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Effect of pulsed light treatment on sugars and microbial load in mature coconut water

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Abstract
Mature coconut water (MCW) is a highly perishable drink susceptible to microbial degradation. Preservation by pulsed light treatment is an innovative technique for coconut water without affecting its organoleptic qualities. The effect of pulsed light treatment (500V and 1000V for 30, 60, and 90 sec) on pH, TSS, total sugars, reducing sugars, non-reducing sugars and microbial load of mature coconut water was studied. Pulsed light treatment caused insignificant change in pH, and TSS. A significant decrease was observed in total sugars, reducing sugars, and microbial load. The non-reducing sugar content, however, reduced insignificantly with voltage. Due to these findings, pulsed light treatment could be a more effective means of controlling microbial growth in mature coconut water than thermal treatment.

Keywords: Pulsed light treatment, sugars, microbial load, mature coconut water

Introduction
Mature coconut water is one of the most versatile natural products because it can be used for many applications. Several health and nutritional benefits can be attributed to the unique chemical composition of coconut water (Xu *et al.*, 2022) [7]. Generally mature coconut water from the coconut processing industry discarded as waste and also contributes to environmental pollution (Chauhan *et al.*, 2014) [1]. It was necessary to make the use of available mature coconut water by extending the shelf life, ensuring food safety and at the same time retaining the nutritional quality (Kantachote *et al.*, 2017) [2]. The method of processing has a significant impact on the quality of functional food products. Non-thermal preservation methods can kill the microbial contamination under mild temperature and can sustain colour, flavor, taste, nutrients in the food material (Morris *et al.*, 2007) [4] these methods can prevent the critical effects of heat on the bioactive compounds in fruit juices. In recent years, pulsed light (PL) technology have emerged as superior alternatives to chemical and thermal decontamination processes. In PL treatment, microorganisms are generally killed by high-intensity, short light pulses (Mandal *et al.*, 2020) [3].
To date no reports are available on the effect of pulsed light treatment on quality of mature coconut water to extend its shelf-life. Hence the study was conducted to evaluate the effect of pulsed light treatment on the physicochemical and microbial characteristics of mature coconut water.

Materials and Methods
Collection of mature coconut water
Mature Coconuts of the West Coast Tall variety, with an age range between 11-12 months, were obtained from a coconut nursery at the Tamil Nadu Agricultural University, Coimbatore, India. Coconuts were dehusked and split into two halves with stainless steel cutters, and water was collected in a SS container after being filtered with muslin cloth. The MCW was treated immediately after collection in order to maintain its quality.

Pulsed light processing
Fresh mature coconut water (MCW) was fed into the feed tank, pumped through the pipeline into the quartz tube, and exposed to the pulsed light at a fixed flow rate of 100 ml/min. The samples were treated by varying the process parameter such as input voltage (500V and 1000V) and exposure time (30, 60, 90 sec). The physicochemical and microbial analysis was done with the control and treated samples in order to find the effectiveness of the pulsed light treatment on the mature coconut water.

Determination of pH and TSS

An Accuracy refractometer (Erma Inc. Tokyo Japan) and a digital pH meter (Brand-ENRIC, Ahmedabad, India) were used to measure the TSS and pH of the MCW.

Determination of Non-reducing sugar

The total sugars and reducing sugars were determined by AOAC method and the non-reducing sugars was calculated using the following formula.

Non-reducing sugar (%) = Total sugar (%) – Reducing sugar (%)

Microbiological analysis

Total plate count was used for the microbiological analysis of MCW. Pour plate enumeration was used to count serially diluted samples. A microbial load was determined by incubating diluted samples on plate count agar for 24-48 hours at room temperature.

Results and Discussion

The effect of pulsed light treatment on the physicochemical properties of mature coconut water

The pulsed light treatment effect on the physicochemical characteristics of mature coconut water at different voltages of 500 and 1000 V for the duration of 30, 60, and 90 min was studied.

Total Soluble solids (TSS) content of fresh mature coconut water was 5 °Bx and the TSS of pulsed light treated samples showed an insignificant change. The effect of pulsed light treatment on TSS of the present study is in agreement with (Pala and Toklucu, 2013) [5] for orange juice and (Türkmen and Takci, 2018) [6] for black carrot juice.

There was no significant change (p>0.01) in the pH of mature coconut water after pulsed light treatment. The pH of fresh mature coconut water was 4.85 and is slightly reduced to 4.83 after treatment with 1000V for 90 sec.

Effect of pulsed light treatment on the nutrients content of mature coconut water

The effect of pulsed light treatment on the pH, total sugars, reducing sugars, and non-reducing sugars of the mature coconut water immediately after treatments were analyzed and presented in Fig. 1 and Fig. 2.

The fresh sample had an initial total sugar, reducing sugar, and non-reducing sugar content of 5.1, 2.53, and 2.57% respectively. There was a significant decrease in total sugar content noticed after the treatments. The maximum decrease in total sugar content of 4% was found in samples treated at a maximum voltage of 1000V for 90 sec. Pan *et al*., (2004) [8] also reported a similar trend of decrease in total sugar content after UV-C treatment of strawberry fruit.

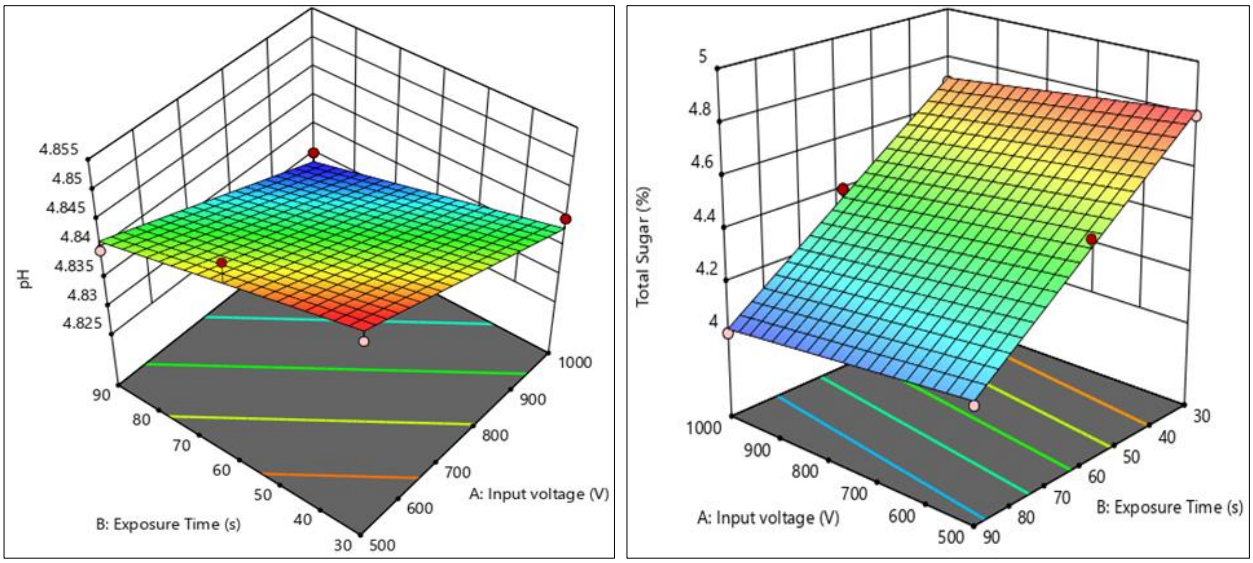
A similar slight decreasing trend was found in both reducing and non-reducing sugar. But the non-reducing sugar content reduced insignificantly when the voltage was varied. The maximum decrease was found in samples treated at 1000V input voltage and 90 sec exposure time for both reducing sugar and non-reducing sugar and it was reduced to 2.15 and 1.85% respectively. The decrease in sugar content was found to depend upon the combined effect of voltage and time. The minimum reduction of sugar content was reported in samples treated for minimum input voltage of 500V for 30 sec.

Effect of pulsed light treatment on microbial load of mature coconut water

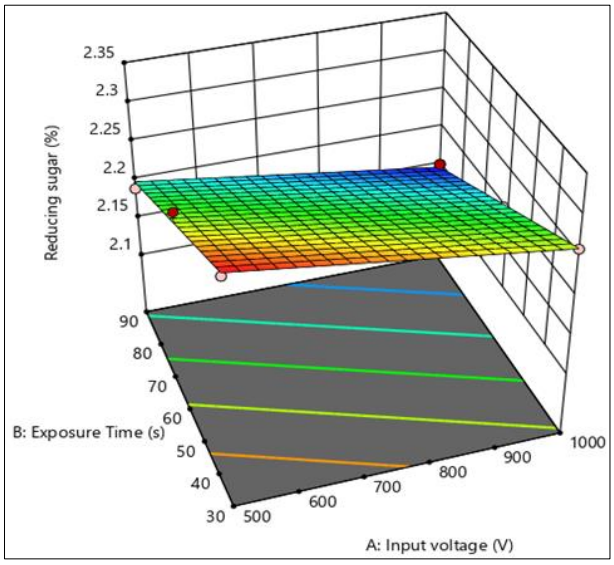
The changes in microbial load of the mature coconut water to the input voltage and exposure time immediately after pulsed light treatments were analyzed and demonstrated in Fig. 2. Input voltage supplied to the lamp and exposure time are the important factors in microbial inactivation (Maftei *et al*., 2014) [9]. The gradual increase in microbial inactivation efficiency can be observed with increasing voltage and treatment time. The total plate count of treated samples was analyzed immediately after treatment. The total plate count of the control sample was found to be 6.3 log cfu/ml.

The pulsed light treatment significantly (p<0.05) reduced the growth of microbial populations and it may be due to the photochemical or photothermal mechanism. The maximum reduction in the total plate count of 4.25 log cfu/ml was observed at 1000 V and 90 sec treatment time. The minimum microbial reduction (5.01 log cfu/ml) was observed at 500 V and 30 sec treatment time.

A similar result of the reduction in the microbial population of tender coconut water after pulsed light treatment was reported by (Preetha *et al*., 2017) [10].

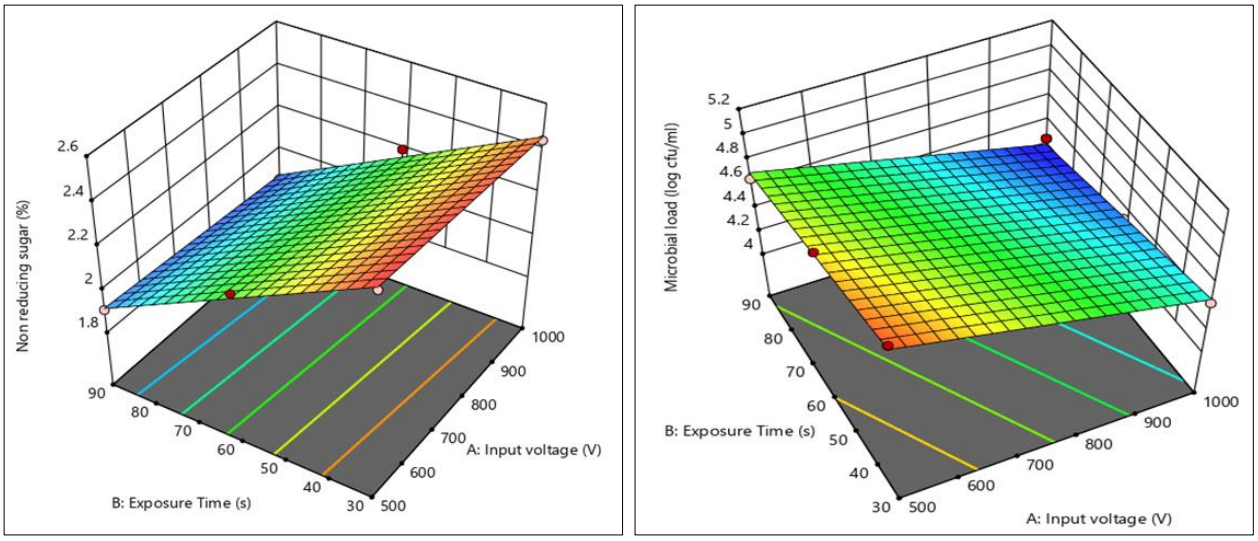


a b



c

Fig 1: Effect of pulsed light voltage and exposure time on pH (a), total sugars (b), and reducing sugars(c) of MCW



a b

Fig 2: Effect of pulsed light voltage and exposure time on non reducing sugar (d), and microbial load (e) of MCW

Conclusion

In the present study pulsed light treatment insignificantly changed pH and TSS. While the total sugar and reducing sugar decreased significantly. But the non-reducing sugar content reduced insignificantly when the voltage was varied. The microbial load in mature coconut water decreased significantly after pulsed light treatment. The maximum reduction in the microbial count was observed at maximum input voltage 1000V for 90 sec. As a result, pulsed light treatment could be a better alternative to thermal treatment for controlling microbial growth in mature coconut water. Pulsed light treatment can therefore preserve mature coconut water.

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