HERBAL COMBINATIONAL MEDICATION OF ASLUSSOOS (GLYCYRRHIZA GLABRA) CONTAINING GLYCYRRHIZIC ACID INHIBITS CHRONIC BRONCHITIS (MUZMIN ILTEHAB SHO'B)- A POTENTIAL PHARMACOLOGICAL APPLICATION WITH MECHANISTIC INSIGHT-A RESEARCH ARTICLE

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Abstract

Chronic bronchitis, a major component of chronic obstructive pulmonary disease, is characterized by persistent cough, excessive mucus secretion, and airflow limitation. Conventional therapies provide symptomatic relief but are often associated with adverse effects and limited long-term benefits. Unani medicine describes this condition as a disorder of Sue Mizaj Ratab of the lungs with excessive ratoobat (secretions). The present open randomized clinical study was designed to evaluate the therapeutic efficacy and safety of Aslussoos, a well-known Unani drug possessing expectorant, anti-inflammatory, and demulcent properties, in patients of chronic bronchitis. Thirty clinically diagnosed patients aged 40–60 years were enrolled and treated with Sufoof-e-Aslussoos (3 g twice daily) for 30 days. Clinical assessment and laboratory investigations, including haematological parameters and pulmonary function tests, were conducted before and after treatment. Statistical analysis using paired t-test revealed highly significant improvement ($p<0.0001$) in haematological indices, reduction in inflammatory markers, and marked enhancement in pulmonary function parameters such as FEV_1, FEV_1/FVC ratio, and peak expiratory flow rate. The study concludes that Aslussoos is an effective, safe, and economical therapeutic option for the management of chronic bronchitis, supporting its traditional use with modern scientific evidence.

Keywords: Chronic bronchitis; Muzmin Iltehab Sho'b; Aslussoos; Unani medicine; COPD; Pulmonary function test; Herbal therapy

I. Introduction Chronic bronchitis (*Muzmin iltehab sho'b)*

Chronic bronchitis is an inflammation of the airways (trachea, bronchi or bronchioles) in your lungs. People with chronic bronchitis have symptoms like a cough and shortness of breath most days of the month, three months out of the year, for two years or longer. Chronic bronchitis is commonly used to refer to chronic obstructive pulmonary disease. Though you may still hear the term "chronic

bronchitis," it's now more accurately called COPD. Very few people have chronic bronchitis without the airway blockage (obstruction) of COPD.

Acute bronchitis is usually caused by a virus like the common cold or the flu. It lasts a few days to a few weeks. Chronic bronchitis is when you get symptoms of bronchitis frequently for two years or longer. It's usually caused by smoking or other lung irritants. Chronic bronchitis and emphysema are both forms of COPD. They cause similar symptoms but affect different parts of your lungs. Chronic bronchitis causes swelling and mucus in your airways, or tubes, that bring air in and out of your lungs. Emphysema affects the small air sacs at the end of your airways (alveoli) and causes them to collapse. People with COPD often have some damage to both their airways and alveoli. Chronic bronchitis/COPD often affects people who smoke or used to smoke, but you can also be at risk if you:

- Around someone who smokes.
- Frequently exposed to dust or chemical fumes.
- Asthma.

Chronic bronchitis is when you have a cough and shortness of breath frequently, caused by damage to your lungs. Irritation in your airways causes an immune system reaction that makes them swell up and fill with mucus. Usually, bronchitis is temporary. But when your airways are often irritated like from cigarette smoke or breathing in things like dust or smog — it can cause damage that leads to too many mucus-making cells (goblet cells). Additionally, sometimes the tiny, hair-like structures (cilia) that clear mucus out aren't working properly. This damage makes your airways swell and fill with mucus often. This makes you cough and have trouble breathing.

II. Symptoms & causes chronic bronchitis (Alamat wo Wajuhat Muzmin iltehab sho'b)

The main symptom of chronic bronchitis/COPD is a persistent (stubborn) cough with mucus that happens frequently for at least two years. Other symptoms include:

- A whistling sound when you breathe (wheezing).
- Shortness of breath (dyspnea).
- Fast heart rate (tachycardia).
- Tiredness (fatigue).

Smoking is the leading cause of chronic bronchitis. Pollutants in the air or other lung conditions, like asthma, can also increase your risk. In some cases, you won't know the cause. Chronic bronchitis/COPD isn't contagious. But if you have chronic bronchitis, contagious diseases like a cold or the flu might be more likely to make your symptoms worse (exacerbation).

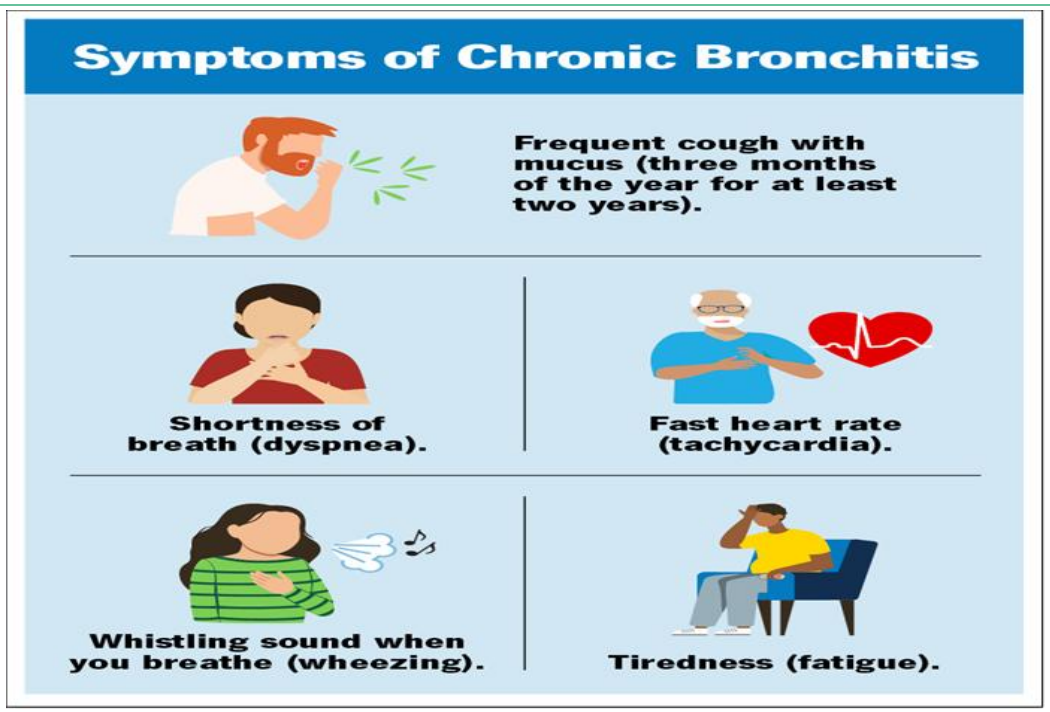


Fig. 01 Sign and Symptom of chronic Bronchitis

III. Diagnosis and Tests

A healthcare provider will diagnose chronic bronchitis by determining how well your lungs are working. They'll ask you about your health history and symptoms and listen to your heart and lungs. They'll give you lung function tests and might order chest X-rays or other imaging. Tests for chronic bronchitis include:

- **Pulmonary function tests**. Pulmonary function tests give your provider an idea of how well your lungs are working. Spirometry is a common lung function test your provider may use if they think you have chronic bronchitis.
- **Chest X-ray** or **CT scan**. Imaging can show your provider if there's any damage or areas of concern in your lungs. They'll use a machine to take pictures of your heart and lungs. They'll look for signs of diseases that could be causing your symptoms.
- **Blood tests**. Your provider may do blood tests, using a needle in your arm, to check your overall health. They may do an arterial blood gas test, a special kind of blood test taken from the artery in your forearm. This checks the levels of oxygen and carbon dioxide in your blood.
- **Electrocardiogram**. Your provider might use an ECG or EKG to check how well your heart is working.

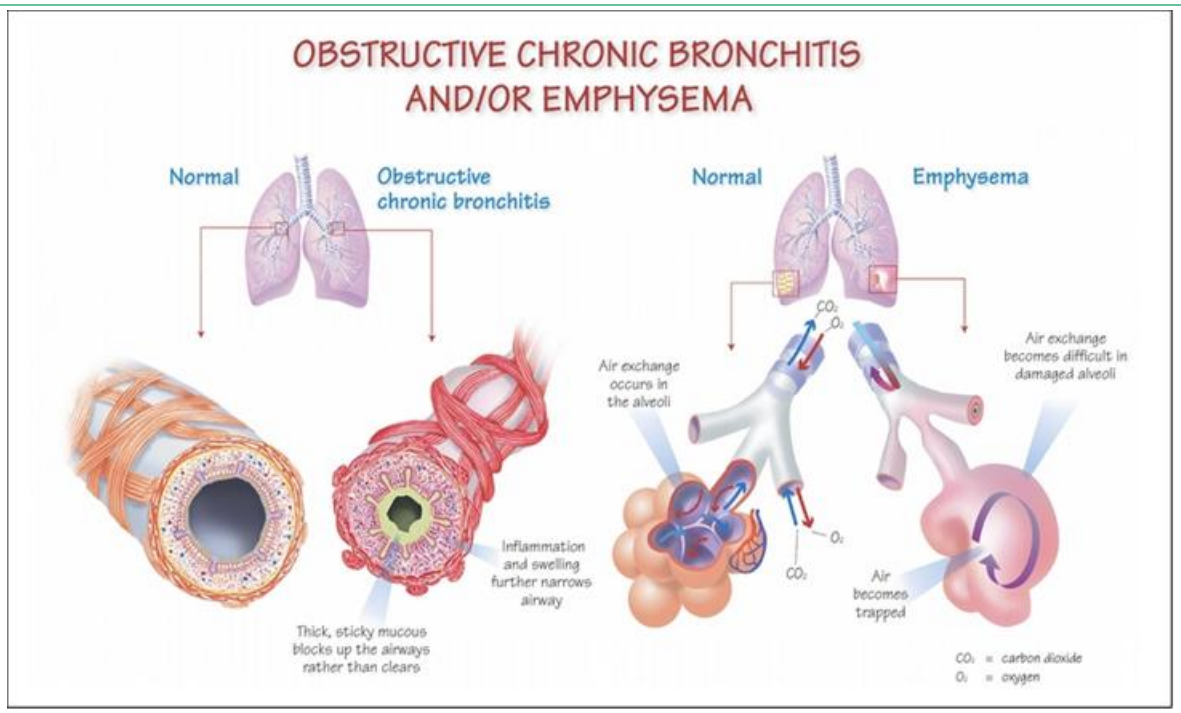


Fig. 02 Chronic Bronchitis-A common health issue

IV. Management and Treatment

Chronic bronchitis treatment focuses on managing symptoms. Depending on how severe your symptoms are, your provider might suggest many types of therapy, including:

- **Smoking cessation**. If you smoke, quitting can help you breathe better and keep chronic bronchitis from getting worse.
- **Bronchodilators**. Bronchodilators are medicines that help open your airways. You usually use an inhaler to take them.
- **Steroids**. Your doctor might prescribe corticosteroids in an inhaler or as a pill to reduce inflammation.
- **Pulmonary rehabilitation**. Pulmonary rehabilitation teaches you exercises and other strategies to help you breathe better and improve your quality of life.
- **Oxygen therapy**. If chronic bronchitis is severe, you may not be getting enough oxygen. Oxygen therapy delivers extra oxygen through a mask on your face or a tube in your nose.
- **Antibiotics**. As having chronic bronchitis can make you susceptible to getting sick frequently, your provider might give you antibiotics to take when they think you have an infection.

Fig. 03 Aslussoos used in of chronic Bronchitis

Healthcare providers call bronchitis "chronic" if you have symptoms at least three months out of the year. Symptoms may sometimes get better or worse, but unlike acut bronchitis chronic bronchitis never fully goes away and may get worse over time. Chronic bronchitis can be mild or very serious. It's usually a sign that you have lung damage that can get worse over time. You can't cure the damage, but your provider can help you manage your symptoms, slow down its progression and reduce flare-ups. Your provider can tell you what to expect for your specific condition. Chronic bronchitis usually can't be cured, but your symptoms can improve with treatment. Treatment can improve your quality of life and sometimes keep your condition from getting worse.

The best ways to reduce your risk of chronic bronchitis include:

- Not smoking, quitting smoking and avoiding exposure to tobacco smoke.
- Avoiding chemicals and other lung irritants.
- Managing asthma or other conditions that affect your breathing

V. Introduction and Pharmacognosy of Plant.

Nature has always been a great source of therapeutic substances, delivering us various medicinal plants that produce valuable phytochemicals. Licorice is scientifically known *as Glycyrrhiza glabra* and belongs to the Leguminosae family. *G. glabra* is an ayurvedic herb that is frequently utilized. Licorice is one of the most commercially valuable plants globally, having a wide range of uses in tobacco, cosmetics, the food industry, and pharmaceuticals. Phytochemical and pharmaceutical analysis has been extensively explored thoroughly of licorice. In traditional Chinese medicine, *Glycyrrhiza glabra* is considered an "essential herbal medication." According to a traditional Chinese medicine belief, "nine out of ten formulae contain licorice," and licorice is one of the most effective herbal medicines for reducing toxicity and increasing the efficacy of other herbal medicines when used together. It may also be a health food product and natural sweetener because it is a "medicine food homology" herbal medication. *Glycyrrhiza glabra*, one of the about 30 kinds of licorice, is one of the most widely utilized species in feed and food. Amino acids, proteins, simple sugars, polysaccharides, mineral salts, pectin, starches, sterols, gums, and resins are all found in licorice.

According to the World Health Organization, licorice is used as a demulcent for sore throats and an expectorant for bronchial catarrh and coughs. There have been no reports of potentially toxic compounds from the taxa that have been studied so far. However, some adverse consequences are recognized, such as using high dosages over a prolonged period, resulting in serious illnesses.

Nevertheless, the plant may be used for a medicinal purpose in small dosages for significant ailments, and there are no known side effects.

The licorice powder and extract were found to be useful for the treatment of sore throat, cough and bronchial catarrh. It is anti-tussive and expectorant loosening and helping to expel congestion in the upper respiratory tract as it accelerates tracheal mucus secretion. The demulcent action is attributed to glycyrrhizin. It has been recently found that Liquiritin apioside is an active compound present in the methanolic extract of liquorice. The compound inhibits capsaicin induced cough

VI. Material and Method

The present study in titled as "Study of *Muzmin iltehab sho'b* with therapeutic evolution of a Unani drug" was conducted. Before embarking upon the project, a comprehensive protocol was chalked out and put forth for ethical clearance, from the Institutional ethical committee. After ethical clearance clinical study was started by enrolling eligible patients.

1. Criteria for Selection of Cases:

A. Inclusion Criteria:

- The patients attending the OPD.
- Patients of both sexes between the age of 40 to 60 years.
- Patients evaluated according to clinical sign and symptoms.
- Written consent of patient to participate in the study.

B. Exclusion criteria: -

- Patients with active cardiac diseases and major diseases of heart.
- A case of acute bronchitis
- Cases of emphysema
- Cases of bronchiectasis

2. Selection of subjects

Patients were selected on the basis of clinical diagnosis. Any patient, above 40 years of age, giving history of chronic cough for 3 months during each of the two successive years, was selected from *Moalajat* OPD and evaluated for the consideration as a research subject. In the process of selection, spirometry was done. If the FEV1 / FVC was found <80% and referred investigations were found normal; the patient was diagnosed as a case of *Muzmin iltehab sho'b* (chronic bronchitis). These diagnosed patients, if fulfilled all the terms of inclusion criteria, were selected for the study, Written informed consent was sought from every patient before inclusion in the study.

During the selection procedure, complete history including general physical and systemic examination was carried out and recorded on a prescribed case report proforma which was designed with the consultation of the guide. The patients were enquired about their name, age, sex, marital status, address and occupation.

A. Chief complaints:

All the patients were interrogated about their chief complaints and duration of suffering in detail, which were noted down in chronological order in the prescribed Proforma.

B. Past history:

While taking the history, emphasis was given on past history for any disease especially pulmonary tuberculosis, carcinoma of the lung, bronchiectasis, cystic fibrosis and chronic congestive heart failure etc.

C. Dietary habits:

Dietary habits, type of diets, etc. were inquired.

D. Personal history:

Smoking habits, Paan chewing etc. were inquired about in personal history.

E. Family history:

Regarding family history, patients were asked about the presence of any significant history of respiratory disease in the family.

F. Socioeconomic history:

In socioeconomic history, patients were asked about their monthly income, education and occupation.

G. Systemic and local examination:

After history, general physical examination was done with special emphasis on pulse (rate, rhythm, character and volume), blood pressure, temperature, respiratory rate, respiratory distress with simple activities, build, skin, hair, tongue, eyes, clubbing of fingers, cyanosis, pallor, anemia, oedema and lymphadenopathy etc. Likewise, a careful systemic and local examination was also done to look for any findings and involvement of any other serious illness.

3. Investigations:

Certain investigations were carried out aiming following important objectives.

- To exclude the patients other than *Muzmin Iltehab Sho'b* (chronic bronchitis) as a part of exclusion criteria.
- To establish the safety of the test drug. Following investigations were done in every case.
    - Hb%
    - TLC
    - DLC
    - ESR
    - X-Ray Chest PA View
    - PFT

4. Informed consent

Patients, fulfilling the inclusion criteria as mentioned above, were given the information sheet having details regarding the nature of the study, the drug to be used, method of treatment etc. Patients were given enough time to go through the contents of informed consent sheet. They were given the opportunity to ask any question, and if agreed, they were asked to sign the informed consent form.

5. Study design

This is an open randomized clinical trial.

6. Sample size

The sample size was fixed as 30 patients.

7. Assessment of Mizaj

Determination of mizaj was done on the basis of assessment of different parameters mentioned in literature. These parameters have been shown in the table attached with the case report form in annexure.

8. Duration of protocol therapy

The treatment period was 30 days.

9. Selection of drug

Most of the scholars, while describing the pathogenesis of this disease, have mentioned *Asbab-e-badiyah* i.e smoke, dust, fumes, cold air and *Asbab-e-wasila* as causative factors for the disease. According to them *Asbab-e-badiyah* cause inflammation in the airways and produce *ratoobat* (mucus hypersecretion) that results in narrowing of airways. Cough is produced due to narrowing of airways caused by accumulation of secretion. *Sue mizaj ratab* of lungs and *nazla* produce *sual* (cough). According to Ibn Zohar and others, accumulation of *ratoobat* (secretions) in bronchioles due to *insibabe mawaad* (descent of secretions) causes *sual* (cough) and *zeequnnafas* (breathlessness).

For the rationally effective treatment of this pathology, a Unani drug was required having all those properties which could revert this pathologic aberration towards normalcy to restore normal physiological functions. By careful forage into literature, a drug was found out, the ingredients of which were having all requisite properties like *Muhallil, Mulattif, Mufatteh, Munaffise balgham* etc.

The name of drug along with its dose is given below.

- Aslussoos *(Glycyrrhiza glabra Linn)* 3gm

10. Method of preparation, dosage and mode of administration of test drug.

The drug would be authenticated by expert botanist. The drug will be prepared according to the method mentioned in old classical Unani literature.

Form of drug:

The drug will be used in the form of *sufoof* (powder).

Dose of drug:

Sufoof-e-Aslussoos 3 gram twice a day.

(BD) with water.

11. Follow up during treatment

30 days study was divided into two visits of follow up, which were made at an interval of 15 days. At every visit, the patients were asked about the improvement or worsening in their symptoms and subjected to examination to assess clinical findings. Concomitant treatment was not allowed during the protocol period. The patients, who were taking any other medicine as a treatment of *Muzmin iltehab sho'b,* were advised to observe abstinence for a week from consuming any other drug before commencing treatment with the test drug.

VII. Observation and Results:

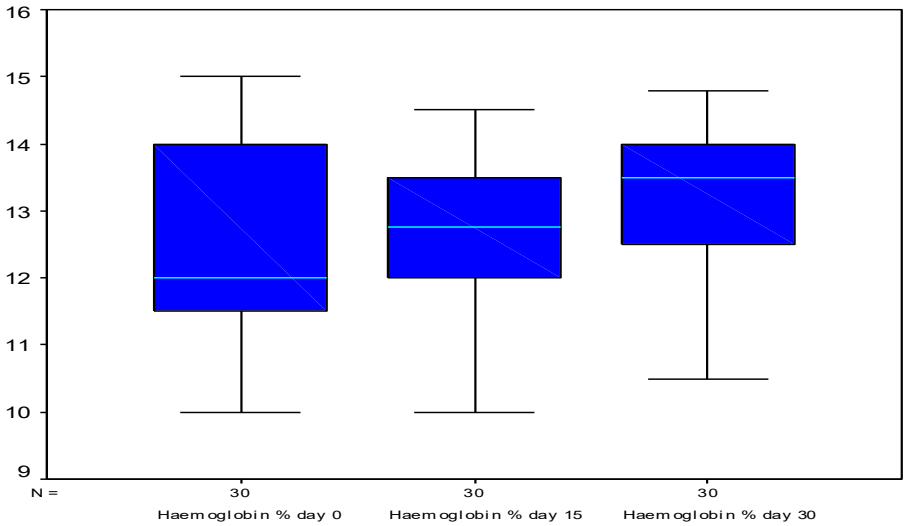
Table No.1 Paired Samples Test

No.	Test	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed) P value
					Lower	Upper			
1	Hb day 0 Hb day 30	12.39 13.25	1.32 1.02	.16	-1.19	-.54	-5.396	29	.000
2	WBC Day0 WBC Day 30	7896.67 6256.67	1797.41 1689.86	230.87	1167.82	2112.18	7.104	29	.000
3	Polymorphs Day 0 Polymorphs Day30	59.93 51.46	7.6956 7.2869	1.4050	5.5931	11.3403	6.026	29	.000
4	Lymphocytes Day 0 Lymphocytes Day 30	42.23 34.27	8.13 5.50	1.04	5.84	10.09	7.669	29	.000
5	ESR Day 0 ESR Day 30	29.50 15.37	11.55 8.82	1.88	10.30	17.97	7.532	29	.000
6	FEV1 Day 0 FEV1 Day 30	47.96 67.27	16.7 16.11	2.71	-24.86	-13.76	-7.122	29	.000
7	FEV1/ FVC Day 0 FEV1/ FVC Day 30	66.42 77.107	19.21 11.012	2.3259	-15.4439	-5.9301	-4.595	29	.000
8	PEF Day 0 PEF Day 30	2.39 3.572	1.185 1.541	.25	-1.69	-.67	-4.709	29	.000

All above mention measuring test results are highly significant, as p-value by paired sample 't' test. (p-value is <0.0001)

Table No. 2 A study subject according to hemoglobin

	Haemoglobin % day 0	Haemoglobin % day 15	Haemoglobin % day 30
Mean	12.39	12.65333	13.25333
Std. Deviation	1.321011	1.11718	1.020728
Minimum	10	10	10.5
Maximum	15	14.5	14.8

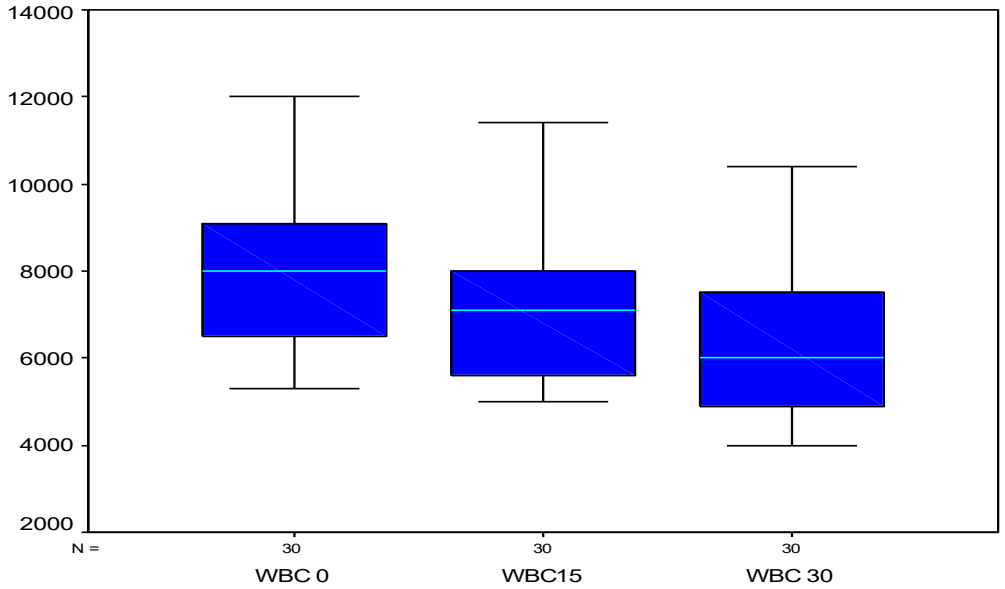


Graph no.1

It is also evident from the table.2 and graph no.1, the mean of hemoglobin study subject on zero day was 12.39% i.e. 1.32 S.D., 15th day 12.65% i.e. 1.11 S. D, and on 30th day 13.25 i.e. 1.02 S. D. respectively. Hence with reference to table no.8 test is highly significant (p-value is < 0.0001).

Table No. 03 A study subject according to WBC Count.

	WBC 0	WBC15	WBC 30
Mean	7896.667	6956.667	6256.667
Std. Deviation	1797.409	1526.927	1689.865
Minimum	5300	5000	4000
Maximum	12000	11400	10400

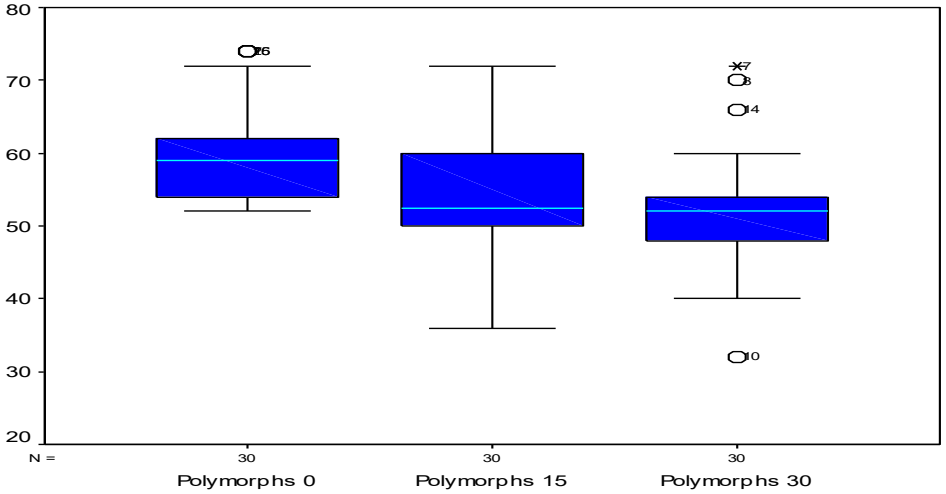


Graph no.2

As shown in table no.3 0and Graph no.2, it is evident that the mean WBC of study subject on zero day was 7896.66 i.e. 1797 S.D., 15th day 6956 i.e. 1526.927 S. D, and on 30th day 6256.66 i.e. 1689.865 S.D. respectively. Hence with reference to table no.8 test is highly significant (p-value is < 0.0001).

Table No.04 A study subject according to Polymorphs.

	Polymorphs 0	Polymorphs 15	Polymorphs 30
Mean	59.93	54.53	51.4667
Std. Deviation	7.6956	7.34	7.2869
Minimum	52	36	32.00
Maximum	74	72	72.00

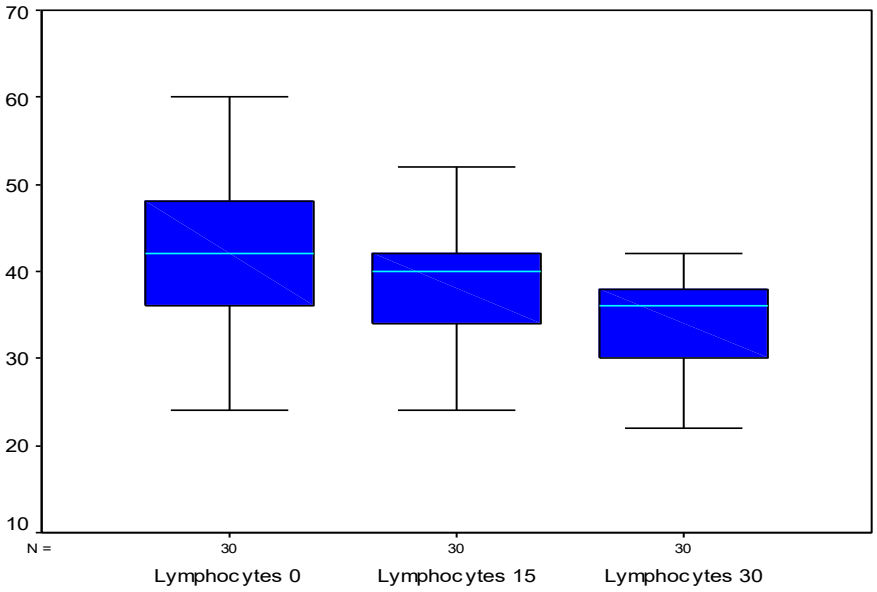


Graph No. 03

As show in table no.4 and graph no.3, it is evident that the mean polymorphs of study subject on zero day were 59.93 i.e. 7.6956 S.D., 15th day 54.53 i.e. 7.34 S. D. and on 30th day 51.46 i.e. 7.2869 S. D. respectively. Hence with reference to table no.8 test is highly significant (p-value is < 0.0001).

Table No.05 A study subject according to lymphocytes.

	Lymphocytes 0	Lymphocytes 15	Lymphocytes 30
Mean	42.23	38.4667	34.27
Std. Deviation	8.13	6.6578	5.50
Minimum	24	24.00	22
Maximum	60	52.00	42

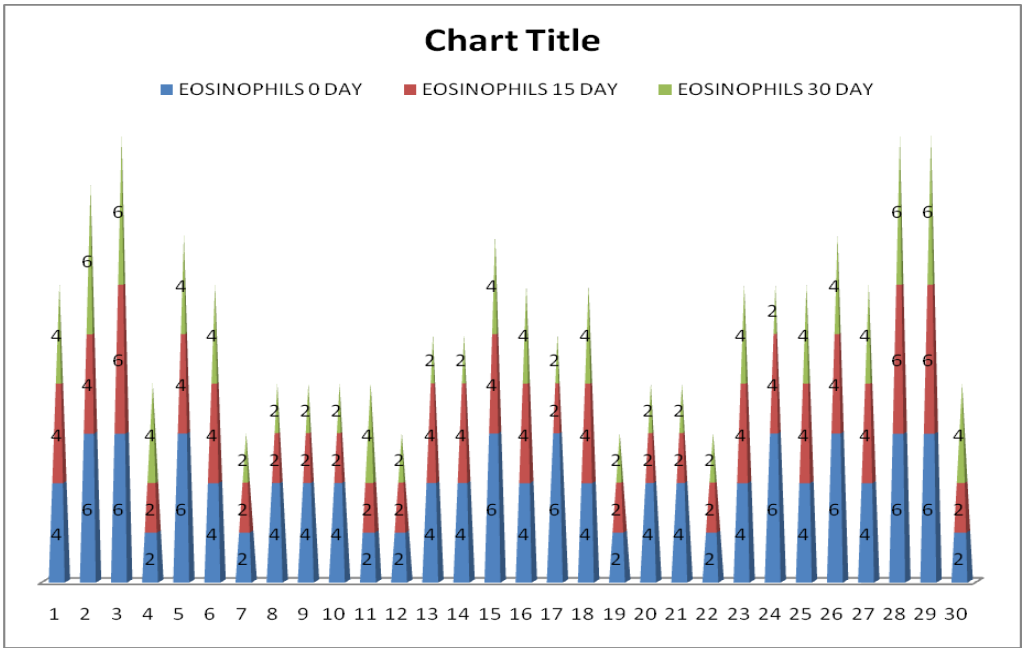


Graph no.04

As shown in table no.5 and Graph no.4, it is evident that the mean lymphocytes of study subject on zero day were 42.23 i.e. 8.13 S.D., 15th day 38.46 i.e. 6.65 S.D. and on 30th day 34.27 i.e. 5.50 S. D. respectively. Hence with reference to table no.8 test is highly significant (p-value is < 0.0001).

Table No.06 A study subject according to eosinophils.

	EOSINOPHILS 0 DAY	EOSINOPHILS 15 DAY	EOSINOPHILS 30 DAY
N	30	30	30
	0	0	0
MEAN	4.13	3.33	3.4
STANDARD DEVIATION	1.47	1.32	1.40



Graph no.05

As shown in table no.6 and Graph no.5, it is evident that the mean of eosinophils of study subject on zero day was 4.13 i.e. 1.47 S.D. on 15th day 3.33 i.e. 1.32 S.D. and on 30th day 3.4 i.e. 1.40 S. D. respectively. Hence with reference to table no.8 test is highly significant (p-value is < 0.0001).

Discussions

Chronic bronchitis is a progressive inflammatory airway disease commonly associated with smoking, environmental pollutants, and recurrent respiratory infections. In Unani medicine, the disease is attributed to insibabe mawaad and accumulation of ratoobat in the bronchi, leading to cough (sual) and breathlessness (zeequnnafas). The present study evaluated the Unani formulation Sufoof-e-Aslussoos based on its classical properties such as Mulattif, Muhallil, Mufatteh, and Munaffis-e-Balgham. The results of the study demonstrate statistically highly significant improvements in both hematological and pulmonary parameters. Reduction in total leukocyte count, ESR, polymorphs, and lymphocytes indicates a decline in systemic and airway inflammation. Improvement in haemoglobin levels suggests better oxygenation and general health status of patients. These findings correlate well with the known anti-inflammatory, antioxidant, and immunomodulatory actions of glycyrrhizic acid, liquiritin, and other bioactive compounds present in Glycyrrhiza glabra. Pulmonary function tests showed marked improvement in FEV_1, FEV_1/, FVC ratio, and peak expiratory flow rate, reflecting reduced airway obstruction and enhanced lung mechanics. The expectorant and demulcent effects of Aslussoos help in liquefying thick mucus and facilitating its expulsion, while its anti-tussive action reduces cough frequency. No adverse drug reactions were reported during the study period, indicating good tolerability and safety of the drug at therapeutic doses. Overall, the outcomes validate the Unani concept of treating chronic bronchitis by correcting underlying pathological humoral imbalance and clearing morbid matter from the respiratory tract.

Summary

The present clinical study assessed the efficacy of Aslussoos (Glycyrrhiza glabra) in the management of chronic bronchitis (Muzmin Iltehab Sho'b). Thirty patients were treated with Sufoof-e-Aslussoos for 30 days and evaluated using clinical, hematological, and pulmonary function parameters. The treatment resulted in significant reduction in inflammatory markers, improvement in blood indices, and marked enhancement in lung function. The findings strongly support the traditional Unani use of Aslussoos as an effective expectorant and anti-inflammatory agent in chronic respiratory disorders.

Conclusion

The study concludes that Aslussoos (Glycyrrhiza glabra Linn.) is a safe, effective, and well-tolerated Unani drug for the treatment of chronic bronchitis (Muzmin Iltehab Sho'b). The significant improvement observed in clinical symptoms, hematological parameters, and pulmonary function tests highlights its therapeutic potential. The results provide scientific validation to classical Unani claims and suggest that Aslussoos can be used as a cost-effective alternative or adjunct therapy in the management of chronic bronchitis. Further large-scale and long-term clinical trials are recommended to strengthen these findings and explore its role in COPD management.

References

1. Pride NB, Stockley RA. Chronic obstructive pulmonary disease. In: *Oxford Textbook of Medicine*. Vol. II, 3rd ed. Oxford: Oxford University Press; 1996. pp. 766–778.
2. Mannino DM, Homa DM, Akinbami LJ, Ford ES, Redd SC. Chronic obstructive pulmonary disease surveillance—United States, 1971–2000. *MMWR Surveillance Summaries*. 2002;51(6):1–16.
3. Tabri AAM. Molaejat Buqratiyah (Urdu translation by CCRUM). Vol. II. New Delhi: Ministry of Health and Family Welfare; 1997. pp. 468–469.
4. Di Stefano A, Maestrelli P, Roggeri A, Turato G, Calabrò S, Potena A. Severity of airflow limitation is associated with severity of airway inflammation in smokers. *American Journal of Respiratory and Critical Care Medicine*. 1998;158:1277–1285.
5. Vestbo J, Prescott E, Lange P; Copenhagen City Heart Study Group. Association of chronic mucus hypersecretion with FEV_1 decline and chronic obstructive pulmonary disease morbidity. *American Journal of Respiratory and Critical Care Medicine*. 1996;153:1530–1535.
6. Mohan H. Textbook of Pathology. 5th ed. New Delhi: Jaypee Brothers Medical Publishers; 2005. pp. 485–487.
7. Cotran RS, Kumar V, Collins T. Robbins Pathologic Basis of Disease. 6th ed. Singapore: W.B. Saunders Company; 2000. pp. 707–717.
8. Kumar V, Cotran RS, Robbins SL. Basic Pathology. 6th ed. Singapore: Harcourt Asia Pte Ltd; 1997. pp. 397, 402–403.
9. Dey NC, Dey TK. A Textbook of Pathology. 15th ed. Kolkata: New Central Book Agency (P) Ltd; 2002. p. 17.5.
10. Deodhare SG. General Pathology & Pathology of Systems. Revised 6th ed. Mumbai: Popular Prakashan; 2002. Vol. II, pp. 1065, 1509–1513.
11. Matsuba K, Wright JL, Wiggs BR, Pare PD, Hogg JC. Changes in airway structure associated with reduced FEV_1. *European Respiratory Journal*. 1989;2:834–839.
12. Lamb D, McLean A, Gillooly M, Warren PM, Gould GA, MacNee W. Relation between distal airspace size, bronchiolar attachments, and lung function. *Thorax*. 1993;48:1012–1017.
13. O'Donnell DE, Revill SM, Webb KA. Dynamic hyperinflation and exercise intolerance in chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine*. 2001;164:770–777.
14. Rodriguez-Roisin R, MacNee W. Pathophysiology of chronic obstructive pulmonary disease. *European Respiratory Monograph*. 1998;3:107–126.
15. McLean A, Warren PM, Gillooly M, MacNee W, Lamb D. Microscopic and macroscopic measurements of emphysema: relation to carbon monoxide gas transfer. *Thorax*. 1992;47:144–149.
16. MacNee W. Pathophysiology of cor pulmonale in chronic obstructive pulmonary disease: Part two. *American Journal of Respiratory and Critical Care Medicine*. 1994;150:1158–1168.
17. Biernacki W, Flenley DC, Muir AL, MacNee W. Pulmonary hypertension and right ventricular function in patients with COPD. *Chest*. 1988;94:1169–1175.
18. William MN. ABC of chronic obstructive pulmonary disease: Pathology, pathogenesis and pathophysiology. *BMJ*. 2006;332:1202–1204.

19. Razi AMBZ. Kitab Al-Mansoori (Urdu translation by CCRUM). New Delhi: Ministry of Health and Family Welfare, Government of India; 1991. pp. 350–351.
20. Jeelani G. Makhzan-e-Hikmat. Vol. II. New Delhi: Aijaz Publishing House; 1994. pp. 379–381.