Objective: The antibacterial property of coconut, the presence of lauric acid, and the ability to extract antimicrobial peptides Cn-AMP (1, 2, and 3) from tender coconut water has drawn attention on its effectiveness in normal consumption. An in-vitro experimental study was conducted to evaluate the antimicrobial efficacy of tender coconut water in its natural state on Streptococcus mutans.

Materials and Methods: Fresh tender coconut water and pasteurized tender coconut water were taken as test samples, dimethyl formamide was used as the negative control, and 0.2% chlorhexidine was used as the positive control. Pure strain of S. mutans (MTCC 890) was used for determining the antibacterial effects. The test samples along with the controls were subjected to antimicrobial sensitivity test procedure and the zone of inhibition was examined. Kruskal–Wallis test was used to check for any significant differences in the antibacterial efficacy between the samples.

Result: There was no zone of inhibition with the tender coconut water, fresh and pasteurised, and negative control (dimethyl formamide). Zone of inhibition was seen in positive control (0.2% Chlorhexidine).

Conclusion: No antimicrobial activity was demonstrated with tender coconut water in its normal state (in vitro).

Keywords: Antimicrobial, lauric acid, Streptococcus mutans, tender coconut water

Abstract

INTRODUCTION

Dental caries is an infection of composite etiology with substantial evidences that Streptococcus mutans is responsible for it. Therefore, reducing their intensities in the oral cavity would offer a further justification for the inhibition of dental caries. Ongoing research on medicinal and natural products is increasing and the use of plants and their derivatives, which possess preventive and therapeutic effects, could contribute to oral health.[1-3]

Cocos nucifera L. is an important fruit tree in the world, providing nutrients to many people, particularly in the humid and subtropical provinces; because of its numerous usages it is frequently called the “tree of life.”[3] It is a clear, colorless, sweet, and naturally flavored slightly acidic drink. Decades of research have shown that coconut water is a rich source of nutrient, including essential amino acids (lysine, leucine, cysteine, phenylalanine, tyrosine, histidine, and tryptophan), palmitic and oleic acids, and dietary minerals. Others minerals such as iron, zinc, and manganese are also present at appreciable levels. The principal sugars in coconut water are glucose, fructose, and sucrose, whereas tartaric, citric and malic acids are its abundant organic acids. It also contains vitamin B1, vitamin B2, and vitamin C.[4,5] The liquid endosperm of tender coconut water is an excellent soft drink and contains vitamin B, especially nicotinic acid (vitamin B3), pantothenic acid (vitamin B5), biotin, riboflavin (vitamin B2), folic

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acid, trace amounts of thiamine B1, and pyridoxine B6. Further, coconut water contains sugars, sugar alcohol, vitamin C, folic acid, free amino acids, phytohormones, enzymes, and growth promoting factors.[3] Coconut water in its envelope is sterile and comprises both organic and inorganic compounds (almost all minerals found in food). Because coconut water is considered to be natural medicine in different civilizations, it was screened to identify defense peptides with bactericidal properties.[4] C. nucifera has been recognized as an entity with multiple uses associated with every component and being biologically active in one way or other. Extract of C. nucifera is used in treatment of leishmaniosis wounds. In the Indian subcontinent, it is used as a rehydrating agent in cholera, diarrhea, and dysentery, treatment of cancer, and as a hair nutrient in alopecia. The roots are astringent, diuretic, and anthelmintic, and are useful in pharyngodynia, uterine disorders, bennorrhagia, bronchitis, hepatopathy, strangury, and helmenthiasis.[5-8] It is reported that coconut water cures bladder infections, eliminates kidney stones, and progresses sexual vivacity.[9]

The antimicrobial property of coconut is because of its high lauric acid content that has been used as medications for certain oral infections, e.g. mouth sores. Some studies have reported that sucrose monolaurate and glycolipid component present in coconut has anti-caries properties.[2] This effect is probably due to condensed glycolysis and sucrose oxidation in a noncompetitive method affected by Streptococcus mutans and hence inhibits in-vitro dental plaque.

Tender coconut water is readily available, economically reasonable, and traditionally tolerable besides having various general and oral health benefits without any side effects. The studies related to antimicrobial efficacy of tender coconut water in its natural state on S. mutans are not available. Hence, the present study was conducted to assess the antimicrobial efficacy of tender coconut water against S. mutans.

MATERIALS AND METHODS
An in vitro experiment was conducted to evaluate the antimicrobial effectiveness of tender coconut water in its natural state on S. mutans.

NATURAL TENDER COCONUT WATER
A young green, medium-sized coconut was obtained from the local market. Fresh tender coconut water was extracted and collected in its natural form in a sterile test tube.

PASTEURIZED TENDER COCONUT WATER
Pasteurization was done by the holding method. Tender coconut water was transferred to a sterile test tube by holding the test tube at 63°C for 30 minutes.

RESULTS
The mean values for zone of inhibition were higher with positive control (60.27 ± 0.2), followed by negative control (15.28 ± 0.1) and pasteurized tender coconut (14.23 ± 0.2), whereas it was less for fresh tender coconut (3.08 ± 0.2). This difference was highly statistically significant (P < 0.001) using Kruskal–Wallis test, suggesting that the antimicrobial efficacy of fresh tender coconut was significantly less when compared to positive control, i.e. chlorhexidine [Table 1]. Chlorhexidine is used as a gold standard against which other antimicrobial agents are compared.

DISCUSSION
The present study was conducted to assess the antimicrobial activity of tender coconut water in its natural state on S. mutans. The antibacterial property
of coconut, the presence of lauric acid, and the ability to extract antimicrobial peptides Cn-AMP (1, 2, and 3) from tender coconut water has drawn attention on its effectiveness in normal consumption.

Fresh tender coconut water and pasteurized tender coconut water were taken as test samples, dimethyl formamide was used as negative control, and 0.2% chlorhexidine was used as the positive control in this study. Pure strain of \textit{S. mutans} (MTCC 890) was used for determining the antibacterial effects. The test samples along with the controls were subjected to antimicrobial sensitivity test procedure and the zone of inhibition was examined. The mean values for zone of inhibition were higher with positive control (60.27 ± 0.2), followed by negative control (15.28 ± 0.1) and pasteurized tender coconut (14.23 ± 0.2), whereas it was less for fresh tender coconut (3.08 ± 0.2). This difference was highly statistically significant ($P < 0.001$) using Kruskal–Wallis test, suggesting that the antimicrobial efficacy of fresh tender coconut was significantly less when compared to the positive control, i.e. chlorhexidine. Chlorhexidine is used as the gold standard against which other antimicrobial agents are compared.

\textit{C. nucifera} (L.) is frequently called the “coconut tree” and is a naturally prevalent fruit plant on soil. Throughout history, individuals have used herbal plants therapeutically, and minerals, plants, and animals have customarily been key sources of drugs. The ingredients of \textit{C. nucifera} have some biotic properties, such as antihelminthic, anti-inflammatory, antinociceptive, antioxidant, antifungal, antimicrobial, and antitumor actions. A systematic review comprised explorations achieved using technical databases such as Scopus, Science Direct, PubMed, SciVerse, and Scientific Electronic Library Online. Various uses of the plants were somewhat established by prior studies representing analgesic, antiarthritic, antibacterial, antipyretic, antidiarrheal, and hypoglycemic activities. Because each part of \textit{C. nucifera} has diverse ingredients, the pharmacological properties of the plant fluctuate rendering to the amount of the plant evaluated.\cite{15} Chowdhury et al., who studied processing and conservation of green coconut water also did not find any microbial growth in thermally treated tender coconut water.\cite{16} The pure oil and the cream formulations displayed a cidal activity. The active compound in the oil previously identified to be monolaurin could have had enhanced penetration due to the presence of surface active emulsifying agents used in formulating the cream because emulsification of oils generally increases their absorptivity.\cite{10} The water of tender coconut, which is technically the liquid endosperm, is a highly nutritious fluid containing numerous nutrients.\cite{11} In a study of conservation of green coconut water by membrane filtration, Magalhães et al. revealed that 94% of the buyers who tasted the ultrafiltered coconut water loved the product. Nevertheless, there was not at all straight association with fresh coconut water. The green coconut water indeed comprises oxidative enzymes in its constituents. Inside the fruit, the water is sterile but as soon as it is taken out exposed to air it becomes vulnerable to oxidation furthermore of microbial contamination. At present, pasteurization is the main procedure used for beverage protection and microbiological protection. Various studies have been thought to estimate the result of pasteurization environments on the inactivation of oxidative enzymes, peroxidase, and polyphenoloxidase in coconut water as it has previously been confirmed the action of thermal resistant enzymes in such product.\cite{12} Coconut water in its envelope is sterile and composed of both organic and inorganic compounds (almost all minerals found in food). As coconut water is considered
Table 1: Differences in the zone of inhibition between the samples

| SL No | Particulars                        | N  | Mean±SD  | P     |
|-------|------------------------------------|----|----------|-------|
| 1.    | Fresh tender coconut water         | 15 | 3.08±0.2 | 0.0001* |
| 2.    | Pasteurized tender coconut water   | 15 | 14.23±0.2|       |
| 3.    | Negative control                   | 15 | 15.28±0.1|       |
| 4.    | Positive control                   | 15 | 60.27±0.2|       |

*P<0.001 highly statistically significant using Kruskal–Wallis test.

The present study has been undertaken using TCW has not shown any antibacterial effect against *S. mutans* might be because of chemical constituents of coconut water are affected by numerous factors. This was merely a preliminary in-vitro study. Hence, additional future studies are needed to conclude the factors that create the required chemical components for a precise purpose. Jackson et al. presented that coconut water of dissimilar coconut variations comprises diverse concentration of compounds, and that the chemical content also varies during the diverse stages of maturity. Soil and environmental circumstances correspondingly disturb the chemical outline of coconut water. A study conducted in Brazil confirmed that the physical properties of coconut water were affected by fluctuating nitrogen and potassium application. Hence, upcoming studies should be carried out to decide the causes that result in the desirable chemical constituents. Breeding studies can also be carried out to produce coconut water enhanced with definite chemical compounds. Even though coconut water is already well-studied in terms of chemical content, there might still be mysterious solutes which contribute to its special biological effects. With the improvement of more innovative discovery techniques, screening can be strengthened to identify novel compounds of therapeutic values present in coconut water.

Tender coconut water has various health benefits without any adverse effects, and thus, can be suggested for extended period use. We would advise that traditional oral hygiene practices, even though not confirmed scientifically, have time-tested valued properties. Pertaining to plant ingredients, these favorable properties may possibly be correlated to the lively chemical components. Additional studies are required to illuminate the vigorous constituents of *C. nucifera* and their manner of action as well as their potential in mixture using supplementary plant extracts. If recognized, the active combinations could be combined into modern oral care systems such as toothpastes or mouthwashes. This may possibly provide the opportunity of merging the benefits of traditional and contemporary practices to suggest extreme advantage to manhood for improved oral health.

**Conclusion**

The present study demonstrated that, there was no antimicrobial efficacy of fresh and pasteurized tender coconut water against *S. mutans* despite having lauric acid.

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Nil.

**CONFLICTS OF INTEREST**

There are no conflicts of interest.

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