# List of publications from the present work

**List of Publications**

1. Begum, A., Kalita, D., Bhattacharya, S., & Srivastava, B. (2023). Time-dependent rheological behavior of pineapple pulp foam and its relationship with foaming properties and quality attributes of dried powder. *Journal of Food Engineering*, *336*, 111208.
2. Begum, A., Islam, S., Kumar, A., & Srivastava, B. (2025). Modelling the enzymatic activity of pineapple pulp affected by DBD voltage and treatment time of atmospheric cold plasma. *Journal of Food Science and Technology*, 1-14.

**Other Publications**

1. Kumar, A., Begum, A., Hoque, M., Hussain, S., & Srivastava, B. (2021). Textural degradation, drying and rehydration behaviour of ohmically treated pineapple cubes. *Lwt*, *142*, 110988.
2. Islam, S., Kumar, P., Cheroor, R., Jaiswal, M., Begum, A., Srivastav, P. P., & Srivastava, B. (2024). Influence of non-thermal dielectric barrier discharge (DBD) plasma treatment on pectin methylesterase inactivation and ascorbic acid degradation in Citrus sinensis (cv. Malta) juice. *Journal of Food Measurement and Characterization*, 1-15.

**Participation in National/International conference**

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2. Begum, A., & Srivastava, B., "Characterization of pineapple puree foam by image processing"; *International Conference Technological Innovations for Integration of Food and Health, 14-16, February,* 2019., Tezpur University, Tezpur, Assam.
3. Begum, A., Hoque, A, & Srivastava, B., "Foam characterization of cold plasma treated pineapple pulp and its drying behavior", *27th Indian Convention of Food Scientists and Technologists (ICFoST-2020),* 30th January -1st February, 2020, Tezpur University, Tezpur, Assam.
4. Begum, A.,Kumar, A., & Srivastava, B., "Cold plasma assisted inhibition of Enzymatic browning in pineapple pulp and modeling inactivation kinetics", Sustainable Approaches in Food Engineering and Technology (SAFETy-2021), 24th -25th June, 2021, Tezpur University and University of Georgia, USA.

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# Time-dependent rheological behavior of pineapple pulp foam and its relationship with foaming properties and quality attributes of dried powder

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ABSTRACT

The time-dependent rheological characteristics of pineapple pulp foam (PPF), prepared by whipping the pulp with varying concentrations (2–6%) of skim milk powder (SMP), were investigated at different shear rates (1, 10, and 50 $s^{-1}$). The PPF showed time-dependent shear-thinning behavior that could be explained by the Hahn and Figoni-Shoemaker models ($|r| \leq 0.997$). The time and shear-rate-dependent structural breakdown coefficients (B- and M-values) varied due to foam properties (stability, expansion, and drainage volume) and SMP concentration. These coefficients could be suitable indices to judge the stability of the foam. The effective moisture diffusivity during foam drying increased significantly with SMP ($p \leq 0.05$); the physical properties of powder were also influenced. A strong correlation existed between SMP, foaming, and rheological properties. The principal component analysis (PCA) indicated a good interrelation among rheological properties, foam, and powder characteristics.

## 1. Introduction

Foam mat drying is a simple and alternative method for removing moisture from fruit juices/purees. In this method, the fruit juice/puree is whipped to produce foam with the addition of a foaming agent, spread on a tray, and dried in a stream of hot air. The high sugar-containing viscous foods are challenging to dry due to the stickiness problem of the dried sample (Chandrasekar et al., 2015). Thus, the technology of foam-mat drying is now popular among fruit processing units. Using suitable additives like starch, maltodextrin, glycerol monostearate, propylene glycerol monostearate, carboxymethyl cellulose (CMC), and trichloro phosphate can minimize the stickiness problem and reduces the hygroscopic nature of powder (Muzaffar et al., 2018; Asokapandian et al., 2016). Therefore, incorporating additives can affect the drying characteristics and product attributes.

A food foam consisting of air bubbles in a fruit juice or pulp matrix is obtained before drying (Lobo et al., 2017). Thus, the characteristics of the foam and its stability during the drying phase are helpful for the standardization of the drying process, dry product attributes, and scaling-up purposes. In foam-mat drying, foam is suitably dried to obtain a powder. Thus, the rheology of foam is a critical issue that can affect the downstream processes. The stability of foam is of prime importance as it may also facilitate the drying rate by maintaining foam structure during the drying process. However, studies in this direction, particularly using fruit juice or pulp, are scarce.

The time-dependent characteristics reflect the change in apparent viscosity and related indices against the time of shearing. The time-dependent shear-thinning behavior of fruit pulps and concentrated juices (banana puree, mango pulp, and date syrup) exhibits a decrease in apparent viscosity against time under a constant shear rate (Ibarz et al., 2010; Mohamed and Hassan, 2016). If the reverse trend is observed, it is called an anti-thixotropic fluid, a rare phenomenon in food systems. Further, a few time-dependent flow models are also available to predict shear-stress/apparent viscosity. It will be helpful if the suitability of the models is examined to understand the rheological characteristics of raw material in the form of fruit juice, pulp, or foam.

A review of various foam formation and stabilization aspects is available (Sangamithra et al., 2014). It was indicated that whipping or beating is suitable for preparing foam. Kadam et al. (2012) used tricalcium phosphate and egg albumin as the foaming agents, while CMC was incorporated for foam stabilization to develop foam-mat dried pineapple powder. Pineapple pulp has been selected as a model system in the

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ORIGINAL ARTICLE

# Modelling the enzymatic activity of pineapple pulp affected by DBD voltage and treatment time of atmospheric cold plasma

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**Abstract**

The present investigation mathematically modeled the inactivation of polyphenol oxidase (PPO) and peroxidase (POD) enzymes in pineapple pulp. The pineapple pulp was exposed to dielectric barrier discharge (DBD) plasma at 15, 20, 25, and 30 kV with treatment times of 3, 6, 9, 12, and 15 min. The result showed that, after 15 min of plasma exposure, dielectric barrier discharge (DBD) plasma exposure of 30 kV was sufficient to reach the maximum inactivation of PPO and POD in pineapple pulp up to 90% and 87%, respectively. The regression coefficient of the Peleg and Two-fraction kinetic model was suitable for the model fitting. However, the RMSE/error in both models indicates the limiting characteristics of the fitted models over experimental observations. Based on the model validation, the Peleg model was more adequate for describing both the PPO and POD enzymes in pineapple pulp with $R^2 > 0.99$, RMSE/error $< 0.041$, $A_f$ and $B_f \sim 1$), AIC $\geq -113.348$, and BIC $\geq -4.560$.

**Keywords** Pineapple pulp · Cold plasma · PPO · POD · Enzymes · Mathematical modelling

## Introduction

Fruit juices are consumed more frequently because they are filled with various bioactive components and satisfy customers' need for convenient, pleasant, and healthy foods. Pineapple (*Ananas comosus)* is a tropical fruit popularly known for its taste and nutritional benefits. Pineapple comprises reasonable amounts of minerals (calcium and potassium), ascorbic acid (Vit C), carbohydrates, dietary fibre, water, and minerals that are helpful for the digestive system, support a healthy weight, and promote balanced nutrition. Fresh pineapples are also a good source of Bromelain, a protein-tenderising enzyme that helps digestion, blood clotting, and several therapeutic applications (Hossain et al. 2015). Pineapple also naturally contains oxidative enzymes such as polyphenol oxidase (PPO) and peroxidase (POD). The browning reaction occurs when the fruits containing these enzymes come in contact with atmospheric air. Enzymatic browning causes nutritional and colour loss and may degrade the overall food quality. PPO and POD cancatalyse different steps in the hydroxylation of monophenol into diphenol and the oxidation of diphenol into o-quinones by diphenol oxidase activity (Panigrahi et al. 2021). The conversion of this phenomenon ultimately causes the formation of melanins, which are responsible for the development of undesirable changes in Fruits and vegetables. POD also catalyses the single-electron oxidation of phenols when hydrogen peroxide is present. When phenolic chemicals are finally oxidised, they produce melanin compounds that are black, brown, or red, which causes colour and nutrient loss.

Conventional thermal treatments are commonly used techniques for inactivating enzymes and pathogenic microorganisms in juice processing. Fruit juices rich in heat-sensitive nutrients such as vitamin C, aroma, and flavour compounds may be degraded by thermal treatments (Chakraborty et al. 2014). In order to overcome the problems and reduce nutritional losses, non-thermal electric field treatments are gaining attention in fresh juices or pulp processing units. Care should be taken during their processing to standardize the best processing conditions to reduce the spoilage enzymes. Enzymes like PPO, POD, and Pectin Methyl esterase (PME) are inactivated while retaining healthy nutrients to the fullest extent possible (Cautela et

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