FATE OF ACIDITY AND ALCOHOL DURING FERMENTATION OF SALALAH AND SRI LANKA COCONUT WATER

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ABSTRACT

The aim of the present research is to observe the changes in pH, acidity, and ethanol content during the storage of water from Salalah and Sri Lanka cultivar coconuts in the presence and absence of dry yeast. Coconut water from Salalah and Sri Lanka cultivars were subjected to aerobic fermentation in shaker flasks at room temperature of 25±2 °C and 50 rpm for 28 days. pH, acidity and ethanol content were observed every 7 days. pH decreased while acidity and ethanol content increased with increase in fermentation time. Finally, Salalah coconut water was found to be suitable for use as a fermented energy drink than Sri Lanka coconut water grown in Salalah, Oman.

Keywords: Coconut water, Fermentation, Acidity, pH, Ethanol.

INTRODUCTION

A coconut tree may yield hundreds of flavourful coconuts each season with each coconut containing anywhere from 1 to 2 cups of coconut water [1]. Coconut water is the juice present inside the interior cavity of young coconuts. This water is one of nature's most refreshing drinks, consumed worldwide for its health properties [2]. Coconut water is different from coconut milk which comes from the flesh of mature coconuts [3]. Immature coconuts, when they reach about 5 months of age, are gathered from the coconut tree to collect coconut water. Young coconuts contain sweet, flavourful water and are often sold in the tropics by native street vendors with a hole punched into them for a straw [4]. Coconut water collected from coconuts younger than 5 months are bitter. Mature coconuts of about 10-12 months contain less water and used for copra, the dried meat from which coconut milk and coconut oil are produced [5]. Fermented coconut water is produced from green coconuts that has been fermented using a culture to inoculate the water with various yeasts and beneficial bacteria. It is made in a process similar to other fermented drinks such as Kombucha and kefir. For example, making Kombucha, a popular health drink, is the art of fermenting tea [6]. Sweetened tea is mixed with a culture (Kombucha from a previous batch of the fermented tea) and a SCOBY (a symbiotic culture of bacteria and yeast that grows in the fermenting tea) and fermented for a week to produce an effervescent drink said to help the digestive system and detoxify the body. Or, making milk kefir, a popular fermented milk, is the art of fermenting (or culturing) milk [7]. Milk kefir grains are added to milk and left to culture for 8 to 24 hours in a warm place. During this time, the bacteria present in the milk and kefir grains go to work for us, growing and multiplying, to turn the milk into a creamy drink with a soured tang [8].

LITERATURE REVIEW

Seesuriyachan et al., (2011) produced extracellular polysaccharide using *Lactobacillus confusus* in liquid medium using coconut water [9]. Almeida et al., (2013) produced bacterial cellulose by consuming minerals in coconut water by *Acetobacter xylinum* [10]. Giri et al., (2013) aimed to produce a fermented CW beverage using the potential probiotic Lactobacillus casei L4. CW was fermented with L. casei L4 for 48 h at 35 °C, and pH, organic acid production rate, antioxidant activity, antibacterial activity, sugar, mineral, vitamin B12 levels, and total viable bacteria counts were investigated at 24 and 48 h [11]. Lee et al., (2013) performed probiotic fermentation of coconut with *Lactobacillus acidophilus* L10 and *L. casei* L26 to observe changes in viable cell count, total soluble solids, pH, sugars, organic acids and minerals [12]. Othaman et al., (2014) produced vinegar from an alternative substrate, mature coconut water, and compared with 2 common substrates, coconut sap and pineapple juice [13]. Perumpuli et al., (2014) isolated 3 Acetobacter strains (SL13E-2, SL13E-3, and SL13E-4) that grow at 42 °C and 4 Gluconobacter strains (SL13-5, SL13-6, SL13-7, and SL13-8) grow at 37 °C from the pellicle formed on top of brewing coconut water vinegar in Sri Lanka [14].

Fatima and Mishra (2015) produced vinegar from the juices extracted from banana peel and coconut water using yeast and Acetobacter [15]. Gayathry (2015) produced a natural dietary fibre food product obtained by static fermentation of mature coconut water using *Gluconacetobacter xylinum* [16]. Nugroho and Aji (2015) produced nata de coco by direct inoculation into coconut water [17]. Prado et al., (2015) to develop a non-dairy, fermented functional beverage using coconut water as the main ingredient for providing the intrinsic health properties [18]. Gangwar et al., (2018) assessed the growth, survival and fermentation performance of the probiotic bacterium *Bacillus coagulans* in coconut water to produce a novel non-dairy, probiotic beverage [19]. Zhang et al., (2018) improved the quality of matured coconut water by fermenting low-alcohol coconut water with *Saccharomyces cerevisiae* and evaluated the quality parameters using volatile components and non-volatile flavour-related elements [20]. Ajogun et al., (2020) produced table wine from the different proportions of mixed coconut water, honey and zobo through fermentation with wine yeast at room temperature (28±2 °C) for 7 days [21]. Segura-Badilla et al., (2020) developed a symbiotic drink from coconut water through fermentation using lyophilized *Lactobacillus rhamnosus* SP1 and inulin as a source of soluble fibre [22].

The literature reported anaerobic fermentation of various cultivars of coconut water to produce probiotic and symbiotic energy drinks. As the limited literature is available on aerobic fermentation of coconut water grown in cultivars of Dhofar governorate of Oman, the present work focusses on the development of fermented energy drink from Salalah and Sri Lanka cultivars of coconut water.

METHODOLOGY

Coconut water of Salalah and Sri Lanka cultivars were procured from a coconut shop along beach road of Salalah, Dhofar governorate, Sultanate of Oman. Dry yeast was purchased from the local commercial market in the city of Salalah.

Activation of dry yeast

Commercial dry yeast was activated by dissolving 10 g of yeast in 50 mL of water and activated by heating to 38 °C.

Aerobic fermentation without yeast

Conical flasks (5 numbers of 250 mL each) were taken and 100 mL of coconut water from Salalah cultivar was poured in each flask. The mouth of each conical flask was closed tightly using cotton plug and placed in a thermostat water bath shaker at room temperature of 25±2 °C and 50 rpm for 28 days. The samples were withdrawn every 7 days for the determination of pH, acidity and ethanol content. The same procedure was repeated for Sri Lanka coconut water.

Aerobic fermentation with yeast

Conical flasks (5 numbers of 250 mL each) were taken and 100 mL of coconut water from Salalah cultivar was poured in each flask. 25 mL of activated dry yeast was added in each conical flask. The mouth of each conical flask was closed tightly using cotton plug and placed in a thermostat water bath shaker at room temperature of 25±2 °C and 50 rpm for 28 days. The samples were withdrawn every 7 days for the determination of pH, acidity and ethanol content. The same procedure was repeated for Sri Lanka coconut water.

Analytical procedures

pH was measured by using pH meter according to the standard operating procedure [23]. Acidity was evaluated by acid-base titration with standardized solution of 0.1 N sodium hydroxide, using phenolphthalein as an indicator and the results were expressed as g acid per 100 mL of solution as reported by the AOAC [24]. Ethanol content was determined by the method as explained in [25].

RESULTS

Figure 1 illustrates the effect of fermentation time on pH of coconut water from Salalah and Sri Lanka cultivars grown in Dhofar governorate of Oman without the addition of yeast. Figure 2 illustrates the effect of fermentation time on pH of coconut water from Salalah and Sri Lanka cultivars grown in Dhofar governorate of Oman with the addition of yeast.

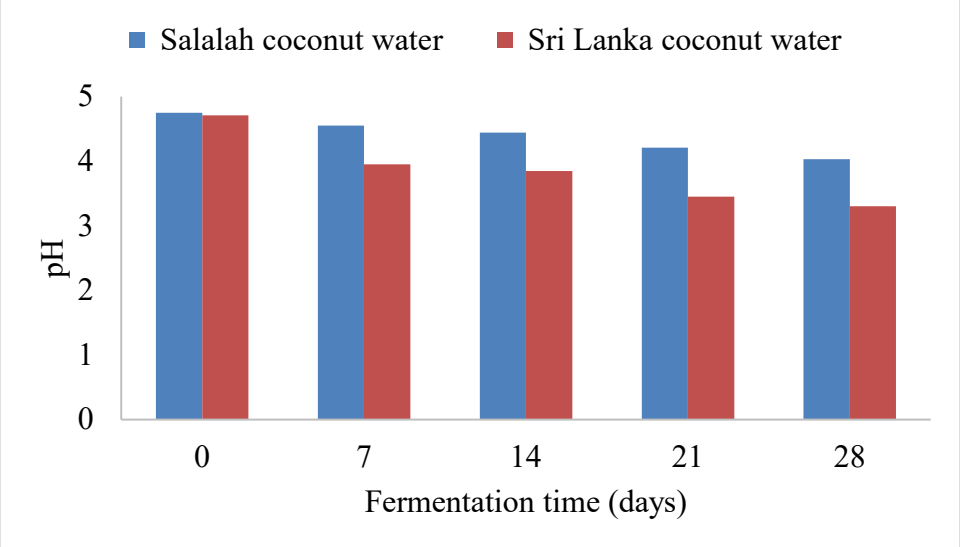

Figure 1. Effect of fermentation time on pH of coconut water from Salalah and Sri Lanka cultivars without the addition of yeast

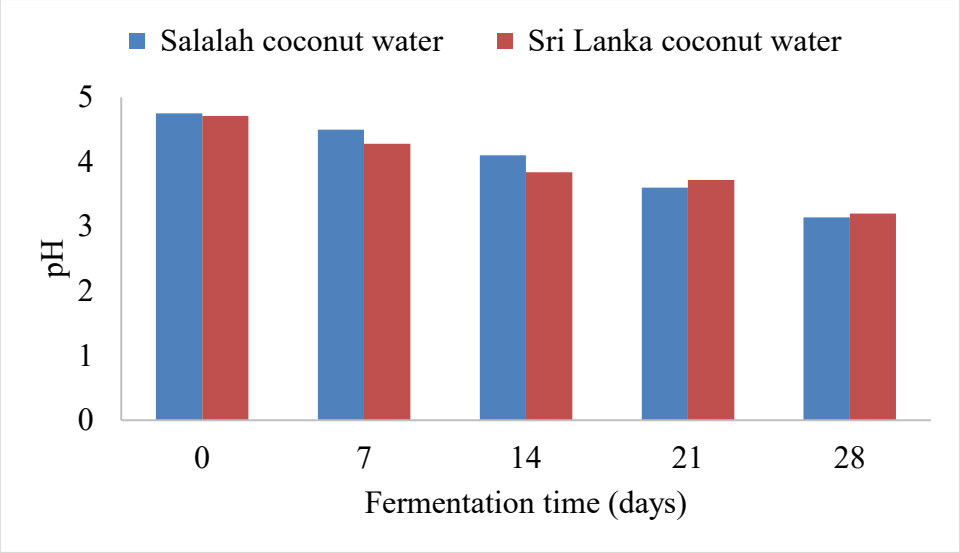

Figure 2. Effect of fermentation time on pH of coconut water from Salalah and Sri Lanka cultivars after the addition of yeast

Figure 3 illustrates the effect of fermentation time on acidity of coconut water from Salalah and Sri Lanka cultivars grown in Dhofar governorate of Oman without the addition of yeast. Figure 4 illustrates the effect of fermentation time on acidity of coconut water from Salalah and Sri Lanka cultivars grown in Dhofar governorate of Oman with the addition of yeast.

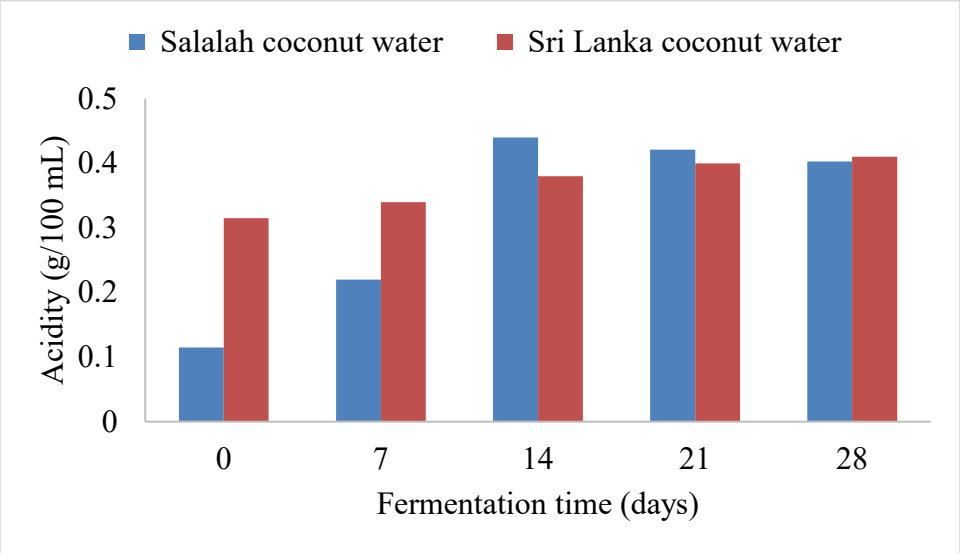

Figure 3. Effect of fermentation time on acidity of coconut water from Salalah and Sri Lanka cultivars without the addition of yeast

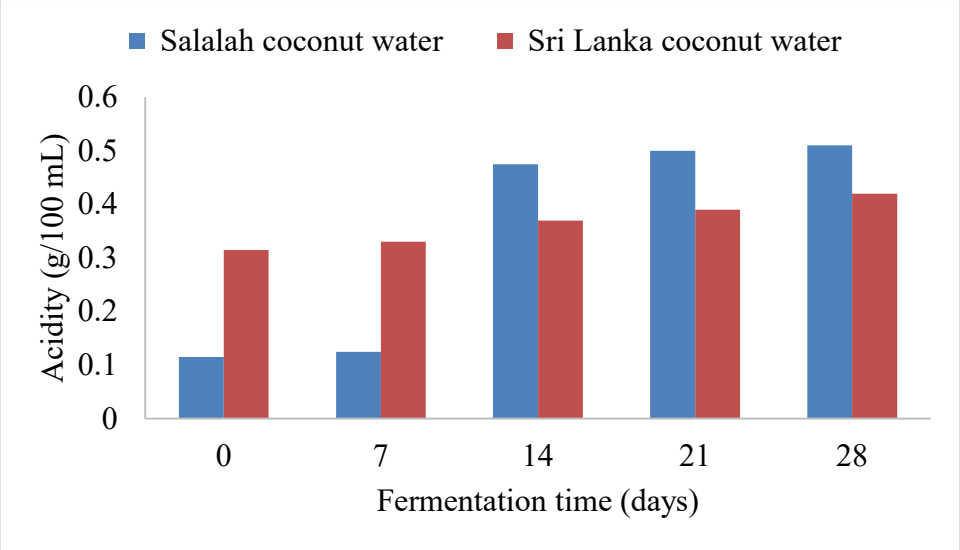

Figure 4. Effect of fermentation time on acidity of coconut water from Salalah and Sri Lanka cultivars after the addition of yeast

Figure 5 illustrates the effect of fermentation time on ethanol of coconut water from Salalah and Sri Lanka cultivars grown in Dhofar governorate of Oman without the addition of yeast. Figure 6 illustrates the effect of fermentation time on ethanol of coconut water from Salalah and Sri Lanka cultivars grown in Dhofar governorate of Oman with the addition of yeast.

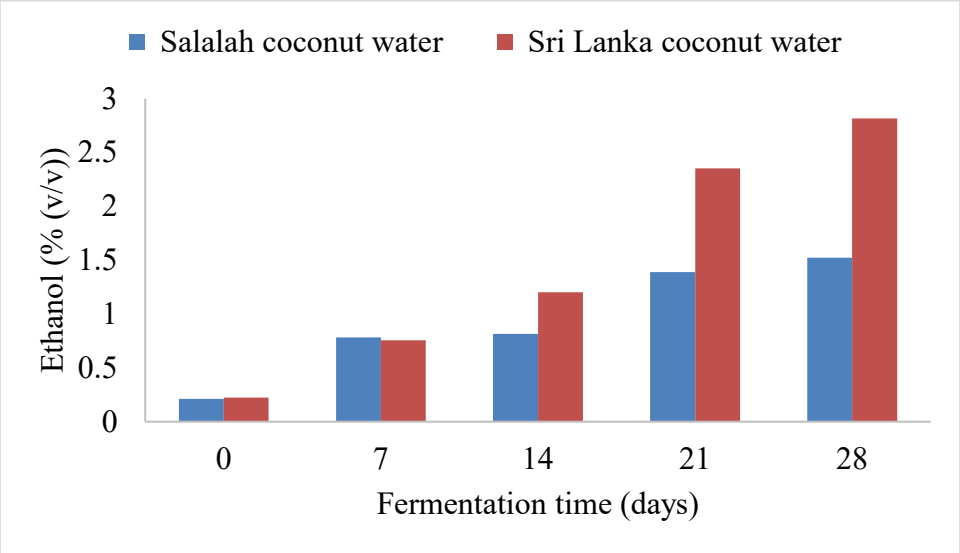

Figure 5. Effect of fermentation time on ethanol of coconut water from Salalah and Sri Lanka cultivars without the addition of yeast

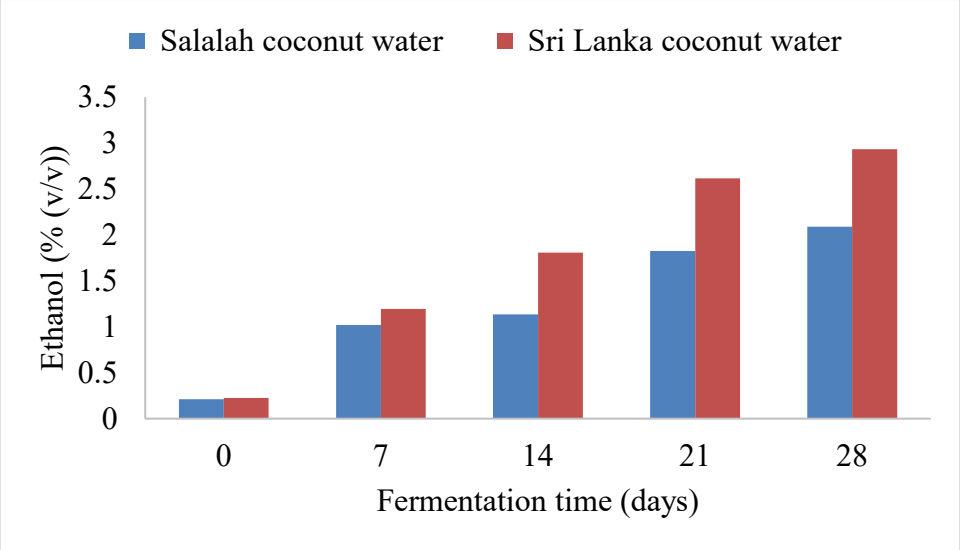

Figure 6. Effect of fermentation time on ethanol of coconut water from Salalah and Sri Lanka cultivars with the addition of yeast

DISCUSSION

Effect of fermentation time on pH

As illustrated in Figure 1, pH decreases with increase in fermentation time due to the formation of organic acids in the broth [9]. The pH values of fresh coconut water from Salalah and Sri Lanka cultivars were 4.75 and 4.71, respectively. The pH reduced to 4.55, 4.44, 4.21 and 4.03 after 7, 14, 21 and 28 days of fermentation, respectively for Salalah coconut water. At the same time, the pH reduced to 3.95, 3.85, 3.45 and 3.3 after 7, 14, 21 and 28 days of fermentation, respectively for Sri Lanka coconut water. As shown in Figure 2, pH decreases with increase in fermentation time due to the formation of organic acids in the broth [9]. The pH values of fresh coconut water from Salalah and Sri Lanka cultivars were 4.75 and 4.71, respectively. The pH reduced to 4.5, 4.1, 3.6 and 3.14 after 7, 14, 21 and 28 days of fermentation, respectively for Salalah coconut water. At the same time, the pH reduced to 4.28, 3.84, 3.72 and 3.2 after 7, 14, 21 and 28 days of fermentation, respectively for Sri Lanka coconut water.

Effect of fermentation time on acidity

As exhibited in Figure 3, acidity increases with increase in fermentation time due to the formation of organic acids in the broth [15]. The acidity of fresh coconut water from Salalah and Sri Lanka cultivars were 0.115 and 0.315 g/100 mL, respectively. The acidity increased to 0.22, 0.44, 0.421, and 0.403 g/100 mL after 7, 14, 21 and 28 days of fermentation, respectively for Salalah coconut water. At the same time, the acidity increased to 0.34, 0.38, 0.4 and 0.41 g/100 mL after 7, 14, 21 and 28 days of fermentation, respectively for Sri Lanka coconut water. As displayed in Figure 4, acidity increases with increase in fermentation time due to the formation of organic acids in the broth [15]. The acidity of fresh coconut water from Salalah and Sri Lanka cultivars were 0.115 and 0.315 g/100 mL, respectively. The acidity increased to 0.125, 0.475, 0.5 and 0.51 g/100 mL after 7, 14, 21 and 28 days of fermentation, respectively for Salalah coconut water. At the same time, the acidity increased to 0.33, 0.37, 0.39 and 0.42 g/100 mL after 7, 14, 21 and 28 days of fermentation, respectively for Sri Lanka coconut water.

Effect of fermentation time on ethanol content

As presented in Figure 5, ethanol increases with increase in fermentation time due to the formation of organic acids in the broth [20]. The ethanol of fresh coconut water from Salalah and Sri Lanka cultivars were 0.212 and 0.224% (v/v), respectively. The ethanol increased to

0.782, 0.816, 1.189 and 1.523% (v/v) after 7, 14, 21 and 28 days of fermentation, respectively for Salalah coconut water. At the same time, the acidity increased to 0.756, 1.203, 2.352 and 2.816% (v/v) after 7, 14, 21 and 28 days of fermentation, respectively for Sri Lanka coconut water. As demonstrated in Figure 6, ethanol increases with increase in fermentation time due to the formation of organic acids in the broth [20]. The ethanol of fresh coconut water from Salalah and Sri Lanka cultivars were 0.212 and 0.224% (v/v), respectively. The ethanol increased to 1.021, 1.134, 1.824 and 2.092% (v/v) after 7, 14, 21 and 28 days of fermentation, respectively for Salalah coconut water. At the same time, the acidity increased to 1.196, 1.808, 2.617 and 2.935% (v/v) after 7, 14, 21 and 28 days of fermentation, respectively for Sri Lanka coconut water.

Summary of discussion

Salalah coconut water has pH, acidity and ethanol content of 4.03, 0.403 g/100 mL and 1.523% (v/v), respectively without the addition of yeast after 4 weeks of fermentation. Whereas, it has pH, acidity and ethanol content of 3.14, 0.51 g/100 mL and 2.092% (v/v), respectively with the addition of yeast after 28 days of fermentation. Sri Lanka coconut water has pH, acidity and ethanol content of 3.3, 0.41 g/100 mL and 2.816% (v/v), respectively without the addition of yeast after 4 weeks of fermentation. Whereas, it has pH, acidity and ethanol content of 3.2, 0.42 g/100 mL and 2.935% (v/v), respectively with the addition of yeast after 28 days of fermentation. Hence, the criteria for fermented energy drink are to have more acidity with less ethanol content, Hence, it could be concluded that Salalah coconut water is more suitable to develop fermented energy drink.

CONCLUSIONS

This work aimed to develop a fermented energy drink from coconut water from cultivars of Salalah and Sri Lanka with and without yeast and monitored process parameters such as pH, acidity and ethanol. Coconut water from Salalah and Sri Lanka cultivars were subjected to aerobic fermentation in shaker flasks at room temperature of 25±2 °C and 50 rpm for 28 days. pH, acidity and ethanol content were observed every 7 days. pH decreased while acidity and ethanol content increased with increase in fermentation time. Finally, Salalah coconut water was found to be suitable for use as a fermented energy drink than Sri Lanka coconut water grown in Salalah, Oman.

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