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Effect of L-ascorbic acid addition on the quality attributes of micro-filtered coconut water stored at 4 °C☆

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ABSTRACT

Coconut water was processed through 2-stage microfiltration system and L-ascorbic acid (25 mg/100 ml) was added to it, and then stored at 4 °C for 28 days. Micro-filtered coconut water, added (AS) or without added (US) ascorbic acid was analyzed for physicochemical, sensorial and microbial changes. With increase in storage time perpetual decrease in nutritional values and sensory qualities of the samples occurred; nevertheless, AS was able to retain these qualities more than US. Added ascorbic acid delayed the decrease of clarity (% transmittance) ($p<0.05$), sensory qualities, and also slowed down the increase of reducing sugar and total fatty acids. A kinetic study of post processing quality loss was also conducted during the storage period. Adequacy of zero and first order kinetic models were dependent on the specific quality attributes that were studied. Principal Component Analysis (PCA) clearly showed that more drastic color and sensory changes occurred in US compared to AS.

Industrial relevance: Recently, microfiltration of coconut water has been found to be an alternative to thermal sterilization. This study was undertaken to evaluate the effect of L-ascorbic acid addition on the quality attributes of micro-filtered coconut water during low temperature storage (4 °C for 28 days). The study makes a reasonable comparison of the quality attributes of micro-filtered coconut water, with or without added ascorbic acid. Concerted effect of microfiltration and L-ascorbic acid addition proved to be a better method for processing coconut water than microfiltration alone.

1. Introduction

Water from green coconut is largely consumed worldwide, not only as a refreshing drink but also because of its various therapeutic qualities (Loki & Rajamohan, 2003). The water when taken out from the nut spoils within a day because of external contamination by microorganisms, which may be in the order of 10^6 cfu/ml in the traditional way of collection (Reddy, Das, & Das, 2005). The commercial production of canned coconut water has employed a high-temperature/short-time preservation process. The thermal treatment eliminates the entire delicate flavor along with the microbes. This severely limits the marketability of the product (Jayanti, Rai, Dasgupta, & De, 2008). Selecting technological processes to preserve the natural wholesome properties of the coconut water still remains a challenge. Recently, microfiltration has been found to be an alternative to thermal sterilization, to obtain processed coconut water, which can be as good as fresh coconut water (Anonymous, 2007; Barrett, Somogyi, & Ramaswamy, 2004; Reddy, Das, & Das, 2007). As such, micro-filtered coconut water was taken as the base material for our present study.

Coconut water contains a considerable amount of fats, oils and minerals, which vary with the cultivar and stage of maturation of the coconut (Campos, Souza, Coelho, & Gloria, 1996; Fonseca et al., 2009; Jackson, Gordon, Wizzard, McCook, & Rolle, 2004; Reddy et al., 2007). Minerals catalyze lipid oxidation and results in free fatty acids (FFA) formation that affects the aroma and the quality of either fresh or processed coconut water. Reddy et al. (2007) observed that microfiltration technique is not sufficient to completely filter lipids from the processed coconut water. This necessitates the addition of antioxidants.

Even if the coconut water is extracted aseptically, its exposure to air initiates some reactions such as oxidation promoted by enzymes polyphenol oxidase (PPO) and peroxidase (POD), which are naturally present in the coconut water (Duarte, Coelho, & Liete, 2002). Also coconut water is rich in minerals and electrolytes (Jackson et al., 2004; Reddy et al., 2007) which catalyzes lipid oxidation and formation of volatile compounds. These reactions have a negative effect on sensorial and nutritional qualities of the coconut water (Campos et al., 1996; Duarte et al., 2002). In order to reduce these problems, Rolle (2007)

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and Anonymous (2007) recommended that the storage temperature for processed coconut water should not exceed 4 °C (refrigeration). In addition, Campos et al. (1996) suggested the addition of ascorbic acid for inhibiting the activity of PPO and POD in coconut water, which does not affect the sensory properties when incorporated up to an optimum level.

Nutritional quality changes during storage can be determined by accurate mathematical models (Zheng & Lu, 2011). Kinetic models have been developed to evaluate degradation of quality parameters including color, browning, ascorbic acid during thermal processing, high pressure processing, sonication, ozonation and pulsed electric field processing (Ahmed, Shivhare, & Raghavan, 2004; Blasco, Estevea, Frígola, & Rodrigo, 2004; Maskan, 2001; Medoua, & Mbofung, 2007; Patras, Brunton, Tiwari & Butler, 2009; Torregrosa, Esteve, Frígola, & Cortés, 2006).

Therefore, the present paper discusses the changes occurring in the quality attributes of micro-filtered coconut water, added (AS) or without added (US) L-ascorbic acid during aseptic storage at 4 °C. Another objective of the study was to investigate the degradation kinetics of some quality parameters of these micro-filtered coconut water samples during storage at 4 °C.

2. Materials and method

Green coconuts with maturation age between 5 and 7 months were harvested from plants present in the vicinity of Tezpur University, Tezpur, Assam. The fruits were visually inspected and those with similar size, shape and maturity were analyzed. Coconuts were used within 24 h after harvest. All chemicals were analytical grade and were obtained from Merck® (India).

2.1. Collection of coconut water

Selected coconuts were initially rinsed in tap water, followed by a dip in cold, chlorinated water (300 ppm of sodium hypochlorite) for 15 min to reduce the microbial load on the fruit surface and then subsequently rinsed with distilled water to eliminate residual chlorine after which they were air-dried (Rolle, 2007). The nuts were then cut with a sharp sanitized stainless steel knife and all the coconut water collected was mixed thoroughly in a sterilized container. Any contamination in this process of water collection was considered to be natural or usual in obtaining coconut water for consumption (Reddy et al., 2007).

2.2. Experimental set-up for constant pressure filtration of coconut water

In the laboratory, a two-stage filtration technique consisting of pre-filtration and final filtration steps, both under constant suction filtration system (-0.8×100 kPa), was developed to process the coconut water. The experimental set-up is shown in Fig. 1. The pre-filtration step, through Whatman filter No. 42, was adopted to eliminate most of the suspended particles of coconut water and to offer less filter-cake resistance or membrane fouling in the final filtration step. The experimental set-up consisted of a heavy duty vacuum bottle for filtrate collection, a hopper for up-stream liquid, and the membrane assembly. The filter medium used for the final filtration was of Millipore make (0.45 µm pore size, 47 mm diameter) and all other filtration apparatus and tubings were of Tarsons make. The upstream was exposed to atmospheric pressure and the filtration was done at a constant pressure differential maintained by a vacuum pump (PALL Life Sciences, USA) and a bypass line connected to the down-stream portion. The pressure difference was read from a gauge fitted to the pump. Before commencing the filtration, all parts including glasswares, pipes, the membrane filter, etc., were sterilized in an autoclave at 103.42 kPa for 20 min. These were assembled inside a biosafety cabinet (Biohazard Safety Cabinet, LABTECH, Korea) to maintain the aseptic condition. Filtration processes were done inside the biosafety cabinet at a room temperature of about 25 °C.

2.3. Addition of L-ascorbic acid (antioxidant)

Following the work of Campos et al. (1996), preliminary study was carried out in our laboratory to find out the most suitable concentration of L-ascorbic acid, which needs to be added to the micro-filtered coconut water for inhibiting the activity of PPO and POD enzymes present in it. Twenty five milligrams of L-ascorbic acid per 100 ml of coconut water was found to be suitable, based on the result of PPO and POD enzyme activity, and sensory analysis of the micro-filtered coconut water (Refer to Section 3.2.).

Seventeen hundred milliliters of micro-filtered coconut water was collected, out of which, 1000 ml of the filtrate was added with L-ascorbic acid (25 mg/100 ml) and the remaining 700 ml of the filtrate

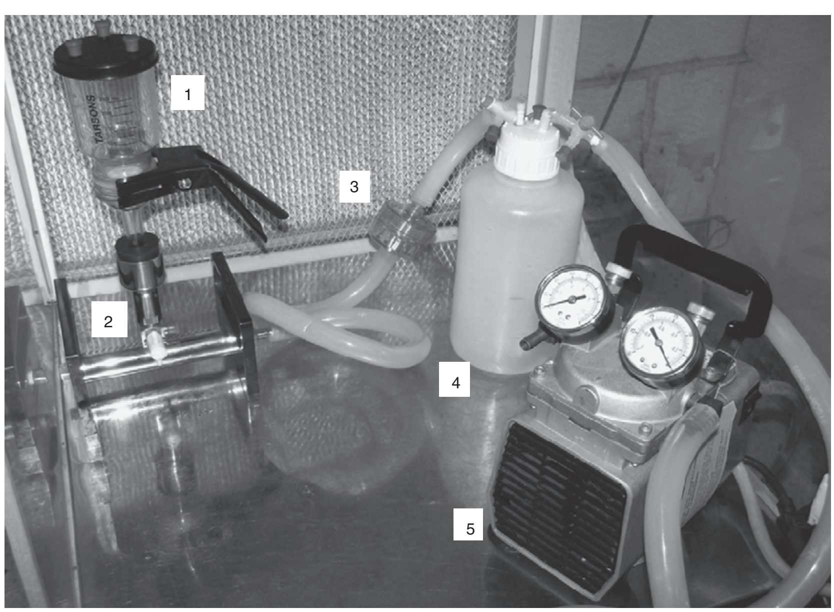

Fig. 1. Experimental set-up for constant pressure filtration of coconut water. (1) Filter funnel with clamps, (2) Manifold containing filtrate coming from Whatman filter No. 42 (prefiltration), (3) In-line membrane filter holder (final filtration), (4) Heavy-duty vacuum bottle to collect filtrate, (5) Suction pump.