Tanzania Journal of Science 46(2): 573-584, 2020
ISSN 0856-1761, e-ISSN 2507-7961

Effects of Onion Juice and *Moringa oleifera* Leaf Juice on the Shelf Life of Sugarcane Juice

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Received 4 May 2020, Revised 15 June 2020, Accepted 30 June 2020, Published June 2020

Abstract

Effects of onion juice and *Moringa oleifera* leaf juice on the shelf life of sugarcane (*Saccharum officinarum*) cultivar R579 juice were studied. R579 sugarcane cultivar was selected based on its juice yield (1500 ml/2.5 kg) compared to *Saccharum officinarum* cultivars R570 (1000 ml/2.5 kg), Bungara (1200 ml/2.5 kg) and Galagaza (800 ml/2.5 kg). The concentrations for onion and *Moringa oleifera* leaf juice were chosen based on recommended dietary allowance (RDA) where design expert software was used to establish the ratios. There was a significant growth of microbes in non-pasteurized sugarcane juice and stored at room temperature. The yeast/mould and *Leuconostoc* sp. counts were 5.48 and 4.45, 9.48 and 10.45, and 4.43 and 3.48 (log CFU/ml) at 12, 168 and 672 hours of storage, respectively. The addition of onion juice (20%), *Moringa oleifera* leaf juice (30%) and combination of 20% onion juice and 30% *Moringa oleifera* leaf juice to the pasteurized sugarcane juice and stored at refrigeration temperature (4 ± 2 °C) significantly controlled the growth of yeasts/moulds and *Leuconostoc* sp. to 1.96 and 0.00, 1.68 and 1.55, and 0.00 and 0.00 (log CFU/ml), respectively, at 672 hours of storage. A combination of 20% onion juice and 30% moringa leaf juice and storage conditions had significance influence on the shelf life of sugarcane juice.

Keywords: Sugarcane juice, onion juice, moringa leaf juice, shelf life, microbial analysis.

Introduction

In Tanzania, extracted, fresh sugarcane juice sold by street vendors is increasing in urban areas such as markets, road sides and bus stands because of its chemical composition with delicate aroma and sweet taste to consumers. Flavonoids and Polyphenols found in sugarcane juice prevent the cell damage from free radicals and reactive oxygen species which are a major source of tumours, coronary diseases and diabetes (Scalbert et al. 2005, Duarte-Almeida et al. 2011, Kadam et al. 2008). Moreover, low acidity and high content of dietary fibres of sugarcane juice influence stable body pH, a smooth movement of materials in the digestive and urinary system, prevention and healing of jaundice by improving the performance of the liver (Sankhla 2011, Chinnadurai 2017).

However, sugarcane juice producers and consumers do not benefit much because of its

short shelf life. The short shelf life of sugarcane juice is attributed to yeasts, moulds and bacteria such as *Leuconostoc* sp. The spoilage of juice is favoured by the low acidity, the high content of simple sugars and the deprived sanitary conditions during its preparation and poor handling of harvested sugarcane (Yusof et al. 2000, Begum et al. 2015, Bomdespacho et al. 2018). The yeast, mould and *Leuconostoc* sp. contaminations affect the stability of the physicochemical properties of sugarcane juice. As a consequence, the juice changes in flavour, aroma and thickness (Eggleston and Legendre 2003, Silva et al. 2016).

Various studies have shown that the shelf life of sugarcane juice can be extended by adding synthetic chemicals such as potassium metabisulphite, dimethyl carbonate, sodium benzoate, citric and ascorbic acids (Suzart 2009, Chauhan 2002, Mishra et al. 2011). However, synthetic preservatives may have certain health hazards to consumers. Sodium benzoate, potassium metabisulphite and ascorbates damage chromosomes and cells, thereby exposing cells to mutation and carcinogenic effects (Sharma 2015, Piper and Piper 2017, Linke et al. 2018). Nevertheless, to avoid the health effects associated with artificial preservatives; natural preservatives are recommended in controlling microbial growth (Wells-Bennik et al. 2016). Natural products such as citrus fruits and vegetable juice can be added to sugarcane juice as preservatives. The addition of passion pulp and calamansi juice to sugarcane juice leads to high antimicrobial activities and lengthens its shelf life (Rezzadori et al. 2013, Noor et al. 2018).

Besides, *Moringa oleifera* tree phytochemicals have antimicrobial effects on a variety of food spoilage germs (Gull et al 2016). *Moringa oleifera* leaves contain useful bioactive compounds such as saponins, cardiac glycosides, terpenoids, steroids and alkaloid compounds that are known to possess antimicrobial properties (Vinoth et al. 2012). Irokanulo et al. (2015) found that 100% and 75% of infected tomatoes which were treated with leaf and stem bark powder of *Moringa oleifera* remained unspoiled for 21 days.

On the other hand, the onion (*Allium cepa*) is a common vegetable with a wide range of antimicrobial compounds including thiosulfinates, organosulfur compounds (OSCs), phenolic compounds and saponins; thus, it may have inhibitory effects on certain cultivars of fungi and bacteria (Griffiths et al. 2002, Benkeblia and Lanzotti 2007, Begum and Yassen 2015). Using a 2.5% onion juice aqueous solution, extended the shelf life of Persian sturgeon to three months (Sarah et al. 2010).

The most interesting thing is that, the onion juice and *Moringa oleifera* leaf juice in sugarcane juice provide thiosulfinates and cepaene (Dorsch et al. 1990, Rao et al. 1999) which inhibit inflammatory cells influx to the lungs as a result of the immune responses. Onion juice and moringa leaf juice have also anti-coagulant factors (Satish et al. 2012, Ebbo et al. 2019).

The blending of sugarcane juice with onion juice and moringa leaf juice to extend its shelf life has not been investigated. Therefore, the main objective of this study was to examine the effects of onion juice and *Moringa oleifera* leaf juice on the shelf life of sugarcane juice.

Materials and Methods

Raw materials

Saccharum officinarum cultivars (R579, R570, Bungara and Galagaza) sugarcanes, *Allium cepa* (red onions) and *Moringa oleifera* leaves were used in this study. R579, R570, Bungara and Galagaza sugarcanes were collected from the Sugarcane Research Institute (SRI) in Kibaha, Tanzania. Sugarcane cultivars were collected in October 2018 and then cut into pieces for easy transporting, which were then sterilized by being immersed into sodium dichloroisocyanurate ($C_3Cl_2N_3NaO_3$) to avoid contamination during transportation. The pieces of sugarcanes were put into a container

previously washed with sodium dichloroisocyanurate solution (Silva et al. 2016). The container with sugarcanes was sealed and transported to Food Science and Technology Laboratory at University of Dar es Salaam for further processing and analysis. Red onions were obtained from the Mabibo market in Dar es Salaam whereby the selection was based on their maturity indices and sizes. Onions were then put into the pre-sterilized container and transported to the Department of Food Science Technology laboratory for further processing and analysis. *Moringa oleifera* leaves were collected in October 2018 from a *Moringa oleifera* tree found in the Yombo area at the University of Dar es Salaam. The leaves were then put into the pre-sterilized container and transported to the Department of Food Science Technology laboratory for further processing and analysis.

Extraction and processing of sugarcane juice

The epidermis was scratched, washed and weighed. The juice was extracted using a stainless steel roller machine fabricated at the Technology Development and Transfer Centre (TDTC), University of Dar es Salaam and the juices yielded by R579, R570, Bungara and Galagaza sugarcane were compared. The filtration of extracted sugarcane juice was carried out in accordance to the method used by Noor et al. (2018) with small modification. Filtered sugarcane juice was divided into two portions; one portion was pasteurized at 72 °C for 10 seconds and cooled to 10 °C. The other portion was not pasteurized. Both the pasteurized sugarcane juice and the non-pasteurized sugarcane juice were stored in sterilized clean glass containers.

Extraction of onion juice

The onions were washed with deionized distilled water boiled at 100 °C for 30 s to remove any contaminations and then the onions were sliced and weighed. A blending ratio of 1 g sliced onion to 5 ml of deionized distilled water was used to obtain onion juice. The ratio of onion to deionized distilled water was selected in accordance to the ratio established by Sarah et al. (2010) with small modification to obtain onion juice. Blending was done at 1600 rpm for 3 minutes using a Vitamix S50 blender made by Vita-Mix Corporation. The content was heated to 60 °C for 3 minutes to inactivate enzymatic and cellular activities. It was then cooled and filtered using a cheese cloth to obtain onion juice. The juice was stored in a sterilized clean container before being added to sugarcane juice.

Extraction of *Moringa oleifera* leaf juice

Moringa oleifera leaves were sorted and washed with deionized distilled water boiled at 100 °C for 30 s to remove any contamination or dirtiness. The ratio of 1 g of *Moringa oleifera* leaves to 5 ml of sterilized deionized distilled water was used to make *Moringa oleifera* leaf juice by blending the leaves in a Vitamix S50 blender with 1600 rpm for 4 minutes. The ratio of leaves to deionized distilled water was selected based on the ratios established by Ramachandran et al. (2017) with small modifications. The content was heated at 60 °C for 3 minutes, cooled and filtered using a cheese cloth to get *Moringa oleifera* leaf juice. The juice was then stored in a clean, sterilized and sealed container before being added to sugarcane juice.

Sugarcane juice blending, storage and interpretation of the shelf life of sugarcane juice

Full factorial design (2^3) was used to establish the study, whereby three factors including concentration (onion juice, moringa leaf juice and combination of onion juice and moringa leaf juice), heat treatment (pasteurization and non-pasteurization) and storage temperature (room and refrigeration temperature) each with two levels were used. Concentrations of 10% onion juice, 10% moringa leaf juice, 20% onion juice, 30% moringa leaf juice, a

combination of 10% onion juice and 10% moringa leaf juice and a combination of 20% onion juice and 30% moringa leaf juice were added to pasteurized and non-pasteurized sugarcane juice (v/v). The ratios were established based on the Recommended Dietary Allowances (RDAs) and were developed using design expert software. The blended pasteurized sugarcane juice and the blended non-pasteurized sugarcane juice and the controls (unblended non-pasteurized sugarcane juice and unblended pasteurized sugarcane juice) were stored at room (30 ± 5 °C) and refrigeration (4 ± 2 °C) temperatures in glass bottles with screw caps sterilized by using paracetic acid solution (Silva et al. 2016) and analysed for yeasts/moulds and *Leuconostoc* sp. growths within 672 hours of storage at the interval of 12, 72, 168, 336, 504 and 672 hours. Shelf life was assessed using a microbial limit level for non-alcoholic beverages, as described in the FDA (2013). The juice sample which had a microbial (yeasts/moulds and *Leuconostoc* sp.) count <2 (log CFU/ml) throughout the storage time (672 hours) was considered not spoiled.

Sample dilution for microbial analysis

Sample dilution for microbial analysis was done on a sterilized lamina floor using infrared light and ethanol. The dilution of the sample was done using the method developed by Andrews and Hammack (2003) with little modification. By using a sterilized micropipette, 1 ml of the sugarcane juice sample was added to 9 ml of 0.85 % of a sterilized saline solution in a test tube to form a 10^{-1} dilute solution. The content was allowed to stand for 3 minutes with occasional shaking of the content for 7 seconds. Serial dilution was continued to five folds (10^{-5}).

Yeasts/moulds and *Leuconostoc* sp. enumerations

The pour plate technique was used to enumerate yeasts/moulds and *Leuconostoc* sp. following the methods described by ISO (1998) and APHA (2001); 1 ml of a diluted sample was added to the plate. This was followed by the pouring of 15 ml of potato dextrose agar (PDA) with chloramphenicol and De Man, Rogosa and Sharpe (MRS) agar with vancomycin into plates. The plates were gently swirled clockwise and anticlockwise to mix the contents. After the agars solidified, the plates were inverted and incubated at 25 °C and 37 °C, respectively, in an incubator for 48 and 72 hours. Then the yeasts/moulds and *Leuconostoc* sp. were counted and the results were expressed in CFU/ml.

Statistical analysis

Minitab 17 was used to analyse data, whereby analysis of two replicates was done using 2 sample T-tests to obtain a P-value within and between groups. The P-value < 0.05 was used to show a significant difference in the means between and within groups.

Results and Discussion

Juice yields from the four different sugarcane cultivars

The sugarcane juices yielded by R579, R570, Bungara and Galagaza were studied to establish a suitable sugarcane cultivar used to extract sugarcane juice; 2.5 kg of sugarcane stalks were pressed on a stainless steel roller machine to obtain the juice. The yields were 1500, 1000, 1200 and 800 (ml), respectively, (Figure 1). There was a significant difference ($p < 0.05$) in the juices yielded by R579, R570, Bungara and Galagaza sugarcane. The juice yields were R579 > Bungara > R570 > Galagaza. The variation in the juice yields might have been influenced by the difference in the composition of the cultivars and soil, as well as the climatic conditions of the areas where the cultivars are grown, the mode of cultivation and the maturity time (Chauhan et al. 2002, Luo et al. 2009).

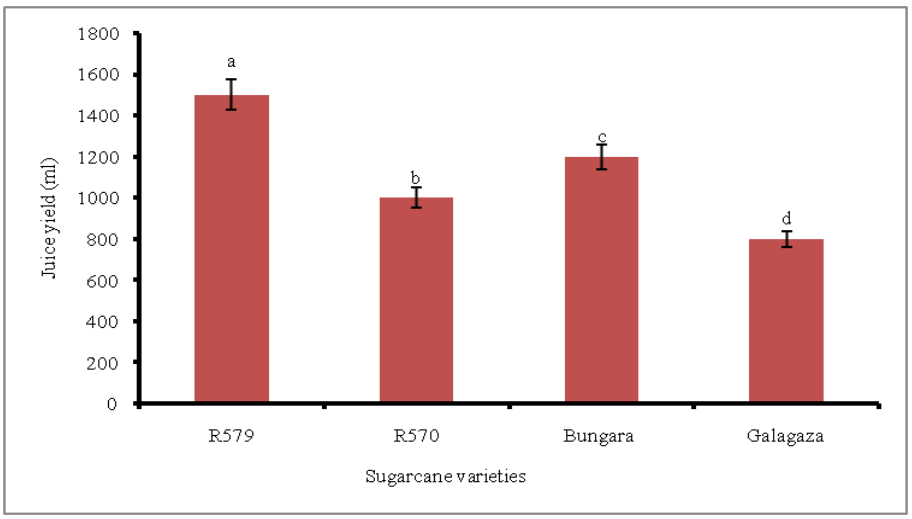


Figure 1: Juice yields from R579, R570, Bungara and Galagaza sugarcane cultivars. Note: Different letter(s) on the error bars indicate(s) significant difference ($p < 0.05$) in juice yields between sugarcane varieties.

Microbial stability in sugarcane juice

The microbial stability of the sugarcane juice from the R579 sugarcane cultivar was studied. Figure 2 (a) describes microbial growth in unblended sugarcane juice(control), in which there was a significant decrease ($P < 0.05$) in yeast/mould and *Leuconostoc* sp. counts because of pasteurization and refrigeration storage. In the non-pasteurized sugarcane juice stored at room temperature, yeast/mould and *Leuconostoc* sp. counts were 5.48 and 4.45 (log CFU/ml), respectively, at 12 hours of storage, 7.23 and 8.34 (log CFU/ml), respectively, at 72 hours of storage, and 9.48 and 10.45 (log CFU/ml), respectively, at 168 hours of storage. Unexpectedly, microbial counts decreased to 6.68 and 8.65 (log CFU/ml), 5.54 and 6.21 (log CFU/ml) and 4.43 and 3.48 (log CFU/ml) at 336, 504 and 672 hours of storage, respectively, the decrease in microbial counts between 336 and 672 hours of storage was associated with the death phase of viable cells. The death phase reduces the number of viable microbial cells after they have reached their maximum growth. The death phase of viable microbial cells is attributed to a decrease in the number of nutrients and an increase in the amount of waste products in a food sample (Meier 2009). The yeasts/moulds and *Leuconostoc* sp. in non-pasteurized sugarcane juice stored at refrigeration temperature were 4.44 and 3.83 (log CFU/ml), respectively, at 12 hours of storage, 6.21 and 5.55 (log CFU/ml), respectively, at 72 hours of storage and 9.63 and 9.96 (log CFU/ml), respectively, at 672 hours of storage. By pasteurizing the sugarcane juice and storing it at room temperature, the counts were 3.77 and 4.48 (log CFU/ml), respectively, at 12 hours of storage, 5.34 and 4.98 (log CFU/ml), respectively, at 72 hours of storage and 8.92 and 7.98 (log CFU/ml), respectively, at 672 hours of storage. For the refrigerated samples, the counts were 3.46 and 2.28 (log CFU/ml), respectively, at 12 hours of storage, 4.45 and 4.22 (log CFU/ml), respectively, at 72 hours of storage and 7.71 and 6.93 (log CFU/ml), respectively, at 672 hours of storage.

The addition of 10% onion juice and 10% *Moringa oleifera* leaf juice individually and a combination of 10% onion juice and 10% *Moringa oleifera* leaf juice to sugarcane juice controlled further microbial counts. For

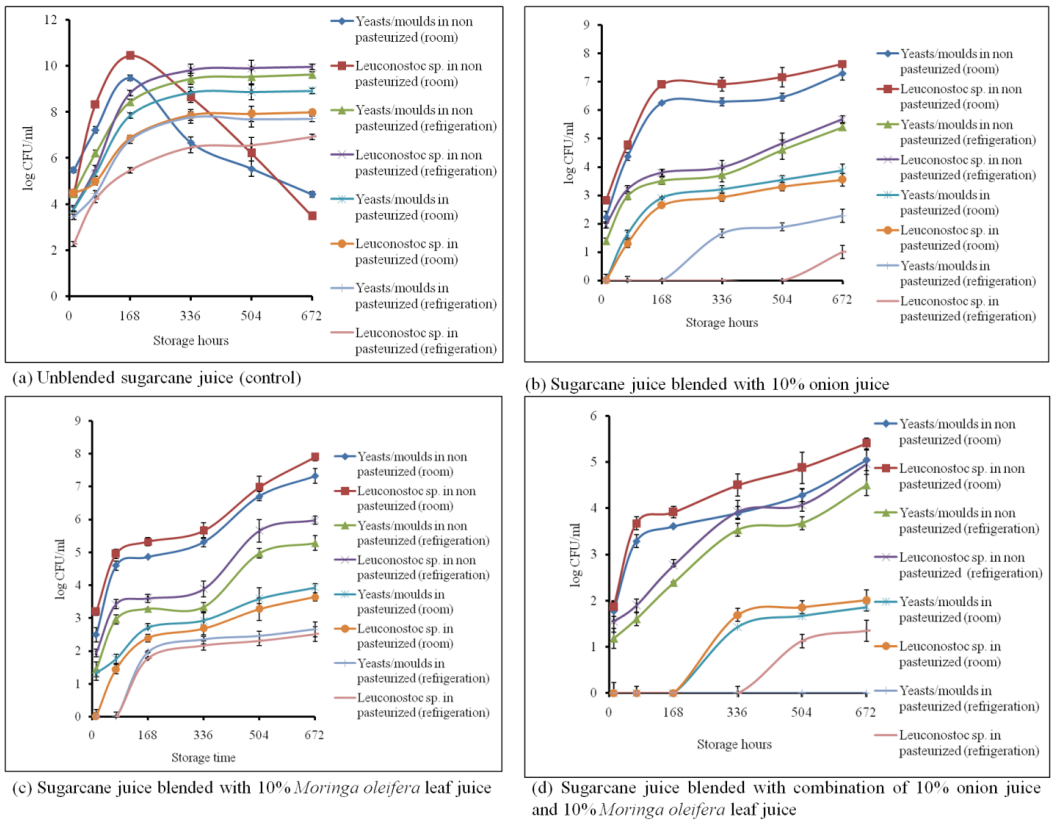
example, with the addition of 10% onion juice (Figure 2(b)) to non-pasteurized sugarcane juice and the storage of the juice blend at room temperature, the microbial counts were 2.22 and 2.81 (log CFU/ml), respectively, at 12 hours of storage, 4.36 and 4.77 (log CFU/ml), respectively, at 72 hours of storage and 7.26 and 7.62 (log CFU/ml), respectively, at 672 hours of storage. But as a result of refrigeration storage, the microbial counts were further controlled to1.38 and 1.95 (log CFU/ml), respectively, at 12 hours of storage, 2.98 and 3.20 (log CFU/ml), respectively, at 72 hours of storage and 5.40 and 5.68 (log CFU/ml), respectively, at 672 hours of storage.

In the pasteurized sugarcane juice, addition of 10% onion juice and stored at room temperature the yeasts/moulds and *Leuconostoc* sp. growth were 0.00 and 0.00 (log CFU/ml) within 12 hours of storage. Conversely, the yeast/mould and *Leuconostoc* sp. counts were significantly increased to1.63 and 1.30 (log CFU/ml), respectively, at 72 hours of storage and 3.87 and 3.54 (log CFU/ml), respectively, at 672 hours of storage. Under refrigeration storage the yeasts/moulds and *Leuconostoc* sp. growths were 0.00 and 0.00 (log CFU/ml), respectively within 72 hours of storage and 2.28 and 1.00 (log CFU/ml) at 672 hours of storage.

Moreover, addition of 10% *Moringa oleifera* leaf juice (Figure 2 (c)) to non-pasteurized sugarcane juice and stored at room temperature, yeasts/moulds and *Leuconostoc* sp. were 2.49 and 3.19 (log CFU/ml), respectively, at 12 hours of storage, 4.60 and 4.95 (log CFU/ml), respectively, at 72 hours of storage and7.32 and 7.90 (log CFU/ml), respectively, at 672 hours of storage. But with refrigeration storage, yeasts/moulds and *Leuconostoc* sp. were controlled to 1.44 and 1.93 (log CFU/ml), respectively, at 12 hours of storage, 2.96 and 3.42, (log CFU/ml), respectively, at 72 hours of storage and 5.28 and 5.97 (log CFU/ml), respectively, at 672 hours of storage.

For the pasteurized sugarcane juice, the addition of 10% *Moringa oleifera* leaf juice and storing the juice blend at room temperature yeast/mould and *Leuconostoc* sp. counts were 1.32 and 0.00 (log CFU/ml), respectively, at 12 hours of storage. However, at 72 hours of storage, yeasts/moulds and *Leuconostoc* sp. were 1.76 and 1.44 (log CFU/ml), respectively, and at 672 hours of storage yeast/mould and *Leuconostoc* sp. counts were 3.92 and 3.64 (log CFU/ml), respectively. Besides, with refrigeration storage, microbial counts were further controlled, that is, yeasts/moulds and *Leuconostoc* sp. growths were 0.00 and 0.00 (log CFU/ml) within 72 hours of storage and at 672 hours of storage yeasts/moulds and *Leuconostoc* sp. were 2.65 and 2.51 (log CFU/ml), respectively.

Nonetheless, the addition of 10% onion juice and 10% *Moringa oleifera* leaf juice to sugarcane juice (Figure 2 (d)) further lowered microbial counts, compared to when onion juice and *Moringa oleifera* leaf juice were added individually to sugarcane juice. For non-pasteurized sugarcane juice and stored at room temperature, microbial counts were 1.78 and 1.86 (log CFU/ml), respectively, at 12 hours of storage, 3.29 and 3.67 (log CFU/ml), respectively, at 72 hours of storage and 5.04 and 5.40 (log CFU/ml), respectively, at 672 hours of storage. In refrigerated samples, the counts were 1.18 and 1.54 (log CFU/ml), respectively, at 12 hours of storage, 1.60 and 1.89 (log CFU/ml), respectively, at 72 hours of storage and 4.50 and 4.96 (log CFU/ml), respectively, at 672 hours of storage. For the pasteurized sugarcane juice stored at room temperature, yeasts/moulds and *Leuconostoc* sp. growths were 0.00 and 0.00 (log CFU/ml), respectively, at 72 hours of storage. However, at 672 hours of storage, the yeasts/moulds and *Leuconostoc* sp. counts were increased significantly to 1.86 and 2.00 (log CFU/ml), respectively. In refrigerated samples, the yeasts/moulds and *Leuconostoc* sp. growths were 0.00 and 1.34 (log CFU/ml), respectively at 672 hours of storage.



(a) Unblended sugarcane juice (control)

(b) Sugarcane juice blended with 10% onion juice

(c) Sugarcane juice blended with 10% *Moringa oleifera* leaf juice

(d) Sugarcane juice blended with combination of 10% onion juice and 10% *Moringa oleifera* leaf juice

Figure 2: Microbial stability in unblended sugarcane juice (control) and sugarcane juice blended with 10% onion juice, 10% *Moringa oleifera* leaf juice and combination of 10% onion juice and 10% *Moringa oleifera* leaf juice**.**

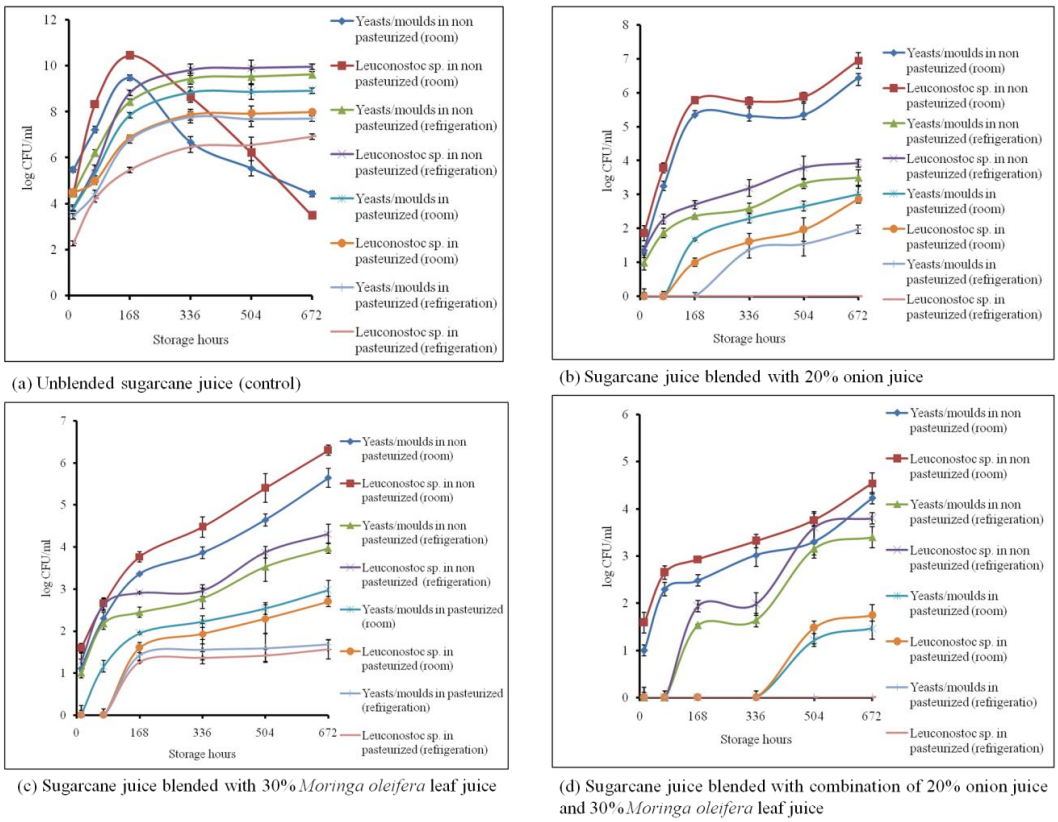
However, increasing the concentration of onion juice (20%), *Moringa oleifera* leaf juice (30%) and the combination of 20% onion juice and 30% *Moringa oleifera* leaf juice decreased microbial counts even further during storage. With the addition of 20% onion juice (Figure 3 (b)) to non-pasteurized sugarcane juice and stored at room temperature, yeasts/moulds and *Leuconostoc* sp. counts were 1.36 and 1.86 (log CFU/ml), respectively, at 12 hours of storage, 3.25 and 3.76 (log CFU/ml), respectively, at 72 hours of storage and 6.43 and 6.69 (log CFU/ml), respectively, at 672 hours of storage. In refrigerated samples, yeasts/moulds and *Leuconostoc* sp. counts were 1.00 and 1.38 (log CFU/ml), respectively, at 12 hours of storage, 1.87 and 2.28 (log CFU/ml), respectively, at 72 hours of storage and 3.50 and 3.98 (log CFU/ml), respectively at 672 hours of storage.

In pasteurized sugarcane juice, the addition of 20% onion juice and stored at room temperature, yeasts/moulds and *Leuconostoc* sp. growth were 0.00 and 0.00 (log CFU/ml) within 72 hours of storage. The counts were increased significantly to 3.01 and 2.87 (log CFU/ml), respectively, at 672 hours of storage. In refrigerated samples, the yeast/mould counts were 0.00 (log CFU/ml) within 72 hours of storage and 1.96 (log CFU/ml) within 672 hours of storage. However, *Leuconostoc* sp. growth was 0.00 (log CFU/ml) within 672 hours of storage.

On the other hand, the addition of 30% *Moringa oleifera* leaf juice (Figure 3 (c)) to non-pasteurized sugarcane juice and storing the juice blend at room temperature made microbial counts be 1.11 and 1.59 (log CFU/ml), respectively, at 12 hours of storage, 2.30 and 2.65 (log CFU/ml), respectively, at 72 hours of storage, 5.64 and 6.30 (log CFU/ml), respectively, at 672 hours of storage. For the refrigerated samples, the counts were 1.00 and 1.27 (log CFU/ml), respectively, at 12 hours of storage, 2.18 and 2.62 (log CFU/ml), respectively, at 72 hours of storage and 3.97 and 4.31 (log CFU/ml), respectively, at 672 hours of storage.

For pasteurized sugarcane juice, the addition of 30% *Moringa oleifera* leaf juice and stored at room temperature, yeasts/moulds and *Leuconostoc* sp. growths were 0.00 and 0.00 (log CFU/ml) within 12 and 72 hours of storage, respectively. However, at 672 hours of storage, yeast/mould and *Leuconostoc* sp. counts were increased significantly to2.97 and 2.70 (log CFU/ml), respectively. For the refrigerated sample, the yeasts/moulds and *Leuconostoc* sp. growths were 0.00 and 0.00 (log CFU/ml), respectively, within 72 hours, and 1.68 and 1.55 (log CFU/ml), respectively at 672 hours of storage. Nevertheless, with the addition of 20% onion juice and 30% *Moringa oleifera leaf* juice (Figure 3 (d)) to non-pasteurized sugarcane juice and stored at room temperature, yeast/mould and *Leuconostoc* sp. counts were 1.00 and 1.59 (log CFU/ml), respectively, at 12 hours of storage, 2.30 and 2.65 (log CFU/ml), respectively, at 72 hours of storage and 4.23 and 4.54 (log CFU/ml), respectively, at 672 hours of storage. In refrigeration storage, the yeast/mould and *Leuconostoc* sp. counts were 0.00 and 0.00 (log CFU/ml), respectively at 72 hours of storage and 3.40 and 3.80 (log CFU/ml), respectively at 672 hours of storage.

When the sugarcane juice pasteurized and stored at room temperature, yeasts/moulds and *Leuconostoc* sp. growths were 0.00 and 0.00 (log CFU/ml) at 72 hours of storage. However, at 672 hours of storage, yeasts/moulds and *Leuconostoc* sp. were significantly increased to 1.46 and 1.74 (log CFU/ml), respectively. For the refrigerated samples, the yeast/mould and *Leuconostoc* sp. were 0.00 and 0.00 (log CFU/ml), respectively, throughout storage time.



(a) Unblended sugarcane juice (control)

(b) Sugarcane juice blended with 20% onion juice

(c) Sugarcane juice blended with 30% *Moringa oleifera* leaf juice

(d) Sugarcane juice blended with combination of 20% onion juice and 30% *Moringa oleifera* leaf juice

Figure 3: Microbial stability in unblended sugarcane juice (control) and sugarcane juice blended with 20% onion juice, 30% *Moringa oleifera* leaf juice and combination of 20% onion juice and 30% *Moringa oleifera* leaf juice.

The results showed that microbial counts in the unblended, non-pasteurized and pasteurized sugarcane juices which were stored at either room temperature or refrigeration temperature were above the acceptable microbial limit level (2 (log CFU/ml)) within 12 hours of storage. Similar findings were reported by Ramachandran et al. (2017), who noted that untreated, pasteurized and non-pasteurized sugarcane juice, at room and refrigeration temperature storage, deteriorated within 12 hours of storage. Furthermore, Oliveira (2007) reported a decline in yeast and mould counts from 10^6 CFU/ml in raw sugarcane juice to 10^1 and 10^2 CFU/ml in pasteurized sugarcane juice, to which lemon juice and pineapple juice were added and stored at refrigeration temperature. Pasteurization is applied to inactivate and reduce some of the microbials in food. But, in and of itself, pasteurization cannot kill other vegetative microbes and their spores, including the heat resistant moulds (*Byssochlamys fulva*) found in sugarcane juice (Farhana and Prema 2006). Besides, moulds and *Leuconostoc* sp. are highly resistant to refrigeration storage and can grow at a temperature range between 2 °C and 12 °C (James and James 2002, Hemme and Foucaud-Sheunemann 2004). Conversely, pasteurizing, the addition of onion juice and *Moringa oleifera* leaf juice at higher concentrations and refrigerating the sugarcane juice produced positive results in this study by

controlling the yeasts/moulds and *Leuconostoc* sp. counts, from 5.48 and 4.45 (log CFU/ml), respectively, in unblended, non-pasteurized, raw sugarcane juice stored at room temperature to 0.00 and 0.00 (log CFU/ml) throughout storage time (672 hours). These findings are similar to the findings reported by Ramachandran et al. (2017) which showed that during pasteurization, the addition of *Moringa oleifera* seed extract and lemon juice at high concentrations to sugarcane juice and refrigeration storage controlled microbial growth in sugarcane juice.

Conclusion

The effects of onion juice and *Moringa oleifera* leaf juice on the shelf life of sugarcane juice stored at either room or refrigeration temperature for 672 hours were investigated. The shelf life of fresh sugarcane juice is limited owing to high rates of microbial activities that take place after extraction of the juice. Onion juice and *Moringa oleifera* leaf juice helped to extend the shelf life of sugarcane juice by controlling yeasts/moulds and *Leuconostoc* sp. growth for 672 hours (28 days). Pasteurization and refrigeration storage influenced further the shelf life of sugarcane juice. Nonetheless, the addition of higher concentration of 20% onion juice and 30% *Moringa oleifera* leaf juice to pasteurized sugarcane juice and stored at refrigeration temperature had better effects than the addition of 10% onion juice and 10% *Moringa oleifera* leaf juice to sugarcane juice or when onion juice and *Moringa oleifera* leaf juice were added individually to sugarcane juice. We recommended further study on the organoleptic test in order to establish the acceptability of the sugarcane juice with either onion juice, *Moringa oleifera* leaf juice or a combination of onion juice and *Moringa oleifera* leaf juice added to it.

Acknowledgments

The authors are grateful to the German Academic Exchange Service (Deutscher Akademischer Austauschdienst) (DAAD) for financial support.

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