** Worldwide, osteoarthritis (OA) is among the most common arthritis [1]. Bony remodelling and joint inflammation can develop from joint cartilage degradation [2]. This complicated disease alters articular cartilage and sub-chronal bone tissue homeostasis. Information and physical examination are used to make the clinical diagnosis. Since pain does not correspond with radiographic disease severity, radiographic evidence to validate the diagnosis is disputed [3-4]. Small and large joints can be affected. Shoulders, hands, and back are usually afflicted, but hips and knees are most often [5]. This disorder causes pain, morning stiffness of just over an hour with daytime improvement, and disability owing to function loss and inability to conduct everyday tasks [6]. Obesity and recurrent injuries often cause knee osteoarthritis [7]. Progressive knee cartilage degradation, or "bowed legs." Weight-bearing osteoarthritis can cause a limp. The hobbling can worsen as cartilage degrades [8]. The United States has the highest prevalence of osteoarthritis [9]. Around 10% of males and 13% of women get symptomatic OA by the time they reach the age of 60. Women are more likely to be affected than men [10]. The ageing population and the obesity epidemic are expected to lead to a rise in symptoms of osteoarthritis [11]. At age 60, 37% of adults had knee OA, and that number rose to 19% in adults aged 45 and up [12].

**Glucosamine hydrochloride:** The amino sugar glutamine hydrochloride is essential for the production of glycosylated proteins and lipids. It is the most common monosaccharide. Cellular glucose metabolism produces glucosamine [13]. Hyaluronic acid is found in joint synovial fluid and bone-end cartilage matrix glycosaminoglycans and proteoglycans.

Exogenous glucosamine comes from shellfish exoskeletons, which produce glucosamine hydrochloride (HCl) and glucosamine sulphate [14]. Salts stabilize 74% pure glucosamine sulphate. Pure glucosamine HCl has no sulphate. Sulphate-free glucosamine HCl is 99% pure[15]. Thus, 1,500 milligrams of glucosamine hydrochloride equals 2,608 mg of sulphate. Glucosamine is quickly absorbed from the GI tract, metabolized in the liver, and eliminated in the urine and faeces after oral intake. Protein binding leads levels to peak 8 hours after oral ingestion, accounting for 90% of the impact. Glucosamine is an OA supplement investigated. How glucosamine works in people is unknown. Since it is part of the joint tissues' cartilage matrix, glucosamine has been suggested as a symptomatic reliever for OA patients via regenerating cartilage [16]. This may reduce pain and disability. In animal research, glucosamine decreases IL-1-induced nuclear factor kappa beta, which reduces inflammation [17]. A few human investigations have found that OA patients' surgical specimens' chondrocytes and synovial cells produce fewer IL-1-triggered catabolic enzymes and inflammatory markers such as prostaglandin E2[18].

**The concept of liquid formulation:** Most oral liquids are homogenous solutions, emulsions, or suspensions of active substances in a liquid foundation. Liquid oral dose forms contain solubilizing, wetting, stabilizing, thickening, suspending, gelling, antibacterial, dispersing, solvent, and vehicle [19]. It may also contain flavouring, sweetening, and colouring. Oral liquid dose forms are easy to take by all ages without discomfort. The solution form makes it easy for geriatrics to swallow. Drug solutions and other liquid dose forms are easily absorbed and more therapeutic. Some benefits of oral liquid dose forms include being easy to swallow for individuals of all ages [20].

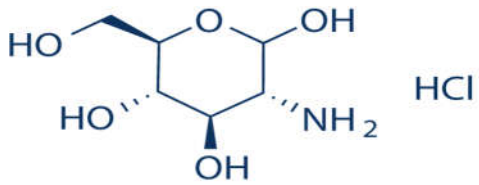
- Faster medication absorption than solid dose forms due to solution/emulsion/dispersion form.
- Easy and quick formulation.
- Sweetener/flavoured vehicles can conceal disagreeable drug taste.
- It has a greater absorption rate, and high optimization rate, and is easily digested.

**DRUG PROFILE**

**For Glucosamine Hydrochloride:**

**Description** : white crystalline powder with odourless

**Structure**




**Molecular formula** : $C_6H_{13}NO_5.HCl$

**IUPAC name** : 2-Amino-2-deoxy-D-glucopyranose hydrochloride(D-glucose,2-amino-2Deoxy-hydrochloride)

**Molecular weight** :215.63

**Solubility** : Soluble in water
Insoluble in organic solvent (like ethanol)
Faintly soluble in methanol [21]

**Melting point** :190-194$^0$C

**pKa** :11.73

**pH** :3.0-5.0

**Mechanism of action:** Glucosamine HCl provides excess basic building block synthesis of cartilage glycosaminoglycans. It slows the progression of osteoarthritis relieving symptoms of joint pain. It increases cartilage and synovial fluid around joints and helps prevent the breakdown of joint cartilage. It acts as a cushion that surrounds the joints by avoiding the damage that is caused to joints. Glucosamine hydrochloride acts as a protective agent that protects cells of joints which helps to maintain cartilage structure. It stimulates the anabolic process of cartilage metabolism. The induced catabolic process shows anti-inflammatory action that delays inflammation [22].

**Pharmacokinetics**

- **Absorption**: Glucosamine HCl shows variable absorption. Glucosamine HCl was 88.7% absorbed by the gastrointestinal tract.

$C_{max}$: 10micromoles
$T_{max}$: 3hrs
} after 1500mg dose
AUC: 20216$\pm$5021

- **Distribution**: Glucosamine HCl shows greater absorption with volume of 2.5 litres.
- **Metabolism:** Orally administered Glucosamine HCl has only 26%bioavailability due to first-pass metabolism. Plasma levels increased 30 times to baseline in healthy volunteers. It is not a protein but rather incorporated into plasma protein. It metabolized to smaller molecules and ultimately to water and urea.
- **Excretion:** Orally administered Glucosamine HCl liquid excreted to 11 through faeces [23].

**Dose:** Glucosamine hydrochloride oral liquid is an oral liquid dosage form. It can be taken easily by any age patient without difficulty. Each **10ml of solution** is equivalent to **500mg of glucosamine HCl** [24]**.**

The dose of this oral liquid can be taken as:

- 30ml-single dose per day
- 15ml-two times per day
- 10ml-three times per day

**AIM and OBJECTIVE**

**AIM:** To formulate the oral glucosamine hydrochloride liquid.

**OBJECTIVE:** The elderly are the target audience for the glucosamine hydrochloride liquid formulation. To alleviate osteoarthritis symptoms, a typical dosage of glucosamine is 1500 mg. However, there is no glucosamine base available, and all the commercially available formulations contain glucosamine salts at a dosage of 1500 mg. Every composition is commercially available in tablet form. The enormous (1500 mg) size of these pills makes them tough to take orally. The result will be an environment that is more conducive to drug consumption among the elderly. For elderly people who have trouble swallowing, the glucosamine hydrochloride fluid formulation is ideal. Advise the elderly to use glucosamine hydrochloride solution in conjunction with other drugs for excellent therapeutic improvement; it is very convenient.

**METHODS AND MATERIALS**

## API Excipient Ratio for Formulation

## TABLE 1: API Excipient Ratio for Formulation

| | | | | |
|---|---|---|---|---|
| 1 | Glucosamine hydrochloride | 1 | | |
| 2 | Sorbitol | 1:8.33 | | |
| 3 | Xanthan gum | F1 | F2 | F3 |
| | | 1:0.05 | 1:0.058 | 1:0.06 |
| 4 | Propylene glycol | 1:0.53 | | |
| 5 | Glycerine | 1:0.83 | | |
| 6 | Simethicone liquid | 1:0.005 | | |
| 7 | Sodium benzoate | 1:0.03 | | |
| 8 | Di sodium edetate | 1:0.03 | | |
| 9 | Menthol | 1:0.0016 | | |
| 10 | Sucralose | 1:0.058 | | |
| 11 | Citric acid anhydrous | 1:0.005 | | |
| 12 | Sweet orange | 1:0.0083 | | |
| 13 | Booster orange | 1:0.008 | | |

**Optimization of Concentration of Excipients with Drug**

**TABLE 2: Optimization Of Concentration of Excipients with Drug**

**For Batch 1000ml**

| s.no | Chemical name | Batch 22058 | Batch 22061 | Batch 22064 |
|---|---|---|---|---|
| 1 | Glucosamine hydrochloride | 60g | 60g | 60g |
| 2 | Sorbitol | 503g | 503g | 500g |
| **3** | **Xanthan gum** | **3g** | **3.5g** | **4g** |
| 4 | Propylene glycol | 32g | 32g | 32g |
| 5 | Glycerine | 50g | 50g | 50g |
| 6 | Simethicone liquid | 0.3ml | 0.3ml | 0.3ml |
| 7 | Sodium benzoate | 2g | 2g | 2g |

| | | | | |
|---|---|---|---|---|
| 8 | Di sodium edetate | 2g | 2g | 2g |
| 9 | Menthol | 0.1g | 0.1g | 0.1g |
| 10 | Sucralose | 3.5g | 3.5g | 3.5g |
| 11 | Citric acid anhydrous | 0.35g | 0.35g | 0.35g |
| 12 | Sweet orange | 5ml | 5ml | 5ml |
| 13 | Booster orange | 0.5ml | 0.5ml | 0.5ml |
| 14 | Sunset yellow supra | 2microgm | 2microgm | 2microgm |
| 15 | Purified water | Up to 1000ml | Upto 1000ml | Upto 1000ml |

**FORCED DEGRADATION STUDIES**:

**Step1**

- Take a volumetric flask add 50ml of hot water and 9g of glucosamine hydrochloride and mix thoroughly until the total drug dissolved.
- Leave the solution for ½ hour and observe it if any changes take place in it.

**Observation:** After a while, it was observed that slight colour change i.e., from **colourless to light yellow.**

**Step 2**

- Take volumetric flask add 50ml of hydrogen peroxide and 9g of glucosamine hydrochloride and mix thoroughly until the total drug dissolved.
- Leave the solution for ½ hour and observe it if any changes take place in it.

**Observation:** After a while, it was observed that **no colour had changed**.

**Step 3**

- Take a beaker add 50ml of hot water,2ml HCl in 250 ml water(N/10HCl) and 9g of glucosamine hydrochloride and mix thoroughly until the total drug is dissolved then boil for 1/2hourat $80^0$C.
- Leave the solution for ½ hour and observe it if any changes take place in it [25].

**Observation:** After a while, it was observed that **no colour had changed**.

**Step 4**

- Take a volumetric flask add 50ml of water,1.05g of NaOH in 250 ml water (N/10NaOH) and 9g of glucosamine hydrochloride and mix thoroughly until the total drug is dissolved then boil for 1/2hour at $80^0$C.
- Leave the solution for ½ hr. and observe it if any changes take place in it.

**Observation:** After a while, it was observed that **the colour changed from colourless to dark brown colour**.

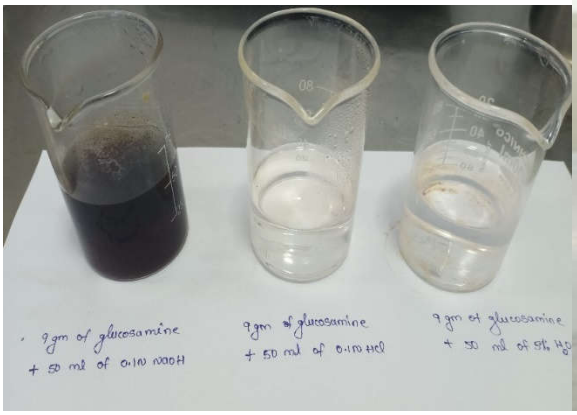



FIG1 FIG 2 FIG 3 FIG 4

**Fig1:** glucosamine HCl with sodium hydroxide

**Fig2**: glucosamine HCl with hydrogen chloride

**Fig3**: glucosamine HCl with hydrogen peroxide

**Fig4**: glucosamine HCl with water

**Results for forced degradation studies to check formulation aspect**

- When the drug reacts with alkali, which means sodium hydroxide, hydrolysis occurred.
- When the drug reacts with acid which means hydrogen chloride it was observed that no hydrolysis occurs
- When a drug reacts with an oxidizing agent which means hydrogen peroxide it was observed that no oxidation occurs.
- When the drug reacts with water it was observed that no hydrolysis occurs

As per the visual aspect, it was observed that alkali is the worst case than water with normal effect than hydrogen peroxide with better effect than acid which is considered as best for formulation [26].

**ACID>$H_2O_2$ >ALKALI**

**Table 3: Results Of Forced Degradation Studies**

| SNO | CHEMICAL | GLUCOSAMINE HCL ADDED | OBSERVATION | DRUG RETAINED | DRUG DEGRADED | % DRUG RETAINED |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Water | 1800mg | Slightly yellow | 1600mg | 200mg | 90% |
| 2 | HCl(acid) | 1800mg | Clear | 1773mg | 27mg | 98.5% |
| 3 | NaOH (alkali) | 1800mg | Dark brown | 900mg | 900mg | 50% |
| 4 | $H_20_2$ | 1800mg | No color change | 1330mg | 470mg | 85% |

**METHOD OF PREPARATION for Batch 22058**

- Take 60g of glucosamine hydrochloride and dissolve in 198g of purified water, stir it thoroughly to dissolve it completely
- Take 503g of sorbitol and add to glucosamine hydrochloride solution, stir it to dissolve.
- Take 3g of xanthan gum and 30g of propylene glycol then add 100ml of boiled water mix it thoroughly and allow to cool for some time. Then add 0.3ml of simethicone liquid to it, add 50g of glycerine mix it properly.
- The above xanthan gum preparation is placed on the mixer and mixed for 3 minutes.
- Remove the xanthium mixture from the mixer and allow to cool it then add it to the glucosamine hydrochloride solution and stir it[27].
- Dissolve 2g of sodium benzoate in 20ml water separately.
- Dissolve 2g of di sodium edetate in 20ml water separately
- Dissolve 3.5g of sucralose in 20ml water separately.
- To create a glucosamine hydrochloride solution, add the solution of sodium benzoate, di sodium edetate, and sucralose individually with a little time gap.
- Take 0.1g of menthol add 2g of propylene glycol to it and mix it properly to dissolve menthol completely.
- To the menthol solution add 5ml of sweet orange and 0.5 ml orange booster mix it properly and transfer this mixture to glucosamine hydrochloride solution
- Then add a pinch of sunset yellow supra to glucosamine HCl solution as it acts as a colouring agent.
- Stir the solution for some time until all the ingredients mix properly
- Check the solution pH.
- The pH obtained is 4.76.
- Then add 0.35g of citric acid anhydrous to the solution, stir it under the stirrer, and again check the solution pH.
- The pH obtained for glucosamine hydrochloride solution is 3.82**.**
- Then transfer the solution into dispensing bottles, and label it with a specific batch number.
- Thus, the glucosamine hydrochloride liquid is prepared [28].

**Label claim**: Each 10mL contains Glucosamine Hydrochloride equivalent to 500mg of Glucosamine.

**Method of Preparation for Batch 22061**

- Take 60g of glucosamine hydrochloride and dissolve in 198g of purified water, stir it thoroughly to dissolve it completely
- Take 500g of sorbitol and add to glucosamine hydrochloride solution, stir it to dissolve.
- Take 3g of xanthan gum and 30g of propylene glycol then add 100ml of boiled water mix it thoroughly and allow to cool for some time. Then add 0.3ml of simethicone liquid to it, add 50g of glycerine mix it properly.
- The above xanthan gum preparation is placed on the mixer and mixed for 3 minutes.
- Remove the xanthan mixture from the mixer allow it to cool then add it to the glucosamine hydrochloride solution and stir it.
- Dissolve 2g of sodium benzoate in 20ml water separately.
- Dissolve 2g of di sodium edetate in 20ml water separately
- Dissolve 3.5g of sucralose in 20ml water separately.
- To glucosamine hydrochloride solution, add the solution of sodium benzoate, di sodium edetate, and sucralose individually with a little time gap.
- Take 0.1g of menthol add 2g of propylene glycol to it and mix it properly to dissolve menthol completely.
- To the menthol solution add 5ml of sweet orange and 0.5 ml orange booster mix it properly and transfer this mixture to glucosamine hydrochloride solution
- Then add a pinch of sunset yellow supra to glucosamine HCl solution as it acts as a coloring agent.
- Stir the solution for some time until all the ingredients mix properly.
- Then add 0.35g of citric acid anhydrous to the solution stir it under the stirrer for some time then again check the solution pH.
- The pH obtained for glucosamine hydrochloride solution is 3.85**.**
- Then transfer the solution into dispensing bottles, and label it with a specific batch number.
- Thus, the glucosamine hydrochloride liquid is prepared.

**Label claim**: Each 10mL contains Glucosamine Hydrochloride equivalent to 500mg of Glucosamine

**Method of Preparation for Batch 22064**

- Take 60g of glucosamine hydrochloride and dissolve in 198g of purified water, stir it thoroughly to dissolve it completely
- Take 500g of sorbitol and add to glucosamine hydrochloride solution, stir it to dissolve.
- Take 3g of xanthan gum and 30g of propylene glycol then add 100ml of boiled water mix it thoroughly and allow to cool for some time. Then add 0.3ml of simethicone liquid to it, add 50g of glycerine mix it properly.
- The above xanthan gum preparation is placed on a mixer and mixed for 3 minutes.
- Remove the xanthan gum mixture from the mixer allow it to cool then add it to the glucosamine hydrochloride solution and stir it.

- Dissolve 2g of sodium benzoate in 20ml water separately.
- Dissolve 2g of di sodium edetate in 20ml water separately
- Dissolve 3.5g of sucralose in 20ml water separately.
- To glucosamine hydrochloride solution, add the solution of sodium benzoate, di sodium edetate, and sucralose individually with a little time gap.
- Take 0.1g of menthol add 2g of propylene glycol to it and mix it properly to dissolve menthol completely.
- To the menthol solution add 5ml of sweet orange and 0.5 ml orange booster mix it properly and transfer this mixture to glucosamine hydrochloride solution
- Then add a pinch of sunset yellow supra to glucosamine HCl solution as it acts as a colouring agent.
- Stir the solution for some time until all the ingredients mix properly.
- Then add 0.35g of citric acid anhydrous to the solution stir it under the stirrer for some time then again check the solution pH.
- The pH obtained for glucosamine hydrochloride solution is 3.86**.**
- Then transfer the solution into dispensing bottles, and label it with a specific batch number.
- Thus, the glucosamine hydrochloride liquid is prepared

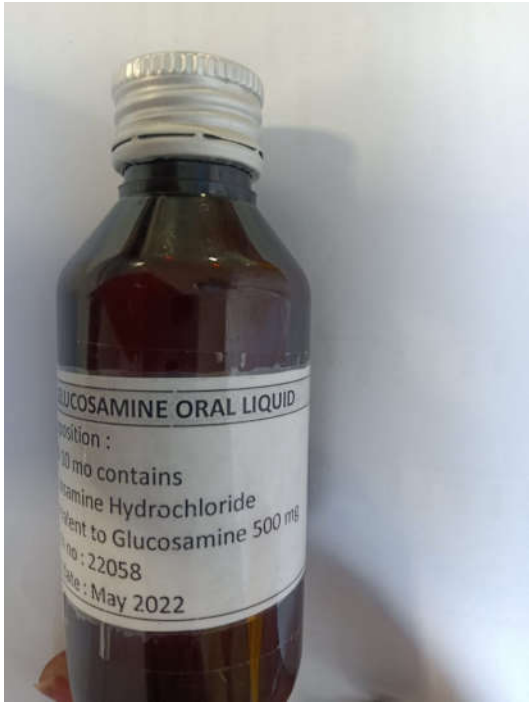
**Label claim**: Each 10mL contains Glucosamine Hydrochloride equivalent to 500mg of Glucosamine

Fig 5: Drug(Glucosamine HCl) with xanthan gum

Fig 6: Mixing of all ingredients

Fig 7: mixing of all ingredients


Fig 8: Glucosamine oral liquid formulation



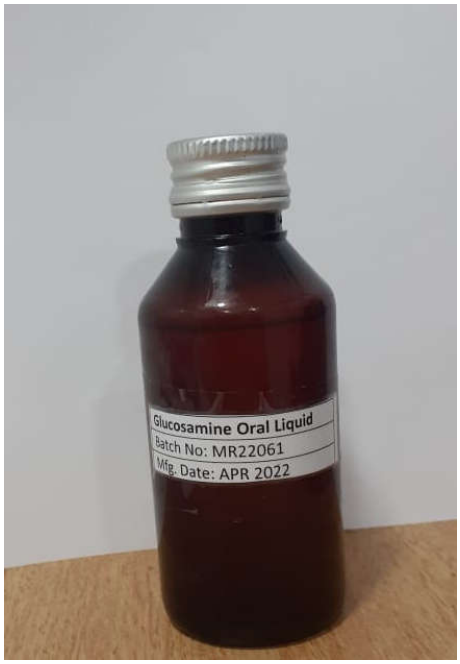




Fig 9 of packed formulation bottles of batch 22058,22061,22064

**OBSERVATION DURING MANUFACTURING**

**Table: 4 OBSERVATION TABLE FOR BATCH 22058**

| S.NO | PARAMETERS | SPECIFICATION | RESULT |
|---|---|---|---|
| 1 | Description | An orange colored, syrupy liquid | An orange colored, syrupy liquid |
| 2 | Ph | 3.5-5.0 | 3.82 |
| 3 | Weight per ml | 1.100g/ml-1.200g/ml | 1.1459g/ml |
| 4 | Assay<br>Each 10ml contains Glucosamine HCl Eq to Glucosamine500mg | 450mg/10ml equivalent to 90%of label claim | 500.5mg/ml( 100%) |
| 5 | Microbial Tests<br>i. TAMC<br>ii. TYMC<br>iii. E.Coli<br>iv. Salmonella sp<br>v. Pseudomonas aeruginosa<br>vi. Staphylococcus aerues | <br>NMT100cfu/ml<br>NMT10cfu/ml<br>Shouldbe absent<br>Shouldbe absent<br>Shouldbe absent<br>Should be absent | <br>40cfu/ml<br><10cfu/ml<br>Absent<br>Absent<br>Absent<br>Absent |

**Report:** In the opinion of the undersigned the sample referred to above is of standard quality as defined in the act and rules made there under for the reason given below[29].

**Observation:** The sample complies with the specification

**Table 5 OBSERVATION TABLE FOR BATCH 22061**

| S.NO | PARAMETERS | SPECIFICATION | RESULT |
|---|---|---|---|
| 1 | Description | An orange colored, syrupy liquid | An orange colored, syrupy liquid |
| 2 | Ph | 3.5-5.0 | 3.85 |
| 3 | Weight per ml | 1.100g/ml-1.200g/ml | 1.1486g/ml |
| 4 | Assay<br>Each 10ml contains Glucosamine HCl Eq to Glucosamine500mg | 450mg/10ml equivalent to 90%of label claim | 501.4mg/ml(100.02%) |
| 5 | Microbial Tests<br>i. TAMC<br>ii. TYMC<br>iii. E.Coli<br>iv. Salmonella sp<br>v. Pseudomonas aeruginosa<br>vi. Staphylococcus aerues | <br>NMT100cfu/ml<br>NMT10cfu/ml<br>Shouldbe absent<br>Shouldbe absent<br>Shouldbe absent<br><br>Should be absent | <br>20cfu/ml<br><10cfu/ml<br>Absent<br>Absent<br>Absent<br><br>Absent |

**Report:** In the opinion of the undersigned the sample referred to above is of standard quality as defined in the act and rules made there under for the reason given below[30].

**Observation:** The sample complies with the specification.

**Table 6 OBSERVATION TABLE FOR BATCH 22064**

| S.NO | PARAMETERS | SPECIFICATION | RESULT |
|---|---|---|---|
| 1 | Description | An orange colored, syrupy liquid | An orange colored, syrupy liquid |
| 2 | Ph | 3.5-5.0 | 3.86 |
| 3 | Weight per ml | 1.100g/ml-1.200g/ml | 1.1486g/ml |
| 4 | Assay<br>Each 10ml contains Glucosamine HCl Eq to Glucosamine500mg | 450mg/10ml equivalent to 90%of label claim | 500.4mg/ml(100.08%) |
| 5 | Microbial Tests<br>i. TAMC<br>ii. TYMC<br>iii. E.Coli<br>iv. Salmonella sp<br>v. Pseudomonas aeruginosa<br>vi. Staphylococcus aerues | <br>NMT100cfu/ml<br>NMT10cfu/ml<br>Shouldbe absent<br>Shouldbe absent<br>Shouldbe absent<br>Should be absent | <br>30cfu/ml<br><10cfu/ml<br>Absent<br>Absent<br>Absent<br><br>Absent |

**Report:** In the opinion of the undersigned the sample referred to above is of standard quality as defined in the act and rules made there under for the reason given below.

**Observation:** The sample complies with the specification

**Packaging:** The formulated solution is Filled in a 100ml bottle sealed in a bottle sealing machine and subjected to analysis.

**Assay**

**Buffer preparation:**

In a 1L volumetric flask, dissolve 3.5g of dibasic potassium phosphate in water, add 0.25mL of ammonium hydroxide, dilute with water to volume, and mix. Adjust with orthophosphoric acid to a pH of 7.5[31].

**Mobile phase:**

- In a 1L volumetric flask, dissolve 750mL of Acetonitrile in 250mL of buffer, and mix.
- Sonicate the prepared mobile phase for 10 min.
- Filter the mobile phase by using Nylon membrane filters.

**Diluent:** In a 1L volumetric flask, dissolve 500mL of Acetonitrile in 500mL of water, and mix.

**Blank solution:** Diluent was transferred into an HPLC vial with a syringe.

**Method of analysis:**

**Standard drug analysis:**

- In a 100ml volumetric flask, 600mg of glucosamine HCl was dissolved in a diluent (acetonitrile: water).
- The solution was sonicated for 10-15 min, then the solution was made up to mark with diluent.
- The standard solution was transferred into an HPLC vial with a syringe using a nylon disc filter.

**Analysis of samples:**

- In a 100ml volumetric flask, 9.60 g of Glucosamine oral liquid (sample solution) was dissolved in a diluent (acetonitrile: water).
- The solution was sonicated for 10-15 min, then the solution was made up to mark with diluent. The solution was filtered through nylon membrane filters.
- The standard solution was transferred into an HPLC vial with a syringe using a nylon disc filter (25mm).
- All three samples were analyzed in the same way as mentioned in the above procedure[32].

## 4. Results and Discussion:

The main challenge in this formulation is to formulate and stabilize glucosamine oral solution of 500mg/10ml. Glucosamine is unstable in aqueous formulation. Glucosamine is unstable at alkaline pH. It is very stable in acidic pH and also with suitable oxidizing agent. This formulation is an oral aqueous solution of Glucosamine Hydrochloride equivalent to 500mg/5ml containing sucralose, propylene glycol, glycerin, and Disodium edetate as stabilizers. Further, we optimized the formula with xanthan gum which is the primary stabilizing agent that helps to prevent the degradation of Glucosamine Hydrochloride Formulation. Further to enhance the stability, the pH of the formulation is adjusted to 3.86 with citric acid anhydrous and the actual limit is 3.5-5.0. To confirm the stability, the formulation was kept on Accelerated stability for 3 months. Results of in-process finished product and Accelerated stability charged samples found within the internal specifications as described in the formulation. This project aims to facilitate geriatric people to consume oral solutions without any difficulty because all the available formulations in the market in tablet form contain Glucosamine Hydrochloride or Glucosamine sulphate potassium chloride of 1500mg where Glucosamine base concentration is less than 1500mg and also tablet/capsule size available is very big which cause difficulty while consuming by geriatric people.

In Glucosamine oral liquid formulation, it contains Glucosamine500mg/10ml as Glucosamine Hydrochloride equivalent to 1500mg/30ml

- All geriatric patients can take 10ml 3 times daily (dose of 1500mg Glucosamine per day)
- All geriatric patients can take 5ml 3 times daily (dose of 750mg Glucosamine per day)
- All geriatric patients can take 5ml 3 times daily (dose of 500mg Glucosamine per day)

This dosage fluctuation is very easy for geriatric patients to take.

This is to declare that Glucosamine oral solution at various standard and convenient formulations is better than tablet formulation. As we performed three trails which were subjected to accelerated stability studies after formulation, in batch number 22061 trail got the desired stability with the necessary parameters

### Linearity:

- In a 100ml volumetric flask, 1000mg of the standard drug (glucosamine HCl) was weighed and dissolved in 100ml of diluent [33].
- From the above solution 8ml,10ml,12ml solution was taken and transferred into a 20ml volumetric flask and made up with diluent.
- The diluted solutions were transferred into vials using nylon syringe filters.
- The solutions were scanned in the HPLC.

# Results of Linearity:

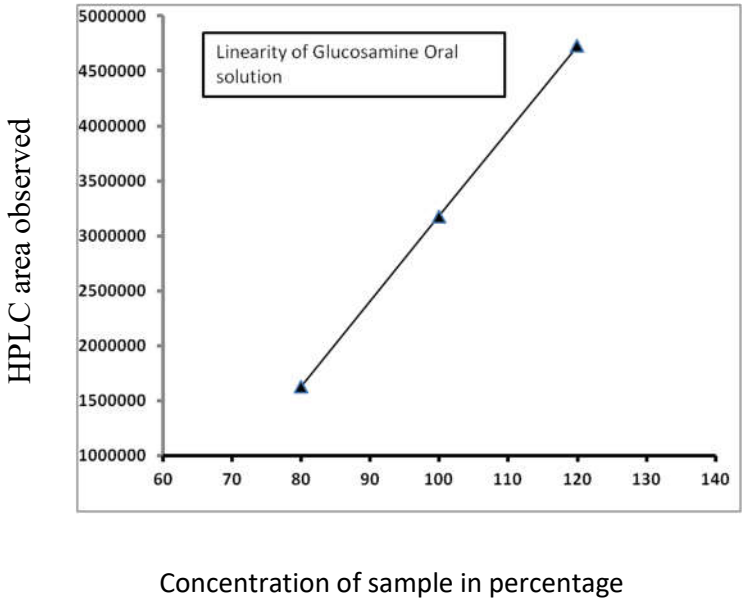



Fig 10: Linearity graph of glucosamine oral liquid sample solution

Table 7: linearity values

| Concentration of sample(%) | HPLC area |
|---|---|
| 80 | 1630091 |
| 100 | 3179835 |
| 120 | 4729579 |

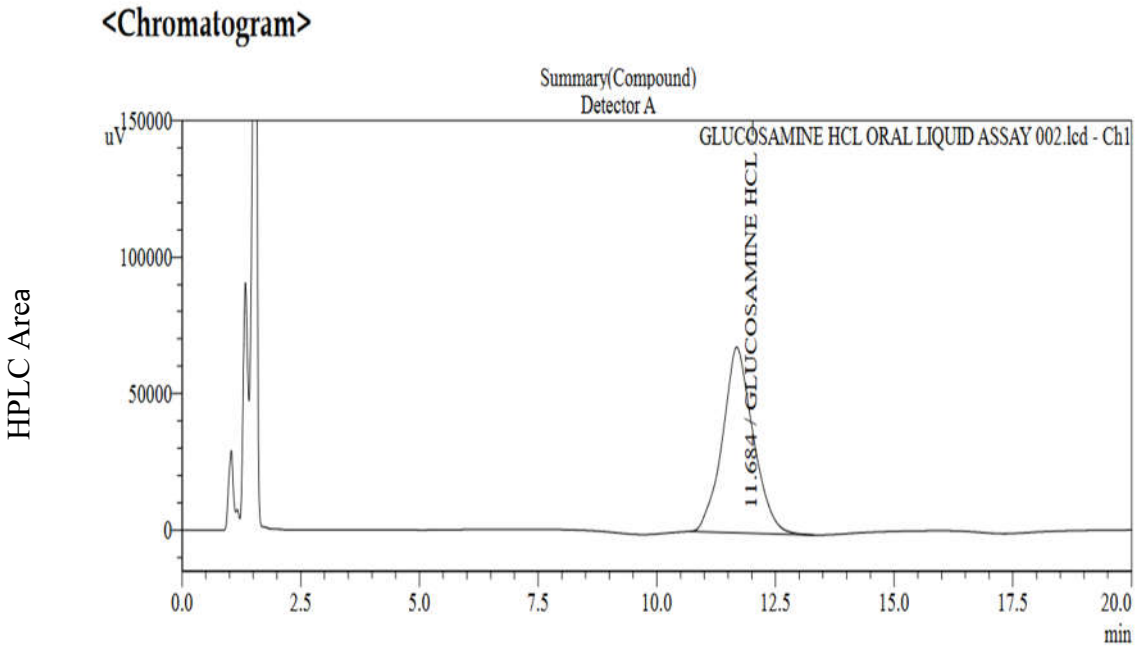



Fig 11: Chromatogram of Glucosamine Hydrochloride standard

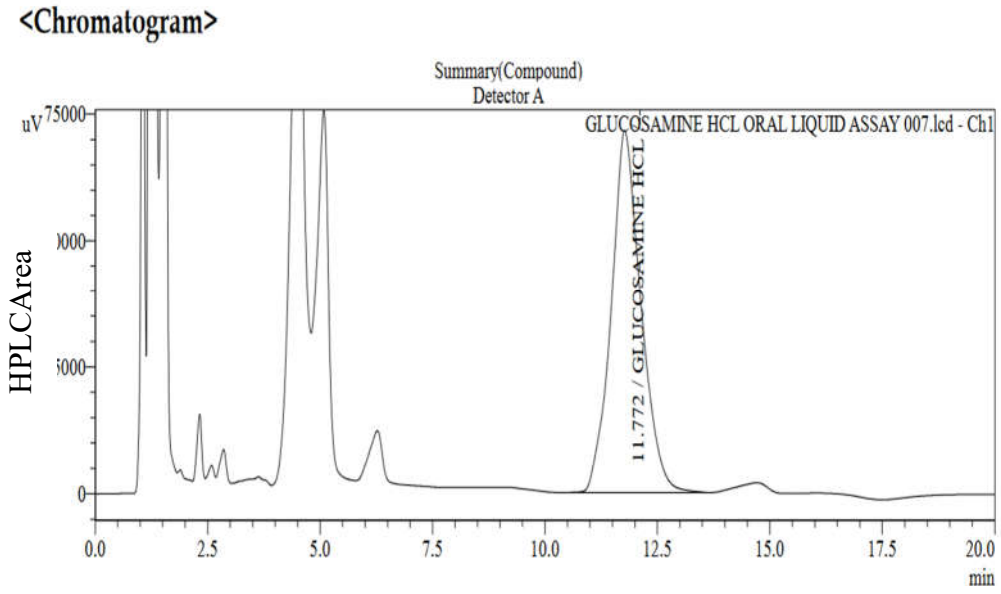



Fig 12 : Chromatogram of Glucosamine oral liquid Sample MR22058

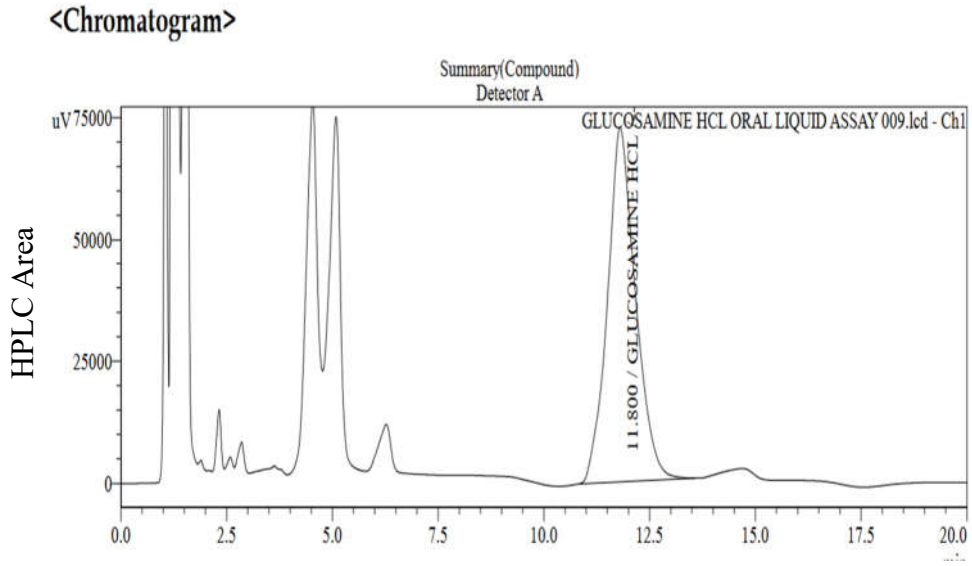



Fig13: Chromatogram of Glucosamine oral liquid Sample MR22061

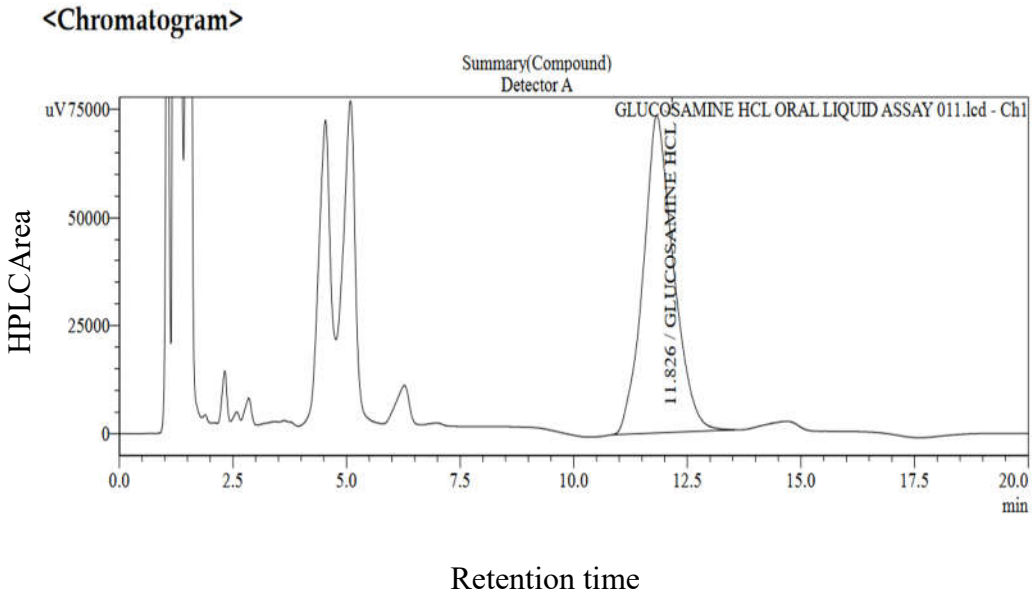



Fig 14: Chromatogram of Glucosamine oral liquid Sample MR22064

Table 8: Observed values of HPLC peak Areas, retention time of glucosamine oral liquid samples and standard

| S.NO | NAME OF SOLUTION | RETENTION TIME | HPLC AREA |
|---|---|---|---|
| 1 | Glucosamine Hydrochloride standard | 11.684 | 3053113 |
| 2 | Glucosamine oral liquid sample batch 22058 | 11.772 | 3277411 |
| 3 | Glucosamine oral liquid sample batch 22061 | 11.800 | 348152 |

| | | | |
|---|---|---|---|
| 4 | Glucosamine oral liquid sample batch 22064 | 11.826 | 3390801 |

**5. Conclusion:** Glucosamine hydrochloride is an amino monosaccharide that is used to treat osteoarthritis. Glucosamine is an essential component of mucopolysaccharides and chitin. Mucopolysaccharides are large complexes of negatively charged carbohydrate chains that incorporate into mucous secretions, connective tissue, skin, ligaments, and cartilage.

The solution form of Glucosamine hydrochloride could be successfully formulated by using a stirrer. The active ingredient Glucosamine hydrochloride is used with many inactive ingredients i.e. excipients like sorbitol are used as a bulking agent, xanthan gum is a viscosity modifier used in different proportions to attain stable formulation, glycerin is used as a sweetening agent, simethicone used as an antifoaming agent. As pH is most important to formulation, I used citric acid anhydrous as a pH modifier.

The HPLC was performed to Glucosamine hydrochloride oral liquid formulation along with the Glucosamine hydrochloride standard that allows qualitative and quantitative analysis of components, it also shows how much amount drug is contained in the sample.

The optimized formulation underwent stability studies at $40^0$C/75%RH. There was no change in physical characteristics.

It is a promising approach as it can release the required quantity of drug to the body and also the entire drug released to the target site and ultimately lead to better patient therapy.

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