

**Anti-inflammatory activity of black tea and honey formation**Rupa Devi R<sup>1</sup>, Dr. S Rajesh Kumar\*<sup>2</sup><sup>1</sup>Department of Anatomy, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai – 600077, India<sup>2</sup>Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu- 600077, IndiaEmail id: [rupa2002raja@gmail.com](mailto:rupa2002raja@gmail.com), [Rajeshkumars.sdc@saveetha.com](mailto:Rajeshkumars.sdc@saveetha.com)**ABSTRACT**

**Introduction:** The combination of black tea and honey may enhance anti-inflammatory activity due to their synergistic phytochemical components. Therefore, the present study aims to evaluate the anti-inflammatory activity of black tea and honey using an in-vitro method. Inflammation is a complex biological response of body tissues to harmful stimuli such as pathogens, damaged cells, toxins, or irritants. It is a protective mechanism that helps the body eliminate the initial cause of cell injury and initiate the healing process. The classical signs of inflammation include redness, swelling, heat, pain, and loss of function. Although inflammation is an essential defense mechanism, chronic or excessive inflammation may lead to several diseases such as arthritis, cardiovascular diseases, diabetes, cancer, and autoimmune disorders.

**Materials and methods: Preparation of Black Tea Extract:** Black tea leaves were weighed and boiled in distilled water for 10–15 minutes. The extract was filtered using filter paper and stored for further analysis. **Preparation of Honey Solution:** Natural honey was diluted with distilled water to obtain different concentrations for the experiment. **Results:** The results showed that both black tea extract and honey exhibited significant anti-inflammatory activity. The inhibition of protein denaturation increased with increasing concentration of the samples. **Conclusion:** An important observation of this study was that the combination of black tea and honey showed enhanced anti-inflammatory activity compared to individual samples. This suggests that the phytochemical compounds present in both substances may act synergistically to produce a stronger biological effect. The synergistic interaction between antioxidants and phenolic compounds may improve their ability to inhibit protein denaturation and reduce inflammatory processes.

**Keywords:** Black tea, honey**INTRODUCTION**

Inflammation is a natural protective response of the body against infection, injury, and harmful stimuli. However, excessive or chronic inflammation can lead to various diseases such as arthritis, cardiovascular diseases, and metabolic disorders(1). Conventional anti-inflammatory drugs such as non-steroidal anti-inflammatory drugs (NSAIDs) are widely used but may cause adverse effects including gastric irritation and kidney problems.(2). Natural products have gained significant attention due to their therapeutic benefits and minimal side effects. Black tea (*Camellia sinensis*) is one of the most widely consumed beverages in the world and contains several bioactive compounds such as polyphenols, flavonoids, and theaflavins which exhibit antioxidant and anti-inflammatory properties.(3). Honey is a natural sweet substance produced by honey bees from floral nectar. It contains flavonoids, phenolic acids, enzymes, vitamins, and minerals that contribute to its medicinal properties, including antimicrobial, antioxidant, and anti-inflammatory effects.(4). The combination of black tea and honey may enhance anti-inflammatory activity due to their synergistic phytochemical components. (1,5)Therefore, the present study aims to evaluate the anti-inflammatory activity of black tea and honey using an in-vitro method. Inflammation is a complex biological response of body tissues to harmful stimuli such as pathogens, damaged cells, toxins, or irritants. (6)It is a protective mechanism that helps the body eliminate the initial cause of cell injury and initiate the healing process. The classical signs of inflammation include redness, swelling, heat, pain, and loss of function. Although inflammation is an essential defense mechanism, chronic or excessive inflammation may lead to several diseases such as arthritis, cardiovascular diseases, diabetes, cancer, and autoimmune disorders.(7). Conventional anti-inflammatory drugs, particularly non-steroidal anti-inflammatory drugs (NSAIDs) such as aspirin and diclofenac, are commonly used to control inflammatory conditions. (8)However, prolonged use of these medications may lead to adverse effects including gastric irritation, ulcers, kidney damage, and other systemic complications. Due to these limitations, there has been growing interest in exploring natural products with anti-inflammatory properties that are safer and have fewer side effects.

Natural substances such as plant extracts, herbs, and bee products have been widely studied for their medicinal properties. Among these, tea is one of the most widely consumed beverages worldwide.(9) Black tea, derived from the plant *Camellia sinensis*, undergoes a fermentation process that leads to the formation of polyphenolic compounds such as theaflavins and thearubigins. These bioactive compounds are known to possess antioxidant, anti-inflammatory, antimicrobial, and cardioprotective properties. The anti-inflammatory effects of black tea are mainly attributed to its ability to inhibit inflammatory mediators and reduce oxidative stress.(10)

Honey is another natural substance that has been used in traditional medicine for centuries. It is a natural sweet substance produced by honey bees from the nectar of flowers. Honey contains a wide range of bioactive compounds including flavonoids, phenolic acids, enzymes, vitamins, amino acids, and minerals. These components contribute to its various therapeutic properties such as antimicrobial, antioxidant, wound-healing, and anti-inflammatory activities. Honey has also been shown to reduce inflammation by inhibiting the release of pro-inflammatory cytokines and promoting tissue repair.(11)

Both black tea and honey are rich sources of antioxidants, which help neutralize free radicals and reduce oxidative stress, a major contributor to inflammatory processes. The combination of black tea and honey may produce a synergistic effect, enhancing their biological activities and improving their anti-inflammatory potential. Regular consumption of black tea with honey may therefore contribute to reducing inflammation and promoting overall health.(12)

Considering the medicinal properties of these natural products, the present study aims to evaluate the anti-inflammatory activity of black tea and honey using an in-vitro protein denaturation assay.(13) This study may provide scientific evidence supporting the use of black tea and honey as natural anti-inflammatory agents.

Inflammation is a vital biological response of the immune system that occurs when the body is exposed to harmful stimuli such as infections, physical injury, toxic chemicals, or immune reactions. It plays an important role in protecting the body by removing damaged tissues and initiating the healing process. (14)The typical characteristics of inflammation include redness (rubor), swelling (tumor), heat (calor), pain (dolor), and sometimes loss of function. While acute inflammation is beneficial and necessary for healing, prolonged or chronic inflammation can contribute to the development of many serious diseases including rheumatoid arthritis, asthma, inflammatory bowel disease, cardiovascular diseases, diabetes mellitus, and certain cancers.

The management of inflammatory conditions commonly involves the use of anti-inflammatory drugs, particularly non-steroidal anti-inflammatory drugs (NSAIDs) such as aspirin, ibuprofen, and diclofenac. These medications act by inhibiting enzymes such as cyclooxygenase (COX) that are involved in the production of inflammatory mediators like prostaglandins. Although these drugs are effective in controlling inflammation and pain, their long-term use may lead to adverse side effects such as gastric ulcers, gastrointestinal bleeding, kidney damage, and

cardiovascular complications. Due to these limitations, there has been increasing interest in identifying safer and more effective natural alternatives derived from plants and other natural sources.

In recent years, natural products have gained considerable attention in the field of medical research because of their wide range of pharmacological properties and relatively fewer side effects. Many plant-based products contain bioactive compounds such as flavonoids, phenolic acids, alkaloids, and terpenoids that possess antioxidant and anti-inflammatory activities. These compounds can help reduce inflammation by inhibiting inflammatory mediators, reducing oxidative stress, and protecting cells from damage caused by free radicals.

## MATERIALS AND METHODS

### Materials

- Black tea leaves
- Natural honey
- Distilled water
- Bovine Serum Albumin (BSA)
- Phosphate buffer
- Hydrochloric acid
- Standard anti-inflammatory drug (e.g., Diclofenac or Aspirin)

### Preparation of Black Tea Extract

Black tea leaves were weighed and boiled in distilled water for 10–15 minutes. The extract was filtered using filter paper and stored for further analysis.

### Preparation of Honey Solution

Natural honey was diluted with distilled water to obtain different concentrations for the experiment.

### Anti-inflammatory Assay (Protein Denaturation Method)

The anti-inflammatory activity was evaluated using the protein denaturation method.

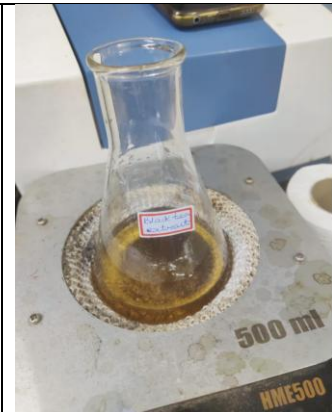
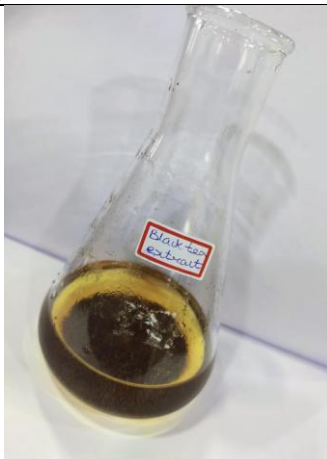
1. Different concentrations of black tea extract and honey were prepared.
2. Each sample was mixed with bovine serum albumin (BSA).
3. The mixture was incubated at 37°C for 20 minutes.
4. The reaction mixture was heated at 55°C for 20 minutes to induce protein denaturation.
5. After cooling, absorbance was measured using a spectrophotometer at 660 nm.
6. The percentage inhibition of protein denaturation was calculated and compared with the standard drug

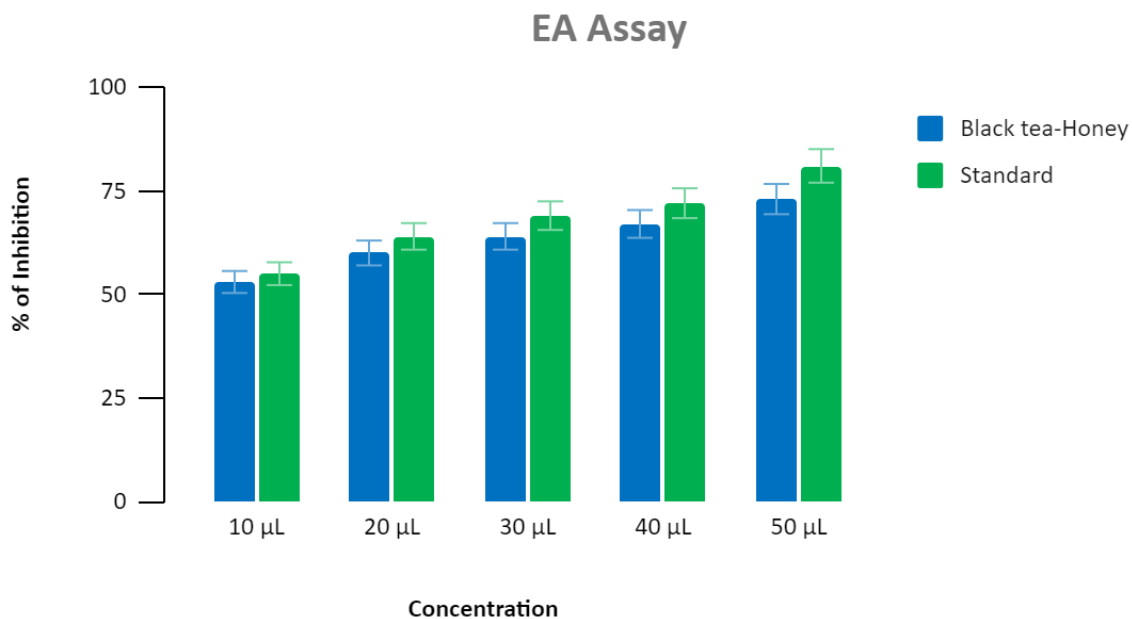
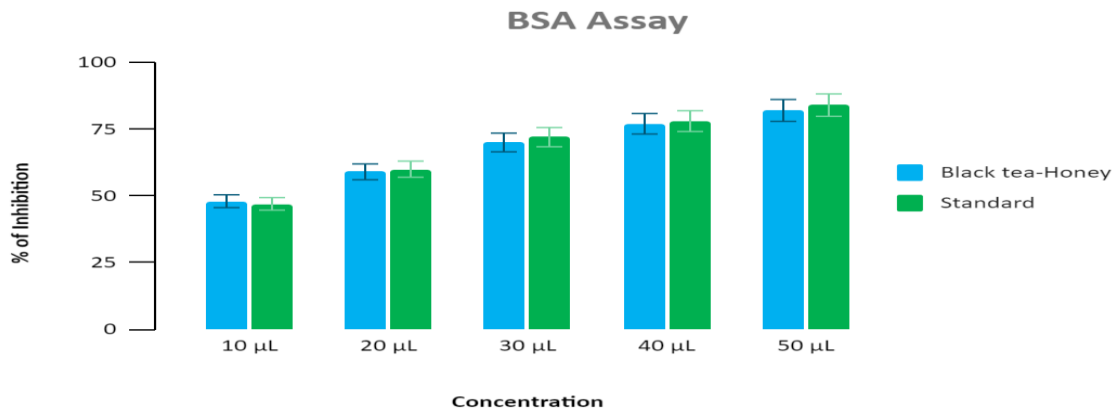
## RESULTS

The results showed that both black tea extract and honey exhibited significant anti-inflammatory activity. The inhibition of protein denaturation increased with increasing concentration of the samples.

The combination of black tea and honey demonstrated higher anti-inflammatory activity compared to individual samples. This suggests a possible synergistic effect between the phytochemical compounds present in black tea and honey.

The activity observed was comparable to the standard anti-inflammatory drug used in the study.

**Figure 1****Figure 2****Figure 3****Figure 4****Figure 5****Figure 6**



## DISCUSSION

The anti-inflammatory activity observed in this study may be attributed to the presence of polyphenols, flavonoids, and antioxidants in black tea and honey. These compounds help reduce inflammation by inhibiting the denaturation of proteins and neutralizing free radicals.

Black tea contains theaflavins and catechins which are known for their anti-inflammatory and antioxidant properties. Honey also contains phenolic compounds that contribute to its therapeutic effects.

The synergistic interaction between the phytochemicals in black tea and honey may enhance their biological activity. Similar findings have been reported in previous studies where natural products demonstrated effective anti-inflammatory potential.

Protein denaturation is a well-documented cause of inflammation. During inflammatory conditions, proteins lose their natural structure and function, which may lead to the production of auto-antigens that trigger inflammatory responses. Therefore, agents capable of preventing protein denaturation can be considered as potential anti-inflammatory agents. In the present study, black tea and honey were found to inhibit protein denaturation effectively, suggesting their potential role in controlling inflammatory processes.

The anti-inflammatory activity of black tea may be attributed to the presence of polyphenolic compounds such as theaflavins, thearubigins, and catechins. These bioactive compounds possess strong antioxidant properties and are capable of neutralizing free radicals. Free radicals and reactive oxygen species are known to play a major role in the initiation and progression of inflammation by causing cellular damage and activating inflammatory mediators. By reducing oxidative stress, these compounds help in suppressing inflammatory responses.(15)

Several previous studies have also reported similar findings regarding the anti-inflammatory and antioxidant properties of tea and honey. The presence of polyphenols and flavonoids in these natural products has been widely recognized for their protective effects against inflammatory disorders. These compounds help in stabilizing proteins, preventing oxidative damage, and reducing the release of inflammatory mediators.(16) The antioxidant capacity of black tea plays a major role in its anti-inflammatory action. Black tea contains high levels of polyphenols that act as free radical scavengers. These antioxidants protect cells from oxidative damage and reduce the activation of inflammatory pathways.(17) Oxidative stress is known to stimulate the release of inflammatory mediators such as tumor necrosis factor (TNF- $\alpha$ ), interleukins, and prostaglandins, which contribute to the progression of inflammation. By neutralizing free radicals, black tea helps in reducing oxidative stress and controlling inflammatory responses.(18)

Another possible explanation for the enhanced activity observed in the combination of black tea and honey is the synergistic interaction between their bioactive compounds. Synergism occurs when two substances work together to produce a greater biological effect than when used individually. (19) The polyphenols from black tea and the flavonoids from honey may interact in such a way that their antioxidant and anti-inflammatory effects are amplified. This may explain why the combined sample showed improved inhibition of protein denaturation compared to the individual components.(20)

## CONCLUSION

The present study demonstrated that black tea and honey possess significant anti-inflammatory activity. The combination of these natural products showed enhanced inhibition of protein denaturation, suggesting a synergistic effect.

Therefore, black tea with honey may serve as a natural alternative for managing inflammatory conditions. Further in-vivo and clinical studies are recommended to confirm these findings and explore their therapeutic applications.

An important observation of this study was that the combination of black tea and honey showed enhanced anti-inflammatory activity compared to individual samples. This suggests that the phytochemical compounds present in both substances may act synergistically to produce a stronger biological effect. The synergistic interaction between antioxidants and phenolic compounds may improve their ability to inhibit protein denaturation and reduce inflammatory processes.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this study. The research was conducted independently, and no financial or commercial relationships were involved that could influence the results or interpretation of the findings. All materials used in the study, including black tea and honey, were obtained from commonly available sources and were used solely for academic and research purposes.

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