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Nigella sativa as an adjuvant therapy in the treatment of pediatric pneumonia

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Abstract

Background Nigella sativa possesses anti-inflammatory and immunomodulatory properties that may attenuate lung injury during infection. This study aimed to evaluate the adjunctive effect of oral Nigella sativa oil on the clinical course, inflammatory markers, and recovery parameters in children hospitalized with community-acquired pneumonia, assessing its potential anti-inflammatory and immunomodulatory benefits.

Methods Between April 2023 and March 2024, 104 children with radiologically confirmed pneumonia were randomized to receive either standard institutional therapy plus oral Nigella sativa oil ($n = 52$) or standard therapy alone ($n = 52$). Primary endpoints were time to clinical stability, defined by normalization of respiratory rate, oxygen saturation $\geq 95\%$ on room air, and resumption of oral feeding. Secondary endpoints included changes in inflammatory and tissue injury biomarkers [white blood cell count, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), lactate dehydrogenase (LDH)].

Results The study included children with a mean age of 4.76 ± 2.58 years, with males comprising 57.69% ($n = 60$) of the participants. Compared with controls, the Nigella sativa group achieved faster normalization of respiratory rate ($p < 0.001$), earlier recovery of oxygen saturation ($p = 0.001$), and earlier resumption of oral feeding ($p = 0.013$). Significant reductions in WBC ($p = 0.036$), CRP ($p = 0.023$), ESR ($p = 0.001$), and LDH ($p = 0.027$) were observed. No adverse effects were reported.

Conclusion Adjunctive oral Nigella sativa oil supplementation was associated with faster clinical recovery and improved inflammatory profiles in children with pneumonia.

Clinical trial registration ClinicalTrials.gov (Identifier: NCT05952102), First submitted and met quality control criteria on July 11, 2023; first posted publicly on July 19, 2023.

Keywords Nigella sativa oil, Adjuvant therapy, Pediatric pneumonia

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Background

Pneumonia remains a leading cause of morbidity and mortality among children, particularly in low- and middle-income countries (LMICs). Globally, it accounts for the highest number of deaths in children under five years of age [1]. The annual incidence of pneumonia in this age group is estimated at 34–40 cases per 1000 children in high-income countries, while rates in LMICs are 2–10 times higher, with correspondingly greater severity and mortality [2, 3].

Nigella sativa (black seed), a member of the Ranunculaceae family, has long been used in traditional medicine across the Middle East for its analgesic, antiseptic, and anti-inflammatory properties. It has been employed in the management of rheumatism, asthma, and bronchitis [4]. According to several studies, *N. sativa* oil has immunostimulant properties that aid the fight against infections by triggering different cellular mediators and immunological responses. On the other hand, studies on inflammatory diseases demonstrate that *N. sativa* oil has immunomodulatory and anti-inflammatory qualities through the reduction of pro-inflammatory mediators. Reports have also emphasized *N. sativa* oil's bronchodilation, analgesic, and antipyretic qualities [5].

The major bioactive compound of *N. sativa*, thymoquinone (TQ), exhibits potent antioxidant, anti-inflammatory, and antimicrobial activities [6]. Thymoquinone modulates inflammatory pathways by downregulating cytokines such as TNF- α , IL-1 β , and IL-6, and inhibiting cyclooxygenase (COX) and lipoxygenase (LOX) enzymes. Moreover, it has demonstrated broad-spectrum antimicrobial and antiviral effects, including potential benefits in COVID-19 due to its immune-modulating properties [7].

Despite these promising findings, most evidence arises from adult or animal studies, with limited data regarding the safety, optimal dosing, and efficacy of *N. sativa* in children with pneumonia. Therefore, this study aimed to evaluate the adjunctive therapeutic benefits of oral *Nigella sativa* oil supplementation, alongside standard antibiotic and supportive therapy, in hospitalized children with pneumonia.

Methods

Study design and setting

This randomized controlled study was conducted on 104 pediatric patients diagnosed with pneumonia and admitted to the Pulmonology Unit, Pediatric Department, during the period from April 2023 to March 2024. Written informed consent was obtained from the guardians of all patients.

Sample size calculation

The required sample size was calculated using the EPI INFO sample size calculator for analytic studies. With a significance level (α) of 0.05, a study power of 80%, and a 95% confidence interval, the calculated sample size to assess the role of *Nigella sativa* in the treatment of pediatric pneumonia was 104 patients. This number included an additional 10% to account for potential losses during the follow-up period. Participants were randomly allocated into two equal groups ($n = 52$ per group).

All children aged between two months and 18 years who met the clinical criteria for pneumonia were included in the study. The diagnostic criteria comprised symptoms such as fever, cough, tachypnea, and respiratory difficulty, along with signs of respiratory distress, including nasal flaring, lower chest wall indrawing, or hypoxia in room air. Clinical assessment also considered auscultatory findings such as focal crackles or decreased breath sounds, supported by radiological evidence of pneumonia on chest X-ray [8].

Children with underlying immunodeficiency, chronic lung disease, malignancy, congenital pulmonary malformations, or neuromuscular disorders affecting respiratory function were excluded from the study.

Randomization and study groups

Eligible participants were randomly assigned into two groups:

- Group 1 (*Nigella sativa* group; $n = 52$): Received *Nigella sativa* oil in soft gelatin capsule form (each capsule containing 450 mg of *Nigella sativa* oil), at a dose of 40 mg/kg/day [9]. The supplement was administered as an adjunct to standard pneumonia treatment for 10 days. For children who could not swallow capsules, the contents were mixed with a small amount of water or fruit juice immediately before ingestion to ensure palatability and compliance.
- Group 2 (Placebo group; $n = 52$): Received standard-of-care treatment for pneumonia in accordance with institutional guidelines, in addition to a matching placebo.

A randomization table was generated using the computer software program “Research Randomizer” to ensure unbiased allocation. Allocation concealment will be maintained through the use of sealed, opaque envelopes. Additionally, outcome assessors will remain blinded to group assignments to minimize the risk of assessment bias. The control group received standard therapy alone, whereas the intervention group received

Nigella sativa oil in addition to standard therapy. No placebo capsule identical in appearance was used.

Outcome assessors and data analysts were blinded to treatment allocation to reduce assessment bias. Participant and clinician blinding was not feasible due to the characteristic odor and taste of *Nigella sativa* oil.

The standard antibiotic protocol in the pediatric department involves the use of 3rd generation cephalosporins, either as monotherapy or in combination with ampicillin-sulbactam, for the treatment of uncomplicated pneumonia. Meropenem and vancomycin were used for the treatment of complicated pneumonia.

Clinical evaluation

All enrolled patients underwent a thorough clinical examination. This comprised a detailed medical history that included information on age, sex, duration of symptoms, previous hospitalization, and antibiotic use. A comprehensive physical examination was conducted, which included systemic and general evaluations. The respiratory system received special attention, and clinical symptoms such as chest indrawing, reduced chest expansion and lung auscultation including crepitations, wheezing, bronchial breath sounds, and diminished air entry were documented. Measurements of respiratory rate and peripheral oxygen saturation (SpO₂) were made both before and after treatment.

Before randomization, patients were clinically and radiologically assessed to determine pneumonia severity and distribution pattern (unilateral/bilateral, lobar/multilobar) to ensure comparable baseline characteristics between groups. Pneumonia severity was assessed using the Respiratory Index of Severity in Children (RISC) at both baseline and during follow-up, according to the criteria described by Reed et al., [10]. The RISC score incorporates several clinical parameters, including oxygen saturation $\leq 90\%$ (3 points), presence of chest indrawing (2 points), wheezing (– 2 points), refusal of feeding (1 point), and weight-for-age z-scores, with scores assigned as follows: $Z \leq -3$ (2 points), $-3 < Z \leq -2$ (1 point), and $Z > -2$ (0 points). The maximum possible total score is 6, with higher scores indicating greater severity.

Investigations

Laboratory tests including complete blood count (CBC) with differential, renal function tests (urea and creatinine), liver enzymes (alanine aminotransferase (ALT), aspartate aminotransferase (AST)), serum albumin, total bilirubin, inflammatory markers such as C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), lactate dehydrogenase (LDH), and pleural fluid analysis and culture were included. A chest X-ray and lung ultrasound were performed in all patients, while a CT scan of the

chest was only performed when complicated CAP is anticipated.

Lung ultrasound was done after plain radiography on the same day. Chest ultrasound is performed using Mindray machine- appropriate transducers and frequencies, according to the age and the body build of the child (5–8 MHz micro convex, 5–12 MHz linear array, and 3–5 MHz convex transducers) most effective in visualizing the chest wall, pleura, and the lung peripheral parenchyma.

The technique consisted of longitudinal scans, from top to bottom, along the anatomical lines of the thorax (parasternal, midclavicular axillary, and paravertebral lines) as well as axial scans along with the intercostal spaces. In most cases, dorsal regions were examined in the sitting position, while anterior regions were examined in the supine position. Ultrasound findings associated with pneumonia were recorded, such as hypoechoic areas of various sizes and shapes, air bronchograms, fluid bronchograms, B-lines, the vascular pattern within the consolidation, and pleural effusion.

Outcome

The primary outcomes of the study included the duration of clinical improvement in pneumonia, specifically measured by the time required for normalization of respiratory rate, body temperature, and oxygen saturation. Clinical stability was defined according to the criteria of British Thoracic Society (BTS) pediatric pneumonia guidelines. Normalization parameters included: temperature $< 37.5^{\circ}\text{C}$ for at least 24 h, age-adjusted respiratory rate within normal range, oxygen saturation $\geq 95\%$ on room air, absence of chest indrawing, and the ability to maintain oral intake [8].

In addition, the study evaluated the impact of treatment on inflammatory biomarkers, including C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and lactate dehydrogenase (LDH) after 10 days of treatment as well as the length of hospital stay. Secondary outcomes included the discharge or death of the patient and the occurrence of pneumonia-related complications.

Statistical analysis

Statistical analysis was done by SPSS v27 (IBM®, Armonk, NY, USA). Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of data. Quantitative parametric data were presented as mean and standard deviation (SD) and were analyzed by unpaired student t-test. Quantitative non-parametric data were presented as the median and interquartile range (IQR) and were analyzed by the Mann Whitney-test. Qualitative variables were presented as frequency and percentage (%) and analyzed using the Chi-square test or Fisher's exact and Monte-Carlo test when

appropriate. A two-tailed P value <0.05 was considered statistically significant and highly significant if the p value <0.001 .

Results

Demographic and clinical data

Between April 2023 and March 2024, a total of 143 patients were admitted to the Pediatric Pulmonology Department, with 113 of these patients fulfilling the inclusion criteria. Ultimately, 104 patients completed the study and were included in the analysis. A flow chart illustrating this process is presented in Fig. 1. The average age of the patients was 4.76 ± 2.58 years, with 57.69% ($n=60$) being male. No significant differences were observed between the Nigella sativa and control groups regarding age, sex, weight, weight-for-age Z score, or the duration of symptoms prior to admission. Nevertheless, children who received Nigella sativa experienced significantly shorter hospital stay compared to the control group ($p < 0.001$), indicating a potential benefit in reducing the length of hospitalization (Table 1).

There were no statistically significant differences in the clinical symptoms upon presentation between the Nigella sativa and control groups. The most common symptom in both groups was cough, which was reported in 92.3% of the Nigella sativa group and 86.5% of the control

group ($p = 0.339$). Fever was also frequent, affecting 88.5% and 82.7% of the groups respectively ($p = 0.402$). Other symptoms such as difficulty in breathing, gastrointestinal manifestations (abdominal pain and vomiting), refusal of feeding, and grunting were similarly distributed across both groups ($p > 0.05$ for all).

The RISC score, which reflects clinical respiratory severity, improved significantly in the Nigella sativa group ($p = 0.043$), supporting a favorable clinical and laboratory response (Table 2).

There were no significant differences between the two groups in terms of complications. For instance, respiratory failure was recorded in 7.7% of the Nigella sativa group versus 9.6% in the control group ($p = 0.671$), while septicemia occurred in 5.8% and 13.5%, respectively ($p = 0.974$). Those who received Nigella sativa had slightly lower rates of PICU admission (11.5% vs. 19.2%) and mortality (7.7% vs. 9.6%), although Table 1 indicates that these changes were not statistically significant ($p = 0.277$ and $p = 0.727$, respectively).

Laboratory findings

There were no discernible variations in baseline laboratory values between the Nigella sativa and control groups. The Nigella sativa group showed notable improvements in a number of inflammatory and biochemical indicators

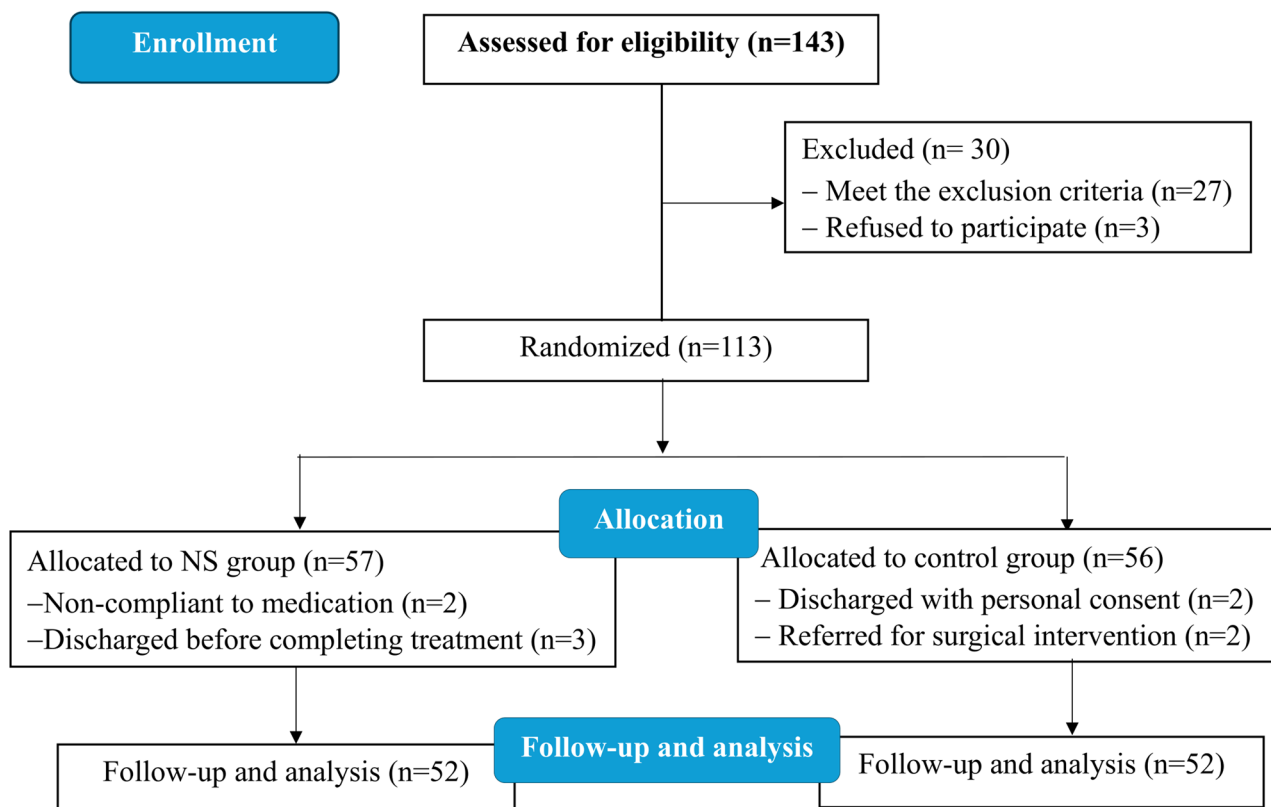


Fig. 1 Flow chart of the study

Table 1 Baseline Characteristics, clinical Features, treatment Outcomes, and complications in the studied populations

	Nigella sativa group (n = 52)	Control group (n = 52)	P value
Sex			
■ Male	31 (59.6%)	29 (55.8%)	0.691
■ Female	21 (40.4%)	23 (44.2%)	
Age (years)	4.75 ± 2.72	4.76 ± 2.45	0.955
Weight (kg)	18.49 ± 8.78	16.59 ± 4.09	0.159
Weight for age Z score	-0.071 ± 0.85	0.007 ± 1.00	0.669
Duration of symptoms (Days)	4 (1–8)	3 (1–8)	0.619
Duration of hospital stay (Days)	6.5 (4.0–8.5)	10.5 (7.5–13.0)	<0.001*
Clinical manifestations			
■ Cough	48 (92.3%)	45 (86.5%)	0.339
■ Fever	46 (88.5%)	43 (82.7%)	0.402
■ Difficulty of breathing	26 (50%)	25 (48.1%)	0.844
■ GIT manifestations: Abd.	37 (71.2%)	34 (65.4%)	0.527
Pain, vomiting			
■ Refusal of feeding	25 (48.0%)	19 (36.5%)	0.238
■ Grunting	27 (51.9%)	23 (44.3%)	0.432
Local chest examination			
■ Chest indrawing	31 (59.6%)	29 (55.8%)	0.691
■ Crepitations	38 (73.1%)	39 (75%)	0.823
■ Wheezes	16 (30.8%)	15 (28.8%)	0.830
■ Bronchial breath	20 (38.5%)	18 (34.6%)	0.683
■ Decrease air entry	25 (48.1%)	26 (50%)	0.844
■ Decreased chest expansion	29 (55.7%)	25 (48.1%)	0.432
Complications			
■ Respiratory failure	4 (7.7%)	5 (9.6%)	0.671
■ Effusion	3 (5.8%)	5 (9.6%)	0.677
■ Pneumothorax	4 (7.7%)	7 (13.5%)	0.987
■ Septicemia	3 (5.8%)	7 (13.5%)	0.974
Type of oxygen support			
■ Nasal O2	48 (92.4%)	47 (90.4%)	0.727
■ Mechanical ventilation	4 (7.6%)	5 (9.6%)	
Outcome			
■ PICU	6 (11.53%)	10 (19.23%)	0.277
■ Mortality	4 (7.69%)	5 (9.61%)	0.727

GIT Gastrointestinal, PICU Pediatric intensive care unit

*P value significant < 0.05, highly significant < 0.001

after treatment. WBC count, CRP, ESR, and LDH levels were considerably lower in the Nigella sativa group ($p = 0.036$, $p = 0.023$, $p = 0.001$, and $p = 0.027$, respectively) (Table 2).

Radiological findings

The Nigella sativa and control groups showed similar baseline results on lung ultrasonography and chest X-rays. Right upper lobe consolidation was the most prevalent radiological characteristic, and there were no significant differences across the groups. Other abnormalities were infrequent and equally distributed,

including increased bronchovascular markings, pneumothorax, and pleural effusion (Table 3). Lung ultrasound revealed no significant group differences in the presence of B-lines, air bronchograms, or effusions (Fig. 2). Among patients who developed complications, pleural effusion was detected in 3 cases in the Nigella sativa group and 1 case in the control group, while pneumothorax occurred in 1 case in each group. All affected patients received the appropriate interventional management (thoracentesis or chest tube drainage, as indicated) in addition to standard medical treatment, with subsequent clinical and radiological improvement.

Duration of clinical stability

Children in the Nigella sativa group showed faster improvement in several clinical parameters compared to the control group. Significant reductions were observed in the time to resume oral feeding, normalize respiratory rate, and improve oxygen saturation ($p = 0.013$, $p < 0.001$, and $p = 0.001$, respectively). Although the duration of fever and chest indrawing improved slightly, these differences were not statistically significant. Overall, Nigella sativa was associated with a quicker clinical recovery (Table 4).

No adverse events or side effects were reported in either group during the 10-day treatment period or the subsequent follow-up. All participants tolerated the intervention well, and no cases of gastrointestinal upset, allergic reactions, or other treatment-related complications were observed. The absence of adverse events suggests that Nigella sativa oil was well-tolerated as an adjunct therapy in children with pneumonia.

Discussion

This study assessed the therapeutic effect of Nigella sativa supplementation in children with pneumonia and revealed several benefits in terms of clinical, laboratory, and recovery parameters.

Even though the Nigella sativa group and the control group had comparable baseline demographic, clinical, and laboratory characteristics, significant differences were observed following treatment, highlighting the potential clinical utility of Nigella sativa as an adjunct therapy.

This study showed that Nigella sativa supplementation led to significant improvements in key hematologic and inflammatory markers, specifically, a decrease in WBC count ($p = 0.036$), CRP ($p = 0.023$), ESR ($p = 0.001$), and LDH ($p = 0.027$). In line with the previous research, Nigella sativa and its active ingredient, thymoquinone, reduce inflammation by preventing leukocyte infiltration and pro-inflammatory cytokines [6, 11].

Furthermore, Alberts and colleagues noted that Nigella sativa offers a wide range of therapeutic advantages for

Table 2 Laboratory findings and RISC score before and after 10 days of treatment in the studied populations

	Nigella sativa group (n = 52)		Control group (n = 52)		P1	P2
	Baseline	After	Baseline	After		
Hemoglobin (gm/dl)	10.11 ± 1.10	10.91 ± 1.91	10.10 ± 1.09	10.94 ± 1.22	0.986	0.780
WBCs (103/ml)	17 (3.7–27)	11.7 (4.3–19.5)	17.55 (3–26.2)	15.9 (5.1–21.2)	0.503	0.036*
Neutrophils (%)	57.10 ± 17.90	54.1 ± 16.50	58.39 ± 17.73	55.2 ± 17.03	0.712	0.515
Lymphocytes (%)	35.05 (5.6–76.8)	31.5 (5.5–75.2)	33.7 (5.6–74.2)	31.8 (4.8–74.2)	0.685	0.222
Platelets (103/ml)	305 (110–577)	310 (125–570)	300 (103–562)	314 (110–567)	0.433	0.239
Serum creatinine (mg/dl)	1 ± 0.22	0.90 ± 0.21	1.1 ± 0.25	0.91 ± 0.25	0.859	0.817
Total bilirubin (mg/dl)	0.68 (0.25–1.05)	0.80 (0.45–1.15)	0.74 (0.27–1.09)	0.85 (0.45–1.10)	0.346	0.526
CRP (mg/L)	124.5 ± 85.9	26.0 ± 8.5	114.6 ± 75.2	30.0 ± 9.2	0.533	0.023*
ESR (mm/hr)	79.4 ± 19.9	21 ± 8.2	70.17 ± 27.1	44 ± 9.8	0.052	0.001*
LDH (IU/L)	1067 (224–2062)	480.0 (199.0–1207)	1122 (220–2060)	520.0 (207.0–1590)	0.775	0.027*
ALT (IU/L)	50.21 ± 7.87	30.01 ± 6.71	49.42 ± 7.39	30.28 ± 6.21	0.295	0.315
AST (IU/L)	70.40 ± 7.96	29.40 ± 6.51	72.79 ± 7.43	30.7 ± 6.33	0.112	0.505
RISC score	3.0 (1.5–4.0/5.0)	0.0 (0.0–3.0)	3.0 (0.0–5.0)	1.0 (0.0–3.0)	0.658	0.043*

P1: between baseline data of both groups, P2: between both groups after treatment

WBCs White Blood Cells, CRP C-reactive protein, ESR Erythrocyte sedimentation rate, LDH Lactate dehydrogenase, ALT Alanine transaminase, AST Aspartate transaminase, RISC Respiratory Index of Severity in Children

*P value significant < 0.05, highly significant < 0.001

Table 3 Radiological findings in the studied populations

	Nigella sativa group (n = 52)	Control group (n = 52)	P value
Chest x-ray findings			
Consolidation right upper lobe	28 (53.8%)	25 (48.1%)	0.633
Consolidation left upper lobe	9 (17.3%)	11 (21.2%)	
Consolidation right lower lobe	6 (11.5%)	4 (7.7%)	
Increase bronchovascular marking	5 (9.6%)	10 (19.2%)	
Pleural effusion	3 (5.8%)	1 (1.9%)	0.674
Pneumothorax	1 (1.9%)	1 (1.9%)	
Lung ultrasound findings			
B lines	33 (63.5%)	31 (59.6%)	0.674
Air bronchogram	15 (28.8%)	19 (36.6%)	
Pleural effusion	3 (5.8%)	1 (1.9%)	
Pneumothorax	1 (1.9%)	1 (1.9%)	

*P value significant < 0.05, highly significant < 0.001

Table 4 Duration of clinical improvement in the studied populations

Duration of improvement of	Nigella sativa group (n = 52)	Control group (n = 52)	P value
Fever (Days)	3.96 ± 0.68	4.32 ± 1.54	0.122
Oral feeding (Days)	3.98 ± 0.73	4.42 ± 1.03	0.013*
Respiratory rate (Days)	3.97 ± 0.78	4.53 ± 1.07	< 0.001*
Chest indrawing (days)	3 ± 1.05	3.90 ± 1.19	0.058
O2 saturation (days)	3.02 ± 1.11	3.79 ± 1.14	0.001*

*P value significant < 0.05, highly significant < 0.001

various respiratory disorders, which are frequently attributed to its anti-inflammatory and antioxidant properties [12].

However, Bin Abdulrahman et al. [13] reported no significant differences in most inflammatory markers between the Nigella sativa and placebo groups. The

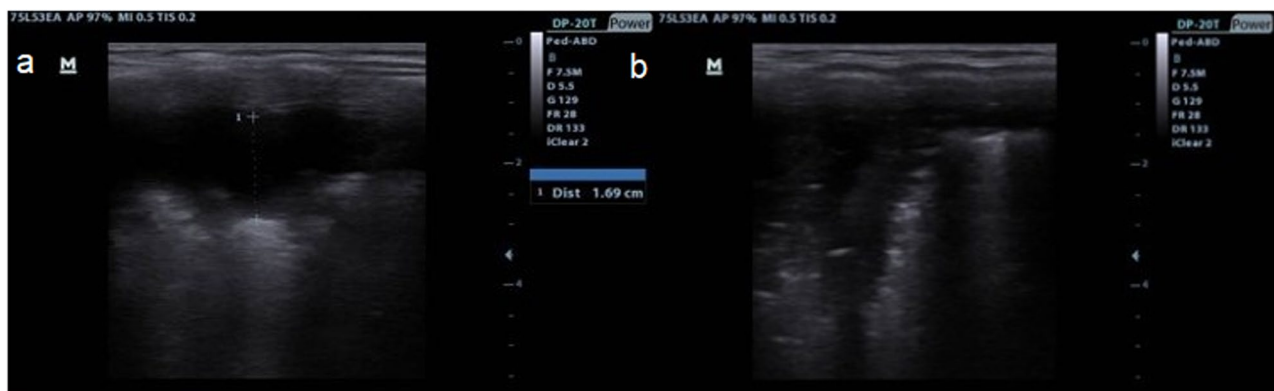


Fig. 2 Lung ultrasound images of pediatric pneumonia. **a** Moderate pleural effusion showing an anechoic fluid collection with a measured depth of 1.69 cm beneath the pleural line. **b** Consolidation with dynamic air bronchogram indicating alveolar involvement

authors suggested that the absence of measurable anti-inflammatory or immunomodulatory effects could be attributed to the relatively short duration of the intervention, noting that a 10-day treatment period may have been insufficient to elicit clinically meaningful changes in patients with mild COVID-19.

Children receiving *Nigella sativa* showed significant improvement in their RISC score, a tool used to measure the severity of respiratory illness. This aligns with a large pediatric study demonstrating that *Nigella sativa* oil supplementation significantly reduced symptom severity, infection frequency, and antibiotic use ($p < 0.001$) [14].

The current study found that the duration of hospital stay was significantly shorter in the *Nigella sativa* group compared to the control group ($p < 0.001$). This finding aligns with previous research done by Koshak et al. [15] who reported that patients receiving *Nigella sativa* oil experienced a shorter mean recovery time compared to the control group ($p = 0.001$), underscoring the therapeutic value of the supplement in respiratory illnesses. Similarly, Cyril et al. [16] also observed reduced hospitalization duration in patients treated with *Nigella sativa*, further supporting its role as a supportive therapy.

Recent clinical trials have investigated the therapeutic potential of *Nigella sativa* in the management of COVID-19, yielding promising results across various populations and varying degrees of disease severity. Koshak et al. [15] demonstrated that *Nigella sativa* oil, when administered alongside standard treatment, significantly accelerated symptom resolution in adults with mild COVID-19. Similarly, a multicenter randomized controlled trial conducted by Ashraf et al. [17] reported that the combined use of *Nigella sativa* and honey led to notable clinical improvements in patients with moderate to severe COVID-19. These included expedited symptom relief, earlier viral clearance, reduced dependence on supplemental oxygen, and a significant reduction in mortality. These outcomes are largely attributed to thymoquinone, the principal bioactive compound in *Nigella sativa*, which has been widely recognized for its broad-spectrum anti-inflammatory, antiviral, and immunomodulatory effects [18, 19].

The mechanistic plausibility of our findings is supported by evidence that *Nigella sativa* and its active constituent, thymoquinone, exert potent anti-inflammatory and antioxidant effects relevant to pneumonia. Thymoquinone inhibits the NF- κ B signaling pathway, thereby downregulating pro-inflammatory cytokines such as TNF- α , IL-1 β , and IL-6 [20], while concurrently enhancing antioxidant defenses through increased superoxide dismutase and catalase activity [21].

The observed reductions in CRP, ESR, and LDH levels in our cohort may thus reflect suppression of systemic inflammation and attenuation of cellular damage.

These biochemical improvements could plausibly explain the more rapid clinical recovery, shorter hospitalization, and improved respiratory severity scores observed among children receiving *Nigella sativa*. By modulating both inflammatory and oxidative stress responses, *Nigella sativa* may enhance host defense, support epithelial repair, and restore pulmonary function during infection.

While the findings of the present study support the potential adjunctive role of *Nigella sativa* in pediatric pneumonia, several confounding factors must be considered. Differences in nutritional status, immune resilience, and variability in antibiotic regimens may have contributed to variations in recovery duration.

These suggest that the clinical benefits of *Nigella sativa* are not disease-specific but likely stem from its ability to modulate immune responses, reduce oxidative stress, and promote tissue healing, making it a promising natural agent for respiratory infections, including both viral and bacterial etiologies.

To our knowledge, this is the first randomized controlled trial to evaluate the effects of *Nigella sativa* supplementation in children with pneumonia, showing that it may help speed up recovery, shorten hospital stays, and improve symptoms.

This study, while offering valuable insights into the potential benefits of *Nigella sativa* in pediatric pneumonia, has several limitations that warrant consideration. Being conducted at a single center, the findings may not be fully generalizable to other settings or populations. The relatively short follow-up period limited the assessment of long-term outcomes or potential relapses. Additionally, the lack of blinding and the absence of a placebo group may introduce bias in both clinical observation and interpretation of results. Furthermore, the study also employed a fixed dosage and duration of *Nigella sativa* without exploring optimal dosing strategies across different age or severity groups. Another limitation of this study is the absence of follow-up radiological evaluation of pneumonia resolution. Radiological improvement often requires a longer period to manifest than clinical and laboratory recovery and therefore was not included in the short-term outcome assessment. These limitations highlight the need for larger, multicenter, placebo-controlled trials with extended follow-up to validate and expand upon these findings.

Conclusion

This study suggests that adjunctive *Nigella sativa* supplementation may accelerate recovery and reduce inflammation in children with pneumonia when used alongside standard treatment. While the clinical outcomes are encouraging, further studies are warranted to explore the specific mechanistic and pharmacological interactions

between *Nigella sativa* and the disease process to better define its therapeutic role and safety profile.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s43168-025-00490-3>.

Supplementary Material 1.

Acknowledgements

Not applicable.

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by AEF. NNB performed the laboratory test. The first draft was written by RE. AAA edited, reviewed and validated the final manuscript. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available upon reasonable request from the corresponding author.

Declarations

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the research ethics committee of the Faculty of Medicine under the number 36264MS139/4/23. The study was registered at ClinicalTrials.gov (Identifier: NCT05952102). Written informed consent was obtained from the patients' guardians.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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