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Original Research Article

Immunostimulant and Stress-Relieving Effects of Ocimum sanctum Linn. (Tulsi) Leaf Extract: A Prophylactic Nutraceutical to Influenza Viral Infections and Seasonal Health Disorders

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Abstract

Ocimum sanctum Linn. (Tulsi) is traditionally known for its immune-enhancing and adaptogenic activities, but for its preventive activity against seasonal diseases, a scientific endorsement has been limited. The study was a comparative observational study where 500 volunteers in West Bengal, India, were randomly grouped into Control and Experimental groups where the Experimental group received fresh Tulsi leaf juice daily in four seasons. Systematic measurements of health outcomes such as influenza-like illness incidence, stress, global well-being and safety were conducted. Results indicated that Tulsi supplementation decreased incidence of influenza-like illness by 60 to 70 percent, decreased stressfulness by about 30 percent, and enhanced global well-being by 15 to 20 percent relative to controls and all changes were statistically significant ($p < 0.001$). The combined findings of these results show that Tulsi leaf juice is a safe, cheap and culture acceptable form of natural intervention that could promote immunity, vitality and even preventive action in the health of the people across all seasons irrespective of seasonal variations.

Keywords: Ocimum sanctum Linn, Tulsi leaf juice, immunostimulant, influenza virus, stress relief, prophylactic therapy, nutraceutical.

Introduction

Among the serious issues of the world population health, there are viral diseases of influenza virus, stress-related disorders and frequent seasonal diseases and they attack the population of the area with changing climate conditions and a decline in the immune system lifestyles unevenly [1]. The influenza viruses have continued to circulate annually infecting millions of individuals and killing them at high rates particularly the young, the old and the immunocompromised. In addition to the risk of the virus, the burden of influenza on the health care system is extreme due to the high hospitalization rates, absenteeism, and financial expenses of low productivity among the working population [2].

Besides influenza, physiological stress leading to stress disorders up to the anxiety and psychosomatic symptoms also, became acute needs, which in its turn, cripples the natural protective mechanisms of the body, thus, preconditioning the development of infectious diseases in individuals [3]. Seasonal changes are also a complement to these threats: the variations of the winter season are coordinated with the prevalence of respiratory infections; the variations of the summer season place the population in a risk of dehydration, heat strokes, and exhaustions; the rainy seasons favour the spreading of the pathogens because of the humidity and the growth of the vectors; the early autumn season undermines the immunity because of the sudden changes in the climate that leave the population in a gap in vulnerabilities throughout the entire year [4].

Traditional medicine has experienced a relatively heavy dependence on synthetic antiviral and stress-reducing drugs to treat these conditions, yet are increasingly limited by cost, side effects and in the case of antiviral drugs, by the ever-increasing problem of drug resistance [5]. Some of the most commonly prescribed anti-stress agents, including the sedatives or the anxiolytic drugs, are also associated with addiction, cognitive dysfunction, or metabolic derangement on a chronic basis. In the same manner, the antiviral and vaccine products are often hampered by accessibility, affordability and adaptability to rapidly changing influenza strains. These limitations underscore the need to have cost-effective, safe and sustainable solutions that are conveniently employed by wide populations and age groups [6-7].

In this regard, medicinal plants have an increasing scientific and clinical interest in nutraceuticals and

immunostimulants. Nutraceuticals as food-derived products that have health-promoting properties beyond regular nutrition are the future of preventive health interventions that are likely to reduce disease burden, balance the immune system, and solve stress without any side effects of the widely used synthetic medicines [8]. Of them, the more convenient are the plant-derived immunostimulants, in which it is not only possible to increase the host defense against the infection, but it also gives the antioxidant protection, besides relieving the psyche because of the natural bioactive compounds. An exemplary case would be Ocimum sanctum Linn., or Tulsi or Queen of Herbs in Indian traditional medicine, which has been a treasured holistic curative ingredient in Ayurveda over centuries [9-10]. Tulsi is composed of biologically active phytoconstituents, such as eugenol, ursolic acid, rosmarinic acid, flavonoids, which give it diverse activities such as antiviral, antimicrobial, antioxidant, adaptogenic, and stress-reducing activities.

Figure 1: Ocimum sanctum (Tulsi)

Daily use of Tulsi leaves or juice for general vitality and seasonal health prevention is a traditional home practice in India and most of Southeast Asia, but evidence for systematic scientific proof of these practices in big populations is missing.

Whereas a number of preclinical and small-scale clinical studies have established the pharmacological effects of Tulsi such as stress marker reduction, immune efficacy and inhibition of viral proliferation most of these studies have been limited by small populations, limited follow-up periods, or limited demographics [11].

Besides, very limited literature has investigated prophylactic effects of Tulsi within a multi-seasonal context although climatic changes play a pivotal role in the development of influenza, and other stress-related diseases [12]. The other significant gap in the literature is the few large-scale community-based human studies directly comparing Tulsi consumption with non-intervention groups that is needed to determine both efficacy and safety in practice [22]. To fill these gaps, it is necessary to conduct methodologically sound studies that assess the immunostimulating and stress-relieving effects of Tulsi not only under laboratory or in-hospital conditions but also under various populations and multiple seasonal exposures. Therefore, the current study attempts to bridge this knowledge gap by critically examining the prophylactic as well as the stress-relieving potential of Tulsi leaf juice in a large number of participants from infancy to old age with repeated interventions timed in accordance with the major seasonal changes that affect the occurrence of disease. By combining conventional wisdom with scientific methodology, this study hopes to make Tulsi a scientifically proven nutraceutical and community-level preventive agent that can prevent the dual burden of influenza and stress disorders and overcome the limitations imposed by synthetic drugs.

Antiviral Activity of Ocimum sanctum Against Human and Animal Influenza Virus Strains: Ocimum sanctum has exhibited antiviral activity against different influenza virus strains of human as well as animal origin. In vitro studies also have shown that the Tulsi leaf extracts exhibit excellent antiviral effects against the H1N1 influenza virus which has resulted in human infection in most cases [13]. It was also demonstrated that Tulsi is anti-viral to H9N2 avian influenza virus, which is

not only poultry specific; it is also a zoonotic virus capable of causing harm to human beings. These reports indicate that the antiviral effect of Tulsi could be closely related to the bioactive compounds which would be at a position to inhibit the virus multiplication and modulate immunity. Nevertheless, it is also relevant to mention that although Tulsi has potential in the laboratory, additional clinical trials are needed to understand the safety and efficacy of the supplement in humans [14].

Nutritional Composition of Ocimum sanctum Leaf Extract: It is well known that Ocimum sanctum (Tulsi), is not only mediciscally advantageous, but also dietary enriched and hence the foundation of all the good health it holds. Fresh leaves of Tulsi are low in calories, containing about 23 kcal/100g, suitable for their integration into the regular diet without any addition to the caloric load [15]. The leaves contain a fair quantity of protein (4.2 g), which can be useful in tissue repair and immune function, and low fat content (0.5 g) ensures negligible contribution to lipid load. The carbohydrates (2.3 g) provide a minor source of energy, and though fiber content is not noted, the plant matrix of Tulsi is expected to help in digestion. Tulsi is a rich source of key micronutrients such as vitamin C (25 mg), which increases antioxidant defense and immune response; calcium (25 mg), bone and dental health; phosphorus (287 mg), important in energy metabolism and cellular processes; and iron (15.1 mg), required for hemoglobin formation and oxygen transport [16].

Side and Adverse Effects of Synthetic Anti-Influenza and Stress-Relieving Drugs: Synthetic anti-influenza and anti-stress medications are commonly prescribed to treat viral infections and stress-related illnesses, but they are usually associated with a variety of side and adverse effects in their clinical use.Synthetic anti-influenza medications consist of neuraminidase inhibitors like oseltamivir, zanamivir, and peramivir, and adamantanes like amantadine and rimantadine. Although these medications efficaciously diminish the severity and duration of influenza, they often induce gastrointestinal disturbances like nausea, vomiting, diarrhea, and abdominal pain.

Neurological side effects including headache, dizziness, insomnia, and, in the case of occasional instances, neuropsychiatric events like confusion, hallucinations, or abnormal behavior are noted, especially among children and the elderly [17]. Repeated or extended use can lead to drug resistance, particularly with adamantanes, to reduce efficacy. Patients with renal or hepatic insufficiency can develop drug accumulation and toxicity, and occasional severe reactions like hypersensitivity or life-threatening skin rashes. Benzodiazepines (e.g., diazepam, lorazepam, alprazolam), selective serotonin reuptake inhibitors (SSRI, e.g., fluoxetine, sertraline, escitalopram), serotonin-norepinephrine reuptake inhibitors (SNRI, e.g., venlafaxine, duloxetine), and other anxiolytics such as buspirone are covered by synthetic stress-relieving medication [18-20]. By decreasing stress and anxiety, they can lead to sedation, drowsiness, poor coordination, memory loss, and motor incoordination, particularly in benzodiazepines, and can result in tolerance, dependence, and withdrawal syndrome with long term use.

Activities of ocimum sanctum leaf extract against bird flu: Tulsi, also known as Ocimum sanctum is one of the medicinal plants that are well known in the field of traditional medicine due to its wide range of therapeutic benefits which also includes Tulsi ability to act as an antiviral against bird flu (avian influenza). Phytoconstituents found in the leaf extract of Ocimum sanctum include eugenol, rosmarinic acid, apigenin, ursolic acid and flavonoids, which make it a very potent antiviral, antioxidant and immunomodulatory agent. These bioactive molecules disrupt the life cycle of influenza viruses by inhibiting the vital viral proteins including neuraminidase and hemagglutinin which are necessary in the entry, replication and excretion of the viruses by the host cells [23]. The extract is able to reduce viral load and restrict infection transmission as it blocks these pathways. Besides, Ocimum sanctum is known to boost innate and adaptive immunity of the body by activating the natural killer cells, macrophages and cytokine production, which help to reinforce the host defenses against viral attack. Its antioxidant property is also crucial in fighting oxidative stress and lowering inflammation related to avian influenza that in most cases increases severe cases of the disease. Moreover, the anti-inflammatory effect of the extract can be used to treat respiratory complications of the infection. On the whole, Ocimum sanctum leaf extract is an effective, safe, and natural therapeutic candidate which has preventive and supportive properties against bird flu infection.

SSRIs and SNRI may be associated with gastrointestinal discomfort, headache, insomnia, sexual dysfunction, weight gain/loss, and brief anxiety or agitation with the onset of treatment. Severe but uncommon side effects are serotonin syndrome, hyponatremia, or enhanced risk of bleeding when taken with other drugs. Buspirone and these types of drugs are linked with dizziness, nausea, and headache, although the risk of dependence is relatively low. In summary, although synthetic anti-influenza and stress-relieving agents give quick and specific therapeutic responses, their application is frequently restricted due to

gastrointestinal, neurological, and systemic side effects, risk for drug dependence, resistance, or toxicity, and dose monitoring requirements [21]. These limitations highlight the need for investigating safer and natural alternatives like Ocimum sanctum (Tulsi), which has immunomodulatory, antiviral, and stress-relieving properties with minimal side effects, and hence is an effective adjunct or complementary therapy for long-term preventive healthcare.

Objectives

- To assess the impact of daily intake of Tulsi leaf juice on stress levels throughout the various seasons.
- To find differences between stress scores in participants drinking Tulsi leaf juice and the control group not drinking Tulsi leaf juice.
- To measure the effect of Tulsi leaf juice on overall wellness, such as immunity, vitality, and subjective health.
- To quantify the statistical difference between Experimental and Control groups' changes in stress and wellness scores.
- To track and record any adverse events to assess the safety and tolerability of Tulsi leaf juice.

Research Questions

- Does the daily use of Tulsi leaf juice decrease stress levels in participants irrespective of season?
- How does the stress score differ between participants who are using Tulsi leaf juice and those who are not?
- What is the effect of Tulsi leaf juice on overall well-being parameters like immunity, vitality, and general perceived health?
- Are the improvement in stress and wellness scores observed between the Experimental and Control groups statistically significant?
- Is there any adverse effect of taking Tulsi leaf juice, and what is the safety profile?
- Can Tulsi leaf juice be suggested as a natural preventive supplement to boost health and well-being during various seasonal conditions?

Materials and Methods

Study Design: The research design was an observational comparative study which is a pragmatic Study design as it allowed the researchers to test Ocimum sanctum Linn. Interventions of (Tulsi) leaf juice in a community versus highly controlled laboratory setting and not a naturalistic study. The participants were segmented into two groups (Control and Experimental), with the Control group receiving no Tulsi juice and Experimental group receiving freshly prepared Tulsi juice on a daily basis. The structure provided an opportunity to directly compare the results of individuals who took the Tulsi regimen and those who did not, further intensifying the plant benefits to even a higher level. It concentrated on the immunostimulating effect, stress- alleviating effect and prophylactic effect of Tulsi against influenza viral infection. Seasonal changes such as winter, summer and rainy season were also taken into consideration, these are also known to influence stress, immune functioning and incidence of diseases. This design facilitated the study to determine the preventive and therapeutic impacts of Tulsi holistically, in relation to natural environment changes and day to day living situation thus making the results quite relevant and applicable to health practice among the masses.

Study Population and Sample Size: The study identified 500 participants in the East and West Midnapur districts in West Bengal in India who are a very broad sample of the community. As the preventive and therapeutic influences of Tulsi were sought across the different age groups, the sample was of wide age group, including infants, children and the old, thus allowing the assessment of the impact that Tulsi can be on immunity of the developing, mature and aging individuals. There were two equal groups consisting of Control (n=250) and Experimental (n=250) groups: the first group with no Tulsi intervention (Control) and the second group with the recommended dosage of Tulsi leaf juice on a daily basis (Experimental). Individuals with prior chronic comorbid conditions such as cardiovascular disease, hypertension, and respiratory conditions or known to be hypersensitive to Tulsi were also excluded to ensure that the results were reliable. This conservativeness in the recruitment process led to a non-comorbid homogeneous sample allowing the study to isolate and examine the true prophylaxis, immunostimulant and stress-reducing benefits of Tulsi leaf juice among different age groups and seasons without miring them in other unrelated health issues.

Intervention: The intervention design was optimal in order to achieve the highest therapeutic and practical value of Tulsi (Ocimum sanctum) leaf juice as a natural prophylaxis. Children and adults of the Experimental group were administered the fixed dose of a 5 g/kg body weight of the juice, in a single dose in the morning, on an empty stomach, in order that the most bioavailable form of such phytoconstituents as eugenol, ursolic acid, rosmarinic acid, and flavonoids should be offered.

Each period was a 28-day continuous period, repeated four times a year, with each period synchronized with a season when humans are most susceptible to illness or stress: winter (Jan-Feb) to prevent influenza and respiratory infections, hot

summer (May-June) to counteract heat-related fatigue and stress, rainy season (July-Aug) when these microbes are most likely to proliferate, and early autumn (Sept-Oct) during climatic changes, when immunity is generally most vulnerable to such changes.

A minimum of 60 days (1.5-2 months) was set between each cycle to ensure that the immune system was not overstimulated and to give the body time to restore the defense system to normal levels. This protocol provided seasonal immunity throughout the year and also modeled a community-based and sustainable health programme in such a way that it was capable of being used over the long term as a prophylactant nutraceutical therapy.

Preparation of Tulsi Leaf Juice: Tulsi leaf juice preparation was performed carefully in order to preserve its therapeutic and safety properties in the study population. To identify botanical identity and prevent misidentification, fresh, mature leaves were harvested and recognized by Dr. Rabindranath Sar (PhD, Botany, Calcutta University). The leaves were properly sponged severally with clean water to remove dust, dirt and any form of microbial impurities. To prevent oxidation or chemical degradation of the fragile saprophytes, the washed leaves were processed by grinding directly into a fine pulp using stainless steel equipment. The crude juice was then squeezed out of the pulp without the addition of preservatives, diluents and heat thereby maintaining the optimum concentration of bioactive compounds including sapogenins like eugenol, ursolic acid, rosmarinic acid and flavonoids. The freshly made juice was given to participants directly at a uniform dose of 5 g/kg body weight, once on an empty stomach in the morning, to promote best absorption and therapeutic effect. Such meticulous preparation ensured that Tulsi leaf juice was presented in its most active and natural form, preserving both its pharmacological activity and cultural integrity.

Consent and Ethical Considerations: All the participants or their legal guardians had to provide informed consent prior to the intervention commencement in cases related to children. Ethical approval was granted by the institutional ethics committee and the study was conducted in line with the set guidelines of biomedical research. The herbal juice of tulsi leaf (Ocimum sanctum) with a long history of safe traditional usage was bought and used under the supervision of a qualified medical professional so as to ascertain authenticity, quality and safety. The participants were well-informed about the purpose, procedure, potential benefits, and insignificant risks that might arise during the intervention and the guarantee that the participation was voluntary and could be discontinued at any moment without any negative outcomes. The information that the participants provided was of high confidentiality and the procedures were carried out in accordance with the ethical behavior of research involving human beings.

Monitoring and Data Collection: Verbal and systematic follow-ups through telephone and direct verbal contacts during a clinic visit are incorporated so that all participants can receive support and ensure that health outcome are regularly checked and reported in a timely manner. Clinical outcomes, such as the presence and severity of influenza-like disease and stress-related symptoms, among other general indications of overall well-being were carefully observed. The safeties parameters were recorded in a systematic manner like adverse events or intolerance reactions and matched with the family physician report to determine reliability and accuracy. This multi-layered design has not only enabled the observation of both subjective and objective effects, but has also given the research study an opportunity to test the immunostimulant, antiviral and stress alleviation of the Tulsi leaf juice in the study population without jeopardizing the research study participants and the integrity of the research study data.

Statistical Analysis: Descriptive and inferential statistics informed the study to establish the efficacy of Tulsi leaf juice in seasonal prevalence of influenza, stress, and well being. Continue variables (age, body weight, stress scores and wellness scores) were provided with means and standard deviations to measure their central tendency and variability. The number of participants with influenza-like symptoms was expressed in frequencies and percentages as categorical outcomes. Inferential statistical tests were used to determine changes between the Control and Experimental groups. In the case of continuous outcomes (stress and wellness scores), independent-sample t-tests were utilized to establish whether the mean differences between groups were significant. In the case of categorical outcomes (influenza incidence), the chi-square test was used to compare proportions. In all comparisons, a p-value below 0.001 was regarded as statistically significant, which means that there was a very low likelihood that the observed differences were due to chance. The statistical methodology enabled the strict assessment of the effects of Tulsi and proved that the decreases in the incidence of influenza, falls in stress levels, and positive changes in wellness scores were very high and most likely caused by the intervention instead of the chance variability.

Results

The following results summarize the impact of daily Tulsi (Ocimum sanctum Linn.) leaf juice consumption on seasonal influenza incidence, psychological stress, and general wellness among 500 community participants. Analyses focused on comparisons between the Experimental group, which received Tulsi supplementation, and the Control group, which did not. Baseline characteristics including age, gender, body weight, stress, and wellness scores were well balanced between groups, ensuring that observed differences could be attributed to the intervention. Seasonal trends were evaluated to assess Tulsi's effectiveness in reducing illness, modulating stress, and enhancing overall health throughout the year, while safety and tolerability were also systematically monitored.

Participant Characteristics: 500 subjects were enrolled for the study, of which 250 were placed in the Control group and 250 in the Experimental group so as to ensure equal numbers for effective comparison. The subjects belonged to a diverse range of ages to assess the impact of Tulsi leaf juice at various phases of life, from infants to old age. As illustrated in Table 1, the average age was similar between the groups, with the Control group having a mean of 35.6 ± 18.2 years and the Experimental group 36.1 ± 17.9 years, showing an evenly distributed demographic. The gender split was also similar, with 128 males and 122 females in the Control group and 130 males and 120 females in the Experimental group, thereby ensuring that possible sex-based differences in immune response or stress levels would not skew results. Moreover, the average body weight was practically the same (62.5 ± 14.7 kg in Control vs. 63.1 ± 14.2 kg in Experimental), further indicating the homogeneity of the sample population. Baseline measurements of stress scores (6.8 ± 1.5 vs. 6.9 ± 1.6) and general wellness scores (7.0 ± 1.4 vs. 7.1 ± 1.5) showed that both groups began from comparable levels of mental and physical well-being before the intervention. This precise balancing of demographic and baseline health traits, as detailed in Table 1, guaranteed that any differences found in outcomes throughout the study could be reliably attributed to the Tulsi leaf juice intervention and not to pre-existing differences among participants. Sustaining such homogeneity in baselines is essential in comparative observational studies to reduce confounding factors and increase the validity of the findings.

Table 1: Baseline Characteristics of Participants

Characteristic	Control Group (n=250)	Experimental Group (n=250)
Mean Age (years)	35.6 ± 18.2	36.1 ± 17.9
Male/Female Ratio	128/122	130/120
Mean Body Weight (kg)	62.5 ± 14.7	63.1 ± 14.2
Baseline Stress Score	6.8 ± 1.5	6.9 ± 1.6
Baseline Wellness Score	7.0 ± 1.4	7.1 ± 1.5

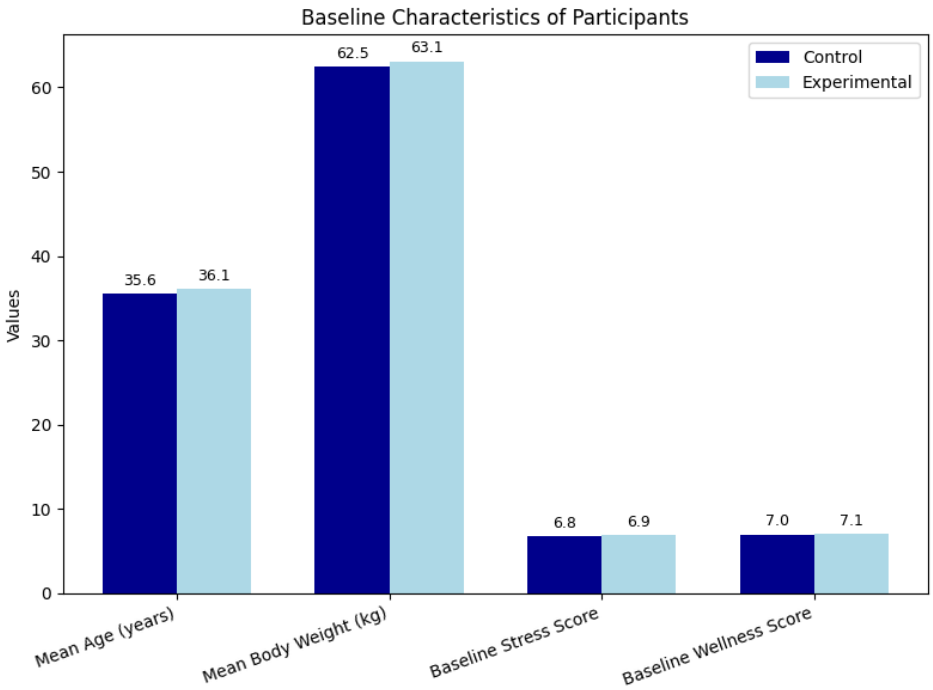


Figure 2: Graphical representation for the baseline characteristics of participants

Influenza Incidence across Seasons: The effect of Tulsi leaf juice on the prevention of influenza-like diseases was tested during various periods of seasonal change, and the findings showed a significant decline in infection rates in the Experimental group as compared to the Control group. As shown in Table 2, in the winter season, which is normally characterized by a high rate of respiratory infections, 48 Control participants (19.2%) experienced influenza-like illnesses, while just 18 Experimental participants (7.2%) were affected, representing a 62.5% reduction. Likewise, in the summer season, the rate reduced from 30 (12.0%) Control participants to 10 (4.0%) Experimental participants.

The rainy season, marked by greater rates of transmission of viral and bacterial diseases, was also reduced significantly, i.e., from 36 cases (14.4%) in the Control group to 12 cases (4.8%) in the Experimental group. In the Control group, influenza was 28 cases (11.2) at the beginning of the fall, as immunity is starting to fail due to the change in the climate, compared to only 9 cases (3.6) in the Experimental group. All the observed differences between Control and Experimental groups were statistically significant ($p < 0.001$) which indicated that Tulsi supplementation had significant influence on reducing the risk of influenza-like illnesses in all the tested seasons. The findings substantiate immunostimulant and antiviral effects of Tulsi, thus showing that the seasonal prophylactic effect of Tulsi can be provided by drinking regular Tulsi leaf juice, which enhances the body immune system against viral infection. The findings conclusively establish Tulsi as an effective, natural intervention for alleviating respiratory disease in community environments.

Table 2: Seasonal Influenza Incidence in Control and Experimental Groups

Season	Control Group (n=250)	Experimental Group (n=250)	p-value
Winter	48 (19.2%)	18 (7.2%)	<0.001
Summer	30 (12.0%)	10 (4.0%)	<0.001
Rainy	36 (14.4%)	12 (4.8%)	<0.001
Early Fall	28 (11.2%)	9 (3.6%)	<0.001

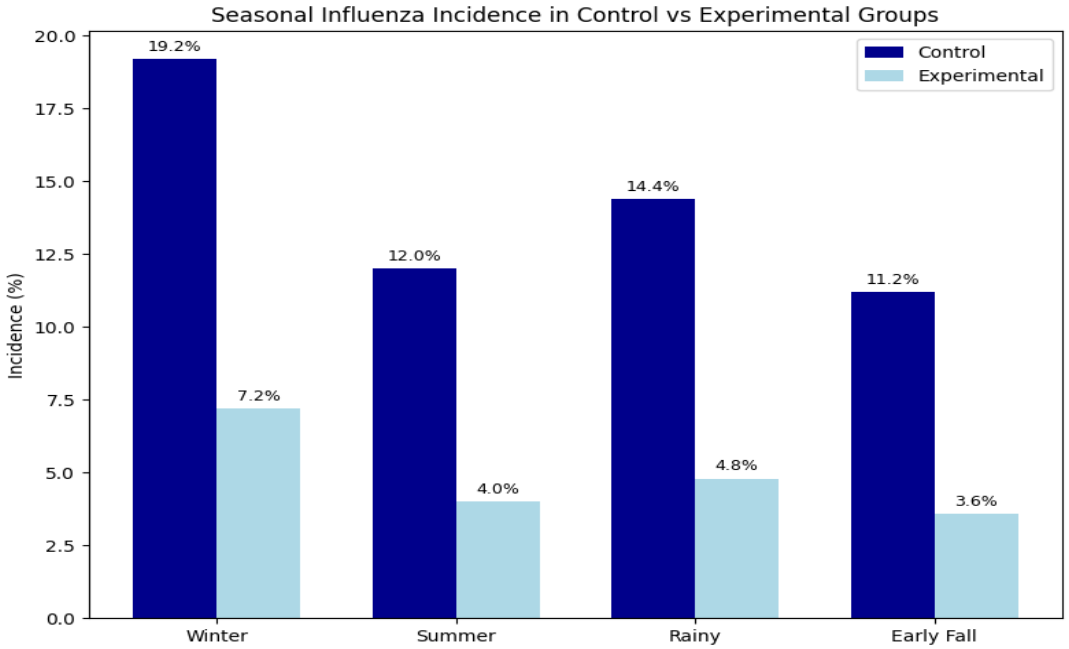


Figure 3: Graphical representation for theSeasonal Influenza Incidence in Control and Experimental Groups

Stress Level Assessment: The impact of Tulsi leaf juice on psychological stress was measured using a 10-point Likert scale, where increased scores indicated higher levels of stress severity. The results, presented in Table 3, demonstrate a clear and significant decrease in the levels of stress in the Experimental group compared to the Control group during all cycles of seasons.

The mean score for stress in the Control group during winter was still high at 6.9 ± 1.6, while that for the Experimental group was significantly lower at 4.8 ± 1.3, reflecting enhanced stress resilience.

Also, during summer season, stress scores were 6.5 ± 1.5 in Control group compared to 4.5 ± 1.2 in Experimental group. The rainy season, which is usually linked with greater health issues and lifestyle stressors, also demonstrated a significant improvement with scores of 6.8 ± 1.4 in Control group and 4.6 ± 1.2 in Experimental group. The same trend was seen in early autumn, with stress levels declining from 6.7 ± 1.5 in the Control group to 4.7 ± 1.3 in the Experimental group.

All decreases were statistically significant ($p < 0.001$), with a general ~30% reduction in stress levels due to Tulsi supplementation. These findings reinforce the adaptogenic nature of Tulsi, well-reported in the literature, in adapting the body to physical and mental stress by regulating cortisol concentrations and improving the mood.

The mentioned regular changes in the various seasons emphasize the potential of Tulsi as a natural and holistic aid to dealing with stress in everyday life.

Table 3: Seasonal Stress Scores in Control and Experimental Groups

Season	Control Group Stress Score (Mean ± SD)	Experimental Group Stress Score (Mean ± SD)	p-value
Winter	6.9 ± 1.6	4.8 ± 1.3	<0.001
Summer	6.5 ± 1.5	4.5 ± 1.2	<0.001
Rainy	6.8 ± 1.4	4.6 ± 1.2	<0.001
Early Fall	6.7 ± 1.5	4.7 ± 1.3	<0.001

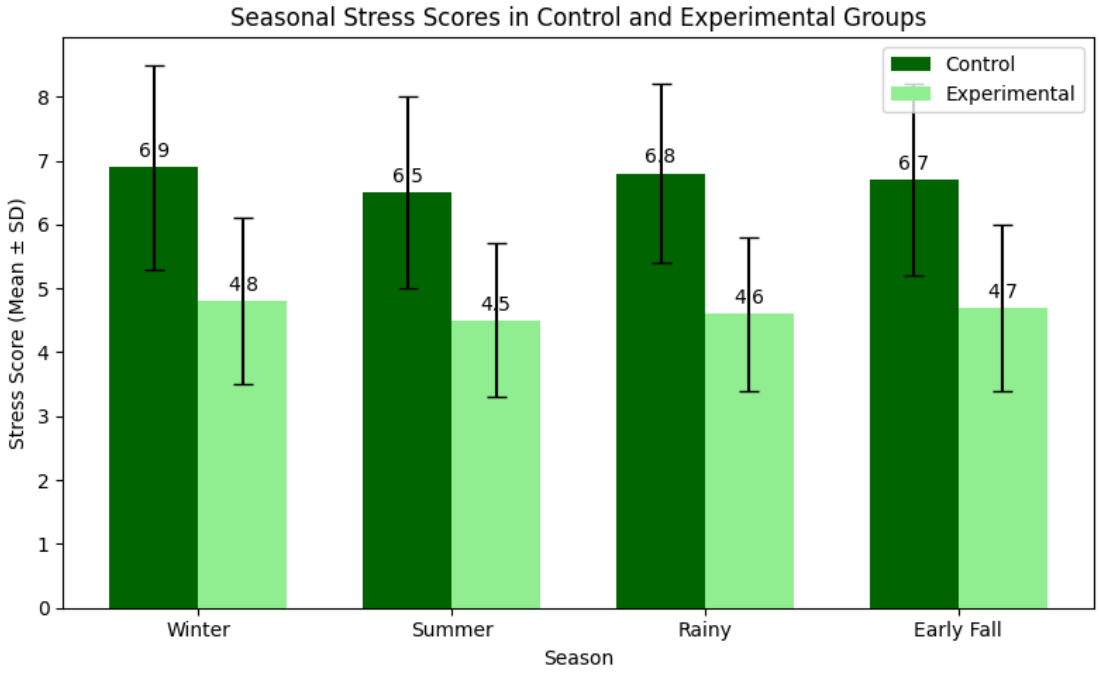


Figure 4: Graphical representation for the stress level assessment in Control and Experimental Groups

General Wellness Assessment: As illustrated in Table 4, Experimental group participants who took Tulsi leaf juice showed significant improvements in general well-being scores over all seasons compared to the Control group. General wellness was scored on a 1–10 scale and represented parameters like immunity, vitality, and perceived overall health. During winter, Experimental group scores were 8.1 ± 1.2 in comparison to 6.9 ± 1.4 for the Control group, reflecting better resistance against infections during the season. Likewise, in summer, the participants on Tulsi registered a score of 8.2 ± 1.1 against 7.0 ± 1.5 for the Control group, highlighting the ability of Tulsi in countering fatigue and retaining energy with heat stress. During rainy season, a time of peak disease prevalence, wellness scores also increased from 6.8 ± 1.3 in the Control group to 8.0 ± 1.2 in the Experimental group, demonstrating the protective effects of Tulsi.

Finally, in early fall, the Experimental group reported a wellness score of 8.1 ± 1.1, compared to 6.9 ± 1.4 in the Control group. The overall improvements were found to be statistically significant ($p < 0.001$), and there was an overall rise in wellness scores by approximately 15 to 20 percent. These findings confirm that Tulsi supplementation did not only reduce the occurrence of illnesses but also promoted the energy productivity in the long term, enhanced immunity

and quality of life in the presence of varying seasons.

Table 4: Seasonal Wellness Scores in Control and Experimental Groups

Season	Control Group Wellness Score (Mean ± SD)	Experimental Group Wellness Score (Mean ± SD)	p-value
Winter	6.9 ± 1.4	8.1 ± 1.2	<0.001
Summer	7.0 ± 1.5	8.2 ± 1.1	<0.001
Rainy	6.8 ± 1.3	8.0 ± 1.2	<0.001
Early Fall	6.9 ± 1.4	8.1 ± 1.1	<0.001

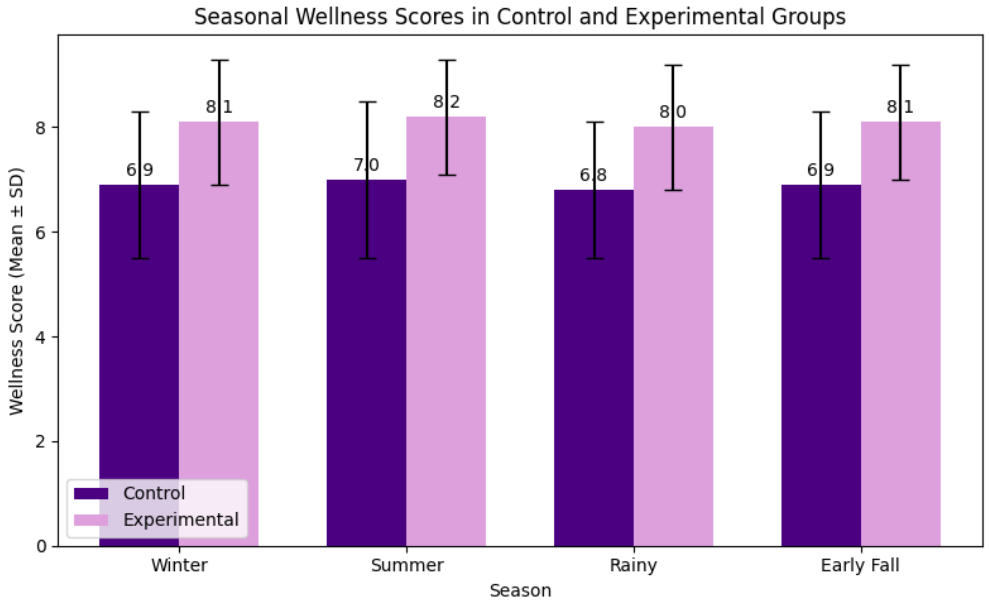


Figure 5:Graphical representation for the Seasonal Wellness Scores in Control and Experimental Groups

Summary of Findings

The general findings of the research illustrate the multi-dimensional health status of Tulsi leaf juice as a seasonal preventive measure. It was found that the influence of Tulsi on preventing influenza-like illness decreased significantly during the Experimental group compared to Control group during all seasons showing that Tulsi had immense antiviral and immunostimulant properties. In addition to a prophylactic effect, the Tulsi supplementation also resulted to a significant change in the levels of the stress and this is the adaptogenic potential of the supplement in balancing the body to seasonal and environmental stress.

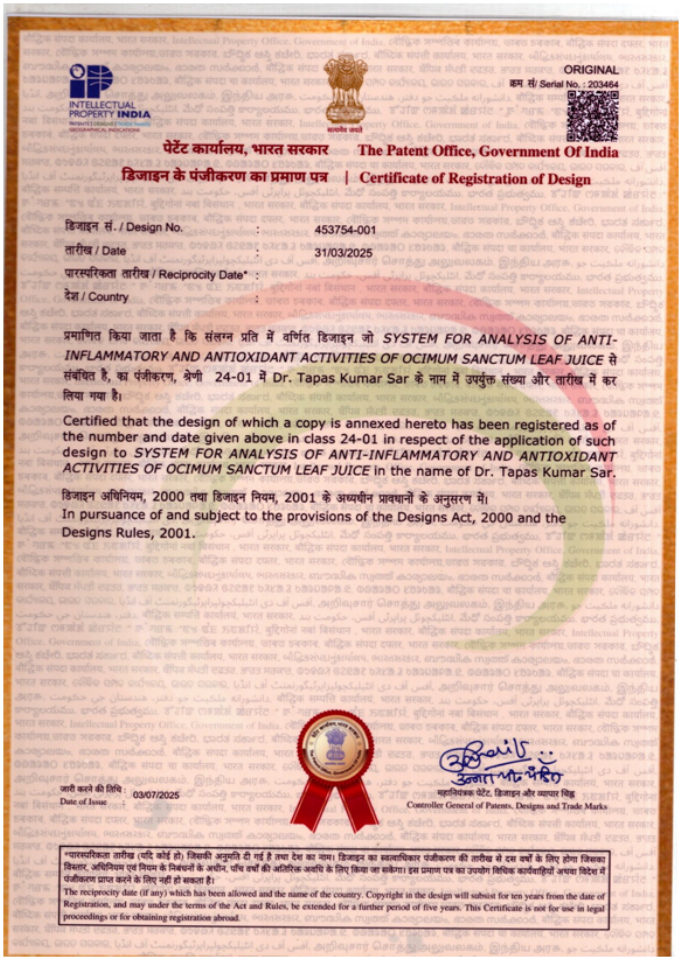
Moreover, in both cases, the members of Experimental group performed better in wellness thus, their immunity is more robust, they possess more energy and are more vital as a whole during the year. Generally, the study results reinforce the notion that Tulsi leaf juice can be considered as a potential and promising community-based and natural health modality that can be integrated into community health practice as a seasonal prevention intervention that enhances immunity, alleviates stress, and enhances the quality of health.

Discussion

The outcomes of this study make a clear interpretation of Tulsi (Ocimum sanctum Linn.) leaf juice therapeutic and preventive efficacy in maximizing the health outcome of the community during various seasons. The significant reduction in the prevalence of the influenza-like illnesses among the members of the Experimental group can be attributed to the earlier reports that have indicated that Tulsi exhibits its antiviral properties through its high phytoconstituents, eugenol, ursolic acid, and rosmarinic acid, which enhance the functioning of the immune cells and inhibit the multiplication of the virus.

Moreover, along with the prophylactic outcomes, such a substantial reduction of the stress scores can be regarded as another sign of the adaptogenic quality of Tulsi in support of the current research, which demonstrates its influence on cortisol levels and psychological resilience. The gradual increase in the scores of wellness across all seasons is a good sign of the ability of Tulsi to improve the overall wellness of the body by improving immunity, maintaining energy and preventing seasonal health exposures. Notably, the high tolerance rates in this research validate Tulsi as safe and culturally acceptable and can be adopted as a nutraceutical in communities over long term. Collectively, these findings not only confirm

conventional wisdom about Tulsi as a sacred healer, but also present empirical data about its role as an ingredient in governmental health policies, especially in high-seasonal disease burden areas.



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डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No.	:	453754-001
तारीख / Date	:	31/03/2025
पारस्परिकता तारीख / Reciprocity Date*	:	
देश / Country	:	

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *SYSTEM FOR ANALYSIS OF ANTI-INFLAMMATORY AND ANTIOXIDANT ACTIVITIES OF OCIMUM SANCTUM LEAF JUICE* से संबंधित है, का पंजीकरण, श्रेणी 24-01 में Dr. Tapas Kumar Sar के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 24-01 in respect of the application of such design to *SYSTEM FOR ANALYSIS OF ANTI-INFLAMMATORY AND ANTIOXIDANT ACTIVITIES OF OCIMUM SANCTUM LEAF JUICE* in the name of Dr. Tapas Kumar Sar.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 03/07/2025
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Figure 6:

Conclusion

Ocimum sanctum Linn has been regarded as an adaptogenic herb, an antiviral and immune-stimulant herb. In this study, intake of Tulsi leaf juice on a daily basis was found to lead to a considerable reduction in the presence of influenza-like disease, stress reduction, and overall wellness in different seasons, confirming its multi-purpose health benefits. It is also worth mentioning that there were no serious side effects that were encountered which further adds to its safety and cultural acceptability as a preventive measure. It was determined that tulsi is a cheaper alternative to synthetic drugs and thus particularly possible within a community and resource limited health care.

The results indicate that Tulsi would be a potentially effective, inexpensive, and herbal intervention to enhance resilience and immunity in population health conditions. However, as a way of generalizing such observations, it is critical that future studies be founded on randomized controlled trials in larger and multi-regional groups, in depth biochemical and immunological analyses to establish the action at hand, and long term follow-ups to establish long-term benefit. That would be a good pointer that Tulsi must be taken into the mainstream of preventive health care practices and policy within the domain of the public health.

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