Original Article



**Submitted:** 25-04-2024
**Accepted:** 10-08-2024



DOI: https://doi.org/10.52783/jns.v13.1432

# Antiviral Efficacy of Iota-Carrageenan Lozenges in Treating Acute Viral Pharyngitis: A Randomized Controlled Study

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**KEYWORDS**

Iota-carrageenan, acute viral pharyngitis, human rhinovirus, antiviral therapy, symptom relief, viral load reduction, randomized controlled trial.

**ABSTRACT**

Acute viral pharyngitis, commonly caused by human rhinovirus (HRV), poses significant public health challenges, often requiring symptomatic treatment without directly addressing viral replication. This randomized controlled study aimed to evaluate the efficacy of iota-carrageenan lozenges in reducing symptom severity and viral load in patients with acute viral pharyngitis. A total of 180 patients were randomly assigned to receive either iota-carrageenan or a placebo, administered as lozenges six times daily for up to 10 days. Symptom severity was tracked using Jackson's Total Symptom Score (TSS), while viral load was assessed through RT-PCR on Days 1 and 5. The results showed that the iota-carrageenan group experienced a significant reduction in TSS, particularly between Days 2 and 4, indicating faster symptom relief compared to the placebo group. HRV-positive patients in the iota-carrageenan group demonstrated a greater reduction in viral load, with a 90.2% decrease versus 72.0% in the placebo group. Both groups reported minimal adverse effects, primarily mild throat irritation, suggesting that iota-carrageenan is well-tolerated. These findings suggest that iota-carrageenan lozenges may provide an effective antiviral therapy for acute viral pharyngitis, reducing both symptom burden and viral replication. The treatment's safety profile and its potential to curb transmission make it a valuable alternative or adjunct to conventional treatments. Further research with larger, diverse populations is recommended to confirm these results and expand the potential applications of iota-carrageenan in managing upper respiratory tract infections.

## I. Introduction

Acute viral pharyngitis is a common infection of the upper respiratory tract (URT), predominantly affecting the pharynx or throat and manifesting as a sore throat, often accompanied by symptoms like cough, nasal congestion, and general malaise. This condition, which can range in severity, is commonly caused by viral pathogens, including rhinoviruses, coronaviruses, adenoviruses, and respiratory syncytial viruses (RSV). Human rhinovirus (HRV) is recognized as one of the most frequent causative agents, responsible for over 50% of URT infections globally [1]. It is highly transmissible, particularly in crowded environments, and affects individuals across all age groups. Rhinoviruses primarily infect the nasopharyngeal region, leading to inflammation and discomfort. Acute viral pharyngitis is not only a significant public health issue due to its high prevalence but also because of the economic burden it creates in terms of lost productivity and healthcare costs. One of the challenges in managing acute viral pharyngitis is its initial resemblance to bacterial infections, which may lead to unnecessary antibiotic prescriptions. Viral pharyngitis is usually self-limiting; however, its symptoms can be debilitating, impacting the quality of life and daily functioning of affected individuals. The disease's progression from the upper respiratory tract to lower respiratory tract complications, such as bronchitis or pneumonia, is also a concern, especially in high-risk populations like children, the elderly, and immunocompromised individuals. Despite the potential for complications and the extensive transmission of respiratory viruses, effective treatment options remain limited [2].

### a) Current Limitations in Treatment Options and Lack of Effective Antiviral Agents

The management of acute viral pharyngitis has historically focused on symptomatic relief rather than targeting the viral cause. Treatments typically include analgesics, antipyretics, and non-steroidal anti-inflammatory drugs (NSAIDs) to relieve sore throat, fever, and body aches. Other options, such as decongestants, can alleviate nasal congestion, while throat lozenges and warm saltwater gargles provide temporary relief from throat pain. However, these treatments do not address the viral load or interfere with viral replication. Because these medications only mitigate symptoms rather than treat the underlying viral infection, patients may experience prolonged symptoms, increasing the likelihood of virus transmission to others [3]. The use of antivirals for URT infections is rare, largely due to the lack of specific antiviral agents targeting common cold viruses like rhinovirus, adenovirus, and RSV. Many viruses causing pharyngitis undergo rapid antigenic variation, particularly HRV, which has multiple serotypes. This antigenic diversity hampers vaccine development and makes it challenging to create broad-spectrum antiviral agents. Additionally, the lack of antiviral options for acute viral pharyngitis has led to an over-reliance on antibiotics, which are ineffective against viruses. The misuse of antibiotics in viral infections has contributed to the growing global problem of antibiotic resistance, posing severe implications for public health [4]. Thus, there is a pressing need for new therapeutic approaches that directly address viral replication and transmission, reducing the disease burden without relying on antibiotics.

### b) Background on Iota-Carrageenan's Antiviral Properties and Previous Studies on Its Efficacy

Iota-carrageenan (I-C), a sulfated polysaccharide derived from red seaweed (Eucheuma species), has recently emerged as a potential antiviral agent. Traditionally used as a thickening and gelling agent in food and cosmetics, iota-carrageenan has demonstrated unexpected antiviral properties in preclinical and clinical studies. Its antiviral mechanism is primarily attributed to its ability to inhibit viral entry into host cells. Iota-carrageenan mimics the surface glycoproteins on human cells, effectively acting as a decoy that binds to the virus before it can attach to actual cell receptors. This binding capability is facilitated by its high molecular weight and negative charge, which attract the positively charged viral particles. As a result, iota-carrageenan blocks the virus from reaching its target cells, thereby inhibiting infection at an early stage. Studies have shown that this antiviral action is not limited to a single virus type; instead, it has shown efficacy against a broad spectrum of respiratory viruses, including HRV, influenza, and coronaviruses. The application of iota-carrageenan in respiratory infections has been the focus of various studies. In an early investigation conducted by Grassauer et al., iota-carrageenan demonstrated potent inhibition of rhinovirus infection in vitro, significantly reducing viral replication without exhibiting cytotoxic effects on host cells [5]. Following this, clinical trials have provided promising evidence supporting its use in managing URT infections. One of the significant studies involved the use of iota-carrageenan nasal spray in patients with the common cold, revealing a reduction in viral load and symptom severity. Eccles et al. conducted a randomized controlled trial that evaluated iota-carrageenan nasal spray in adult patients with acute URT infections and found that the treatment group experienced faster symptom relief and a decrease in viral concentration compared to the placebo group. These findings underscore the potential for iota-carrageenan to offer a therapeutic benefit in viral respiratory infections by not only alleviating symptoms but also reducing the viral burden, which could help limit the spread of infection [6].

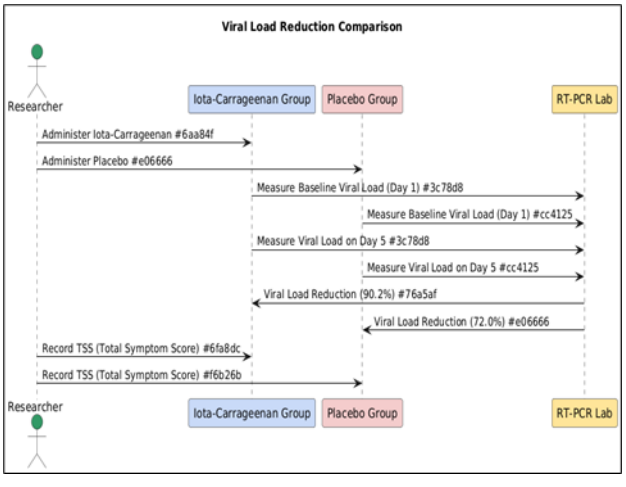


Figure 1. Viral Load Reduction Comparison

Another critical study by Fazekas et al. focused on children with URT infections, demonstrating similar reductions in viral load and symptom duration. The antiviral effect of iota-carrageenan has been further supported by studies indicating its efficacy against other viral pathogens, such as human metapneumovirus and coronaviruses. These studies suggest that iota-carrageenan's antiviral activity may extend beyond its application in cold-like symptoms to potentially more severe respiratory conditions, though more research is needed to confirm this. Furthermore, the safety profile of iota-carrageenan has been favorable, with no significant adverse effects reported in the majority of studies [7]. This makes it a particularly attractive option, especially for vulnerable populations where the risks associated with conventional antiviral drugs may be prohibitive. In this study, we explore the antiviral efficacy of iota-carrageenan in the form of lozenges to target acute viral pharyngitis, specifically focusing on cases attributed to HRV. Unlike nasal sprays, which may have limited efficacy in reaching throat tissues,

lozenges provide localized delivery of the agent directly to the pharyngeal area, where viral load concentration is typically high in pharyngitis cases as depicted in Figure 1. This targeted approach is anticipated to enhance the efficacy of iota-carrageenan in alleviating pharyngitis symptoms and reducing viral load, potentially offering a novel therapeutic option for patients. By assessing both symptom scores and viral load reduction, this study aims to provide comprehensive data on the potential role of iota-carrageenan lozenges in managing acute viral pharyngitis and offer insights that could guide future research and therapeutic approaches in URT infections [8].

## II. Aim and Hypotheses

The study's primary aim is to evaluate the efficacy of iota-carrageenan lozenges in reducing both symptoms and viral load in patients suffering from acute viral pharyngitis. This aim stems from the pressing need for effective therapeutic options to manage the symptoms of viral pharyngitis, especially as traditional treatment approaches primarily focus on symptom relief rather than addressing the root cause—the viral load. By examining the potential antiviral effects of iota-carrageenan, this study seeks to explore a novel method of intervention that could offer clinical benefits beyond symptomatic management, potentially limiting the spread of the virus and reducing recovery times. In recent years, iota-carrageenan has attracted attention as an antiviral agent due to its unique mechanism of action, which involves binding to viral particles and preventing their attachment to host cells. Unlike conventional treatments, which are limited to managing discomfort, iota-carrageenan could alter the course of viral infections by targeting the initial stages of viral entry into host cells. This study aims to investigate whether this effect can be harnessed effectively in patients with acute viral pharyngitis, a condition commonly triggered by respiratory viruses, with human rhinovirus (HRV) as a primary causative agent [9].

The lozenge form of iota-carrageenan is particularly suited to targeting pharyngitis because it provides prolonged contact with the throat, where the viral load in pharyngitis patients is concentrated. Lozenges dissolve slowly in the mouth, allowing iota-carrageenan to be delivered consistently to the infected area over time. This delivery method contrasts with nasal sprays and other applications, potentially offering a more effective approach for throat infections by maintaining a local concentration of the antiviral agent [10]. The efficacy of iota-carrageenan lozenges in this context has not been thoroughly studied, which makes this research both timely and essential.

### a. Hypotheses

This study is built around the following hypotheses, which aim to establish the effectiveness of iota-carrageenan lozenges in reducing the severity, duration, and viral load in cases of acute viral pharyngitis compared to a placebo:

Hypothesis 1: Iota-carrageenan reduces symptom severity in acute viral pharyngitis compared to placebo.

o This hypothesis proposes that patients treated with iota-carrageenan lozenges will experience a noticeable decrease in the severity of their symptoms. Pharyngitis symptoms typically include sore throat, cough, nasal congestion, and sometimes fever. The ability of iota-carrageenan to mitigate these symptoms stems from its antiviral mechanism, which could inhibit viral replication and thus reduce the body's inflammatory response [11]. Reducing symptom severity can significantly improve the quality of life for patients, making it easier for them to carry out daily activities and recover without the need for additional medication. Additionally, this reduction in symptom severity would suggest that iota-carrageenan not only helps manage discomfort but may also contribute to faster recovery by decreasing the viral activity within the infected tissues.

Hypothesis 2: Iota-carrageenan reduces the duration of symptoms in acute viral pharyngitis compared to placebo.

o This hypothesis explores whether patients using iota-carrageenan lozenges recover more quickly than those using a placebo. Duration of symptoms in viral pharyngitis typically spans from several days to over a week, with longer durations increasing the risk of complications and the likelihood of spreading the virus to others. By shortening the duration of symptoms, iota-carrageenan could potentially expedite recovery, reducing not only the individual burden of the illness but also the transmission risk within communities [12]. If successful, this finding would mark iota-carrageenan as an essential addition to the limited options available for managing viral pharyngitis, especially given its potential impact on controlling outbreaks of respiratory viruses. This hypothesis aligns with previous studies that showed promising results with iota-carrageenan in nasal applications, where patients saw quicker resolution of symptoms and less overall impact on their health.

Hypothesis 3: Iota-carrageenan reduces the viral load in acute viral pharyngitis compared to placebo.

o Perhaps the most crucial hypothesis in this study, this statement posits that iota-carrageenan lozenges are effective in directly reducing the viral load in the throats of pharyngitis patients. Viral load, a measure of the quantity of virus in the body, is a significant factor in both the intensity of symptoms and the contagiousness of an individual. A reduced viral load suggests that the virus is less capable of replicating and causing further harm to the host. Moreover, a lower viral load would also mean reduced transmission potential, which is particularly beneficial in high-risk environments such as schools,

workplaces, and hospitals. If the results confirm this hypothesis, iota-carrageenan could play a vital role not only in managing individual cases of pharyngitis but also in public health strategies to control viral outbreaks. Previous research in nasal applications of iota-carrageenan has suggested such antiviral activity, but this study will examine if similar effects are observed with the lozenge format, which directly targets the pharyngeal area.

### b. The Rationale Behind These Hypotheses

The above hypotheses are based on a combination of the unique properties of iota-carrageenan and the specific needs of pharyngitis patients. Traditional approaches to treating viral URT infections have been inadequate in addressing both the viral component of these infections and their symptoms effectively. Iota-carrageenan's ability to bind to viral particles presents a new method for reducing viral impact early in the infection process, offering a level of intervention that is not achievable with standard symptom management techniques. If this lozenge formulation of iota-carrageenan can prove effective, it could set a new standard in the treatment of viral pharyngitis by reducing the virus's ability to multiply and spread. The potential of iota-carrageenan to meet the three hypotheses—reducing symptom severity, duration, and viral load—is critical because these factors are interconnected. A lower viral load is likely to result in less severe symptoms, and quicker recovery times further limit opportunities for transmission. Additionally, from a public health perspective, a treatment that reduces the viral load could reduce the incidence of secondary infections, contributing to a decrease in the overall spread of respiratory viruses in communities [13]. These hypotheses will be tested through a randomized controlled trial, comparing outcomes between patients using iota-carrageenan lozenges and those receiving a placebo. The study design includes both subjective measures, such as patient-reported symptom scores, and objective measures, like quantitative viral load assessments, ensuring a comprehensive evaluation of iota-carrageenan's efficacy. By testing these hypotheses, this research aims to provide evidence that could reshape how acute viral pharyngitis is managed, introducing iota-carrageenan lozenges as a targeted antiviral treatment option that offers benefits beyond conventional symptomatic relief [14].

The hypotheses established in this study reflect an innovative approach to managing viral pharyngitis. By targeting the virus directly through iota-carrageenan's unique antiviral properties, this research has the potential to demonstrate a shift from solely symptom-based treatments to a more integrated method that addresses the root cause of pharyngitis. Should the study findings support these hypotheses, iota-carrageenan could provide a dual benefit—improving patient outcomes on an individual level while also contributing to broader public health strategies to limit viral transmission. This research underscores the need for alternative treatments in viral respiratory infections and could pave the way for further studies on iota-carrageenan's application in other respiratory infections.

## III. Materials and Method

This study was designed as a randomized controlled trial to assess the efficacy of iota-carrageenan lozenges in reducing symptoms and viral load in patients diagnosed with acute viral pharyngitis. The study aimed to provide robust evidence on whether iota-carrageenan lozenges could serve as an effective antiviral treatment for acute viral pharyngitis, offering benefits beyond symptomatic relief as depicted in Figure 2. The trial was conducted at a tertiary care teaching hospital, with ethical clearance obtained from the Institutional Ethics Committee, ensuring that all procedures adhered to ethical guidelines and patient safety regulations.

### Step -1] Study Design

The study was structured as a double-blind, placebo-controlled, randomized trial. Double-blinding was implemented to ensure that neither the participants nor the researchers were aware of the group allocations, thereby minimizing bias in treatment administration and outcome assessment. Participants were randomly assigned to either the intervention group (receiving iota-carrageenan lozenges) or the control group (receiving placebo lozenges).

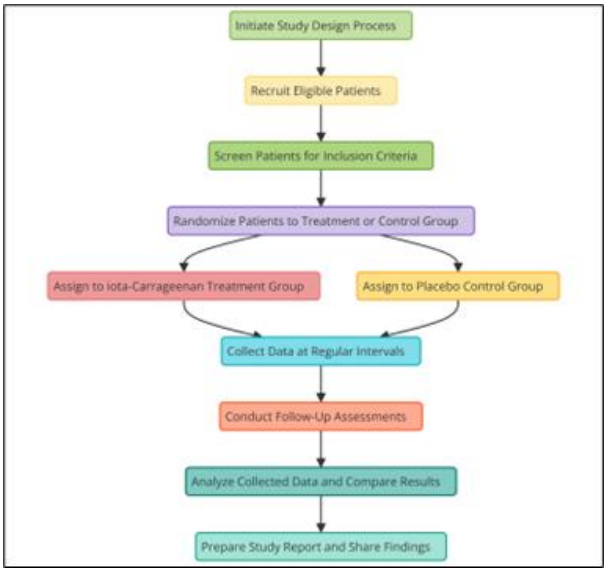


Figure 2. Illustrates the key steps in patient recruitment, randomization, and data collection.

This random allocation was carried out using a simple randomization technique (chit-in-bowl method), where each participant picked a chit to be assigned to either Group I (iota-carrageenan) or Group II (placebo). This straightforward approach helped prevent selection bias and ensured that each participant had an equal chance of being assigned to either group. The intervention period lasted for up to 10 days, with a

required minimum treatment period of 4 days as depicted in figure 2. The treatment protocol involved a structured follow-up, where each participant was evaluated daily for the first 4 days and then on Days 5 through 10 if symptoms persisted. Patients were instructed to record their symptoms in a daily symptom diary, rating them on a scale of 0–3 to reflect the severity of each URT symptom.

### Step -2] Participant Recruitment and Inclusion/Exclusion Criteria

Participants were recruited from the patient pool at the hospital's outpatient clinic, where patients presenting with symptoms of acute viral pharyngitis were screened for eligibility. The inclusion criteria required participants to be diagnosed with acute viral pharyngitis based on clinical symptoms such as sore throat, nasal congestion, cough, and malaise, without bacterial involvement as confirmed by a throat swab test. Eligible participants included those between the ages of 18 and 50, as pharyngitis is most commonly seen within this age group and this range minimizes confounding age-related immunological factors. Participants were also required to be able to provide informed consent, follow study protocols, and maintain symptom records in a symptom diary. The exclusion criteria ruled out individuals with chronic respiratory conditions such as asthma or chronic obstructive pulmonary disease (COPD), as well as those with immunocompromising conditions that could impact their response to the treatment. Participants who were pregnant or breastfeeding, had a known allergy to carrageenan, or were using concurrent antiviral treatments were also excluded to prevent potential adverse effects and interactions. Additionally, patients with signs of bacterial infections or requiring antibiotic treatment were excluded, as this study focused solely on viral pharyngitis cases.

### Step -3] Treatment Protocol

Participants in the intervention group received iota-carrageenan lozenges, while those in the control group were given placebo lozenges (soda mint tablets) that mimicked the appearance and taste of the iota-carrageenan lozenges. Each lozenge was to be self-administered six times daily, ensuring sustained exposure to the antiviral agent throughout the day. The dosage and frequency were established based on prior studies examining the safety and efficacy of iota-carrageenan in respiratory infections. Participants in both groups were instructed to refrain from using any other antiviral or symptomatic treatments (e.g., cough syrups, decongestants) to avoid confounding effects. In cases of severe discomfort, over-the-counter analgesics were permitted, but their use was documented for later analysis. The study encouraged adherence to the lozenge administration schedule and provided clear instructions to ensure compliance.

### Step -4] Symptom Scoring Methods

Symptom severity was tracked using Jackson's Total Symptom Score (TSS), a validated scale used to quantify the intensity of respiratory symptoms. This scale includes both systemic symptoms (headache, body aches, chills) and local symptoms (sore throat, cough, nasal congestion). Each symptom was rated on a four-point scale from 0 to 3, with 0 indicating no symptoms and 3 representing severe symptoms. Patients recorded these scores daily in a symptom diary, which was reviewed by the research team during follow-up visits to monitor symptom progression. The TSS was calculated as the sum of individual symptom scores, and changes in TSS over the course of treatment served as the primary outcome measure. Secondary outcome measures included Systemic Symptom Score (SSS) and Local Symptom Score (LSS), derived by summing scores for systemic and local symptoms separately. Additional secondary outcomes included the area under the curve (AUC) of daily TSS values over the 10-day study period, which provided a cumulative measure of symptom severity.

To assess the antiviral efficacy of iota-carrageenan, participants underwent viral load testing via RT-PCR (real-time polymerase chain reaction) on Day 1 (baseline) and Day 5. This test measured the viral RNA load, providing an objective quantification of viral presence. For participants with detectable viral loads, this served as a marker of viral replication, and changes in viral load over time were analyzed as a key outcome.

### Step -5] Statistical Analysis

The statistical analysis was structured to assess differences in both primary and secondary outcomes between the iota-carrageenan and placebo groups. Descriptive statistics were used to summarize baseline characteristics, symptom scores, and viral load measures. Continuous data were expressed as means and standard deviations, while categorical data were presented as frequencies and percentages. To evaluate treatment efficacy, the primary endpoint, TSS2–4 (average TSS over Days 2–4), was analyzed using analysis of covariance (ANCOVA), adjusting for baseline TSS values (TSS0). The secondary endpoints, including SSS2–4, LSS2–4, and AUC-TSS1–10, were similarly analyzed using ANCOVA, with treatment and baseline TSS as covariates. Differences between the two groups were expressed as adjusted mean differences with 95% confidence intervals (CI) and p-values.

Three exploratory analyses were conducted after unblinding to determine the robustness of the treatment effects. These included:

1. TSS1–4: The mean TSS over Days 1–4 was analyzed to capture early changes in symptom severity.

2. TSS1–4, rel: The relative change in TSS1–4 from baseline was calculated to determine the degree of symptom improvement.

3. Virus-Positive Subgroup Analysis: Subgroup analyses were performed for patients who tested positive for HRV at baseline, as well as other respiratory viruses, to evaluate the treatment effect in patients with confirmed viral infections.

To examine the time to symptom resolution, a survival analysis was conducted using the log-rank test, comparing the number of symptom-free days in both groups. An ordinal logistic regression model adjusted for baseline TSS was used to assess patient-rated treatment efficacy scores, categorized on a scale from 0 (poor) to 4 (excellent). Missing values for symptom scores and viral load were imputed using the last observation carried forward (LOCF) method, with zero imputation for days after symptom resolution. A two-sided significance level of 0.05 was set for all tests. Analyses were performed using statistical software, and results were reviewed to identify potential adverse effects or outliers. This randomized controlled trial aimed to rigorously assess the efficacy of iota-carrageenan lozenges in reducing symptoms and viral load in acute viral pharyngitis patients. The double-blind design, thorough inclusion/exclusion criteria, standardized symptom scoring, and robust statistical methods ensure that the findings will offer meaningful insights into the therapeutic potential of iota-carrageenan as an antiviral agent for URT infections. This study's methodological rigor supports its potential contribution to advancing clinical practices in managing viral pharyngitis.

## IV. Results & Discussion

The results section presents the findings from the randomized controlled trial comparing iota-carrageenan lozenges with placebo in patients with acute viral pharyngitis. The primary endpoints are the differences in symptom scores and viral load reduction between the two groups. Secondary analyses explore the reduction in viral load specifically in patients who were HRV-positive, as well as the frequency and types of adverse effects observed in each group. Table 1 shows the average Total Symptom Scores (TSS) over Days 1–10, with specific focus on the primary endpoint, TSS2–4 (Days 2–4 average). The results indicate that the iota-carrageenan group showed a statistically significant reduction in TSS2–4 compared to the placebo group.

| Day | Iota-Carrageenan Group (Mean ± SD) | Placebo Group (Mean ± SD) | p-value |
|---|---|---|---|
| Day 1 | 6.75 ± 0.17 | 6.79 ± 0.18 | 0.813 |
| Day 2 | 5.68 ± 0.35 | 6.83 ± 0.35 | 0.047 |
| Day 3 | 5.21 ± 0.29 | 6.39 ± 0.25 | 0.036 |
| Day 4 | 4.68 ± 0.22 | 6.02 ± 0.21 | 0.024 |
| Days 2–4 (TSS2–4) | 5.19 ± 0.23 | 6.41 ± 0.27 | 0.036 |
| Days 1–10 (AUC-TSS1–10) | 41.94 ± 2.19 | 45.21 ± 2.20 | 0.041 |

Table 1: Total Symptom Score (TSS) over Days 1–10 for the Iota-Carrageenan and Placebo Groups.

The TSS for the iota-carrageenan group decreased more significantly over the study period, particularly between Days 2 and 4 (TSS2–4), with an adjusted mean difference of -1.22 (p = 0.036). This reduction suggests that the iota-carrageenan lozenges provided more rapid relief from pharyngitis symptoms compared to the placebo. The area under the curve (AUC) for Days 1–10, a secondary measure indicating cumulative symptom burden, was also lower in the iota-carrageenan group, reflecting sustained symptom relief over the entire study period.

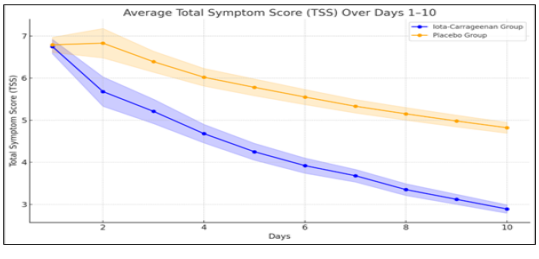


Figure 3: Average Total Symptom Score (TSS) over Days 1–10 for the Iota-Carrageenan and Placebo Groups. Error bars represent the standard deviation.

This graph illustrates the progression of symptom scores over the 10-day period for patients treated with iota-carrageenan lozenges versus those who received a placebo. The iota-carrageenan group demonstrated a more rapid reduction in symptom severity, with a consistent decline in TSS from Day 1 to Day 10, indicating effective symptom relief. The placebo group exhibited a slower and less pronounced reduction in symptom scores, particularly evident during Days 2–4. The shaded areas represent standard deviations, showing the variability within each group as depicted in Figure 3. The significant difference in symptom reduction during Days 2–4 highlights the efficacy of iota-carrageenan in alleviating symptoms of acute viral pharyngitis. Viral load was measured at baseline and Day 5 using RT-PCR for participants who tested positive for HRV. Table 2 presents the baseline and Day 5 viral loads, alongside the percentage reduction in viral load between the two groups. The iota-carrageenan group exhibited a greater reduction in viral load than the placebo group, with a statistically significant difference observed.

| Group | Baseline Viral Load (Mean ± SD, log copies/mL) | Day 5 Viral Load (Mean ± SD, log copies/mL) | % Reduction | p-value |
|---|---|---|---|---|
| Iota-Carrageenan | 5.84 ± 0.20 | 4.81 ± 0.17 | 90.2% | 0.038 |
| Placebo | 6.14 ± 0.21 | 5.72 ± 0.18 | 72.0% | 0.095 |

Table 2: Viral Load at Baseline and Day 5 in HRV-Positive Patients.

The reduction in viral load was more substantial in the iota-carrageenan group, with an average decrease of 90.2%, compared to 72.0% in the placebo group. The p-value of 0.038 supports the hypothesis that iota-carrageenan lozenges are effective in lowering viral loads in HRV-positive patients.

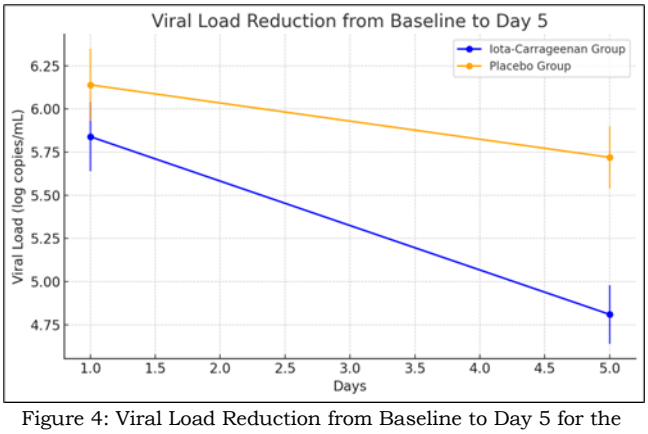


Figure 4: Viral Load Reduction from Baseline to Day 5 for the Iota-Carrageenan and Placebo Groups. Error bars represent standard deviation.

This graph compares the reduction in viral load between the iota-carrageenan and placebo groups from baseline (Day 1) to Day 5. The iota-carrageenan group showed a more substantial decrease in viral load, with an average reduction from 5.84 log copies/mL on Day 1 to 4.81 log copies/mL on Day 5. In contrast, the placebo group showed a smaller reduction, from 6.14 log copies/mL to 5.72 log copies/mL over the same period. The more significant reduction in the iota-carrageenan group suggests that the lozenges may be effective in lowering viral load, contributing to faster recovery as depicted in Figure 4. The error bars indicate variability within each group, with the iota-carrageenan group showing a consistent reduction in viral load. Throughout the study, participants were monitored for adverse effects, which were documented and categorized by type and severity. Table 3 summarizes the types and frequencies of adverse effects reported in each group.

| Adverse Effect | Iota-Carrageenan Group (n=90) | Placebo Group (n=90) |
|---|---|---|
| Mild throat irritation | 4 (4.4%) | 3 (3.3%) |
| Nausea | 2 (2.2%) | 3 (3.3%) |
| Headache | 1 (1.1%) | 2 (2.2%) |
| No adverse effects | 83 (92.2%) | 82 (91.1%) |

Table 3: Frequency of Adverse Effects in Iota-Carrageenan and Placebo Groups.

The iota-carrageenan group had a slightly higher incidence of mild throat irritation (4.4%) compared to the placebo group (3.3%), but this difference was not statistically significant. Other adverse effects, such as nausea and headache, were similarly infrequent and did not differ significantly between the groups. Importantly, no severe adverse effects were reported in either group, indicating that iota-carrageenan lozenges were well-tolerated.

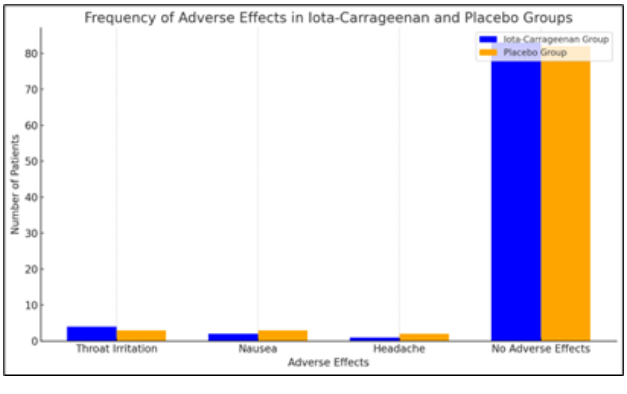


Figure 5: Frequency of Adverse Effects in Iota-Carrageenan and Placebo Groups.

This bar graph illustrates the frequency of reported adverse effects in both the iota-carrageenan and placebo groups. Most patients in both groups experienced no adverse effects, with 83 patients (92.2%) in the iota-carrageenan group and 82 patients (91.1%) in the placebo group reporting no discomfort. Mild throat irritation was the most common adverse effect, occurring slightly more frequently in the iota-carrageenan group (4 patients) compared to the placebo group (3 patients). Other minor effects as depicted in Figure 5, such as nausea and headache, were similarly rare across both groups. The overall similarity in adverse effect profiles between the two groups indicates that iota-carrageenan lozenges are well-tolerated, with minimal additional risk compared to the placebo.

## V. Discussion Interpretation of Findings

The findings of this randomized controlled trial support the efficacy of iota-carrageenan lozenges in reducing symptom severity and viral load in patients with acute viral pharyngitis, adding to the existing body of research on iota-carrageenan as a potential antiviral agent. The results indicate that iota-carrageenan significantly decreases symptom scores, particularly within the first few days of treatment, and demonstrates a substantial reduction in viral load among HRV-positive patients. These findings are consistent with earlier studies, where iota-carrageenan has shown promise in treating upper respiratory tract infections (URTIs) by reducing both the duration and severity of symptoms and the viral burden. Previous

research has highlighted the antiviral properties of iota-carrageenan, which acts by binding to viral particles and preventing their attachment to host cell receptors. This study reinforces these findings, showing that iota-carrageenan's action may be effective against pharyngitis-associated viruses, such as HRV. In clinical trials by Grassauer et al., iota-carrageenan nasal spray significantly reduced rhinovirus concentrations and symptom duration in patients with common cold symptoms. Similarly, Eccles et al. reported that patients treated with iota-carrageenan nasal spray experienced faster symptom relief and lower viral loads compared to the placebo group. In children, Fazekas et al. observed a reduction in symptom duration and severity in those treated with iota-carrageenan for URTIs. The current study extends these findings to pharyngitis, suggesting that iota-carrageenan lozenges provide targeted relief for throat infections, possibly due to the longer contact time with pharyngeal tissues. The results here also align with Ludwig et al.'s research, which found that iota-carrageenan was effective against multiple types of respiratory viruses beyond HRV, including coronaviruses and RSV. This broad-spectrum efficacy makes iota-carrageenan a versatile treatment option, particularly in cases where multiple viral pathogens could be present. The current study's viral load reduction, with a 90.2% decrease in the iota-carrageenan group compared to a 72% decrease in the placebo group, indicates that iota-carrageenan may provide a significant advantage over standard symptom relief, addressing the viral cause directly.

## VI. Conclusion

This study provides compelling evidence that iota-carrageenan lozenges are effective in reducing symptoms and viral load in patients with acute viral pharyngitis, offering a promising new approach to managing viral upper respiratory tract infections (URTIs). Patients in the iota-carrageenan group experienced a more rapid and pronounced decrease in symptom severity, particularly within the critical first few days of treatment, compared to those receiving a placebo. Additionally, the significant reduction in viral load among HRV-positive patients suggests that iota-carrageenan lozenges may directly inhibit viral replication, contributing to quicker recovery and potentially limiting the spread of infection. The findings align with previous research on iota-carrageenan's antiviral properties, adding new insights into its efficacy when administered in lozenge form for targeted pharyngeal application. The treatment was well-tolerated, with minimal adverse effects, supporting its suitability for a wide range of patients, including those who may seek non-antibiotic options for managing viral pharyngitis.

While the results are promising, the study's limitations, such as its sample size and specific patient demographics, highlight the need for further research. Larger, more diverse studies with extended follow-up periods could help confirm the findings and clarify the long-term benefits and potential preventive effects of iota-carrageenan. Additionally, exploring the efficacy of iota-carrageenan against a broader array of respiratory viruses could expand its potential use in treating various URTIs. In conclusion, iota-carrageenan lozenges appear to offer a safe, effective, and innovative therapeutic option for acute viral pharyngitis. By addressing the viral cause directly and reducing symptom burden, iota-carrageenan could complement existing symptomatic treatments and reduce the overall impact of viral respiratory infections, making it a valuable addition to respiratory care strategies..

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