Repercussion of Noni Mouthwash on Surface Characterization of Nickel-Titanium Archwire

Abstract
Objective: Maintaining oral hygiene is very important during orthodontic therapy mouthwashes are prescribed as an adjunct to improve patient’s oral hygiene. Commercially available mouthwashes e.g. Chlorhexidine, Listerine, fluoride containing mouthwashes have shown to alter the surface characteristics of orthodontic wires. Hence the purpose of the study was to evaluate the effect of Noni mouthwash on surface quality and compositional changes of Nickel Titanium orthodontic wires. Materials and Methods: In this in vitro study pre-formed 0.014 inch NiTi arch wire was used. The study comprised of two samples, one control and one test sample which were 25mm in length. Control sample was stored at room temperature without any manipulation while test sample was immersed in Noni mouthwash solution for 1.5 hours, after which the test specimen was removed from the mouthwash solution and rinsed with distilled water. Both control and test samples were sent for scanning electron microscopy analysis, to qualitatively characterize the topography of the wire surface. Electron dispersion spectrum analysis was done to evaluate the various components of both the wires. Results: No significant difference in the average surface roughness for both wire samples was observed. There was no significant difference seen in the composition of wire after immersion in Noni mouthwash. Conclusion: Noni mouthwash did not have significant influence on the surface roughness or altered the composition of the Ni-Ti wire. Hence Noni mouthwash may be prescribed as a natural, non-destructive prophylactic agent for orthodontic patients.

Key-words: Morinda citrifolia (Noni), Surface changes, Nickel Titanium Orthodontic wires, Scanning electron microscopy

Introduction
Orthodontic treatment is vital for correcting the malpositioned teeth as well as creating an attractive smile which helps in improving and maintaining good oral and dental health and contributes to the development of self-esteem of the patient. The principle of orthodontic therapy is to utilize the stored elastic energy in the orthodontic wires to carry out desired tooth movement.[1] Efficient orthodontic treatments rely on the perfect design and condition of the wires. Wires exposed to the oral environment are subjected to acidic environment of the oral cavity and various supplements such as prophylactic agents and mouthwash solutions which results in corrosion of the wire. This gradual corrosion of the wire resulting from chemical reactions can have several adverse effects such as the release of elements from metallic wires and roughening of the wire surface.[2]

Orthodontic treatment requires the use of bands, brackets, wires, and ligatures resulting in a change in oral environment which makes the dental plaque elimination challenging. Dental plaque accumulation accentuates around the bands and brackets during orthodontic treatment leading to gingivitis and dental caries.[3, 4] Studies have shown progression of hyperplastic gingivitis during 1–2 months after bonding of the fixed appliances.[4] Alterations in oral microflora and limited access to teeth surfaces result in gingivitis and decalcifications around fixed appliances, therefore, to prevent these side effects, oral irrigation with different mouthwashes have been suggested.[6, 7]

Chlorhexidine is one of the most commonly prescribed mouthwashes which is used effectively in periodontal and orthodontic patients. This mouthwash inhibits plaque formation and acidogenic bacteria and indirectly can reduce dental caries.[8] However, chlorhexidine mouth rinses are usually prescribed for a short term only due...
to its metallic taste and adverse effects on tooth color and normal oral flora.

Fluoride mouthwashes are also prescribed by orthodontists to guard against demineralization or white spot lesions around orthodontic brackets. However, fluoride ions in the prophylactic agents have been reported to cause corrosion, discoloration, and alteration of the mechanical properties of metallic wires.

Prescribing oral mouthwashes is usually necessary in orthodontic patients, but the main concern is their side effects on orthodontic attachments and wires. These mouthwashes can affect superficial surface characteristics and mechanical properties of metallic parts of orthodontic appliances.

To overcome the side effects of inorganic mouthwashes, more natural and herbal products can be used as mouthwashes. One such natural alternative is Noni juice. *Morinda citrifolia* (Noni) is found to have a broad range of therapeutic effects such as antiviral, antibacterial, antifungal, analgesic, anti-inflammatory, immune enhancing effect which can be used to prevent plaque accumulation, gingival inflammation, and demineralization around orthodontic brackets.

Hence, the objective of this article is to evaluate the effect of Noni juice as a mouthwash on the surface properties of the nickel-titanium orthodontic wire.

### Materials and Methods

In our study two preformed 0.014” Niti wires of length 25 mm each were used.
1. Control group – A single 0.014” Niti wire stored at room temperature without manipulation
2. Test group – A single 0.014” Niti wire immersed in Noni mouthwash.

Test sample was immersed in Noni mouthwash solution for 1.5 h. This exposure time is equivalent to 3 months of 1-min daily mouthwash application.

Just before testing, the test specimen was removed from the mouthwash solution and rinsed with distilled water. Both control and test samples were sent for scanning electron microscopy analysis, to qualitatively characterize the topography of the wire surface. The samples were also sent for electron dispersion spectrum analysis to determine change in the constitution of the wire after immersion in Noni mouthwash, if any.

### Results

Both the control and test wire samples were evaluated using scanning electron microscope under a magnification of 800X. Both the wire surfaces appeared to have numerous linear areas, which might be the result of the manufacturing process of the wire. The test wire surface did not show any dark smudge areas, elongated, mottled, globular or pitted surface characteristics, after exposure to Noni mouthwash, indicating no severe changes in the wire surface topography as compared with the control wire as shown in Figures 1 and 2.

Electron dispersion spectrum analysis of control and test wire samples did not show any change in the constituents of the wire after immersion in Noni mouthwash as shown in Figures 3 and 4.

### Discussion

Fixed orthodontic treatment requires bonding of attachments/brackets to the teeth surface to facilitate tooth movement. These attachments provide a surface for retention of plaque and make oral hygiene maintenance difficult. Maintenance of good oral hygiene during fixed orthodontic treatment is very important to prevent the iatrogenic effects of bonding attachments to the teeth surface. The orthodontist might prescribe mouthwashes to the patients to aid in maintaining the oral hygiene. These mouthwashes can be chlorhexidine (most commonly used) and fluoride containing, but very little attention is paid on the negative effects of these mouthwashes on the properties of orthodontic archwires, which are the mainstay of orthodontic treatment.

Nowadays, many patients are attracted toward the herbal or natural products because they are considered to be harmless and have minimal side effects, if any. *M. citrifolia* (Noni) is a traditional folk medicinal plant which has various nutrients that provide this plant with a wide range of therapeutic effects and nutritional value with many health benefits. More than 160 phytochemicals are present in the Noni plant which includes phenolic compounds, organic acids, and alkaloids which are proven to have antimicrobial, antifungal, anti-inflammatory, and anti-carcinogenic properties.

Analysis has shown that there are no toxic or prohibited substances in *M. citrifolia* juice, and Noni drinks are potential sources of phytochemical constituents and antimicrobial agents which may be useful for pharmaceutical industries.

No study has been conducted to evaluate the effect of Noni mouthwash on the corrosion of orthodontic wires, so this study was undertaken to evaluate the surface changes and compositional changes in orthodontic wire by Noni mouthwash.

Son et al. studied the effect of fluoride mouthwash on the surface quality of orthodontic wires and found that fluoride mouthwash produced qualitative surface topography changes on wires and following fluoride exposure wires exhibited an increase in overall surface roughness. Study done by Brar et al. also found that fluoride-containing Listerine mouthwash produced high corrosion rate of the wire, followed by chlorhexidine, and least corrosion rate was found in organic (neem)
mouthwash. Noni juice has been used as a mouthrinse in gingivitis and oral candidiasis patients. Hence, to make use of anti-candidal property of Noni in orthodontic treatment, we conducted a study to evaluate the effects of Noni mouthwash in orthodontic archwire. Noni mouthwash was prepared from Noni juice.

Preparation of Noni mouthwash – Noni mouthwash was prepared according to study done by Glang et al. where 0.9% NaCl (normal saline) was used to dilute the Noni juice in the concentration of 1:2 (Noni juice: saline) as this concentration was found to completely inhibit aerobic and anaerobic bacterial growth.\(^{[17]}\)

The initial archwire used in orthodontic treatment for leveling and aligning (0.014” NiTi wire) was chosen for the study. The control group was not immersed in any solution whereas the test group was immersed in the prepared Noni mouth rinse for 1.5 h which is equivalent of 3 months of 1 min daily mouth rinsing with Noni mouthwash.

The passivation effect for nickel-titanium wires is provided by the titanium oxide layer formed at the surface of the wire. This surface passivation prevents further oxygen diffusion, resulting in corrosion resistance, however, if the passivation layer is disrupted, the wires become susceptible to corrosion.\(^{[18]}\) In our study, there was no significant change in the wire surface topography indicating that the passivating layer was not disrupted and the corrosion resistance of the wire was maintained.

Studies have found that chlorhexidine mouthwash increases corrosion of orthodontic wires and causes release of nickel and chromium ions from the wires.\(^{[16,19]}\) This provides metallic taste sensation and discoloration of teeth. Noni mouthwash did not cause significant corrosion of the archwire thus decreasing the possibility of metallic ion release. This can be confirmed by electron dispersion spectrum analysis which showed the same levels of different constituents of the wire even after immersion in Noni mouthwash. Hence, proving that Noni mouthwash is reliable in maintaining the surface properties and corrosion resistance of the wire, oral cavity conditions are more complex due to factors such as pH changes, oxygen level concentration, temperature, food debris which leads to increased corrosion of orthodontic wires and further study is needed to evaluate the changes intraorally.
Conclusion
Noni mouthwash did not cause any change in the surface property or the constitution of the orthodontic wire. Hence, Noni mouthwash can be used in orthodontic patients to prevent candida infection, and further research can be carried on this subject to confirm the in vivo use of Noni mouthwash.

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Conflicts of interest
There are no conflicts of interest.

References
1. Quintao CC, Brunharo IH. Orthodontic wires: Knowledge ensures clinical optimization. Dent Press J Orthod 2009;14:144-57.
2. Castro SM, Ponces MJ, Lopes JD, Vasconcelos M, Pollmann MC. Orthodontic wires and its corrosion – The specific case of stainless steel and beta-titanium. J Dent Sci 2015;10:1-7.
3. Lundström F, Hamp SE. Effect of oral hygiene education on children with and without subsequent orthodontic treatment. Scand J Dent Res 1980;88:53-9.
4. Zachrisson S, Zachrisson BU. Gingival condition associated with orthodontic treatment. Angle Orthod 1972;42:26-34.
5. Pender N. Aspects of oral health in orthodontic patients. Br J Orthod 1986;13:95-103.
6. Lundström F, Hamp SE, Nyman S. Systematic plaque control in children undergoing long-term orthodontic treatment. Eur J Orthod 1980;2:27-39.
7. Ciancio SG, Cunat JJ. A comparison of plaque accumulation in bonded versus banded teeth. J Dent Res 1985;64:359.
8. Brightman LJ, Terezhalmy GT, Greenwell H, Jacobs M, Enlow DH. The effects of a 0-12% chlorhexidine gluconate mouthrinses on orthodontic patients aged 11-17 with established gingivitis. Am J Orthod Dentofacial Orthop 1991;100:324-9.
9. Alexander SA, Ripa LW. Effects of self-applied topical fluoride preparations in orthodontic patients. Angle Orthod 2000;70:424-30.
10. Eliades T, Athanasiou AE. In vivo aging of orthodontic alloys: Implications for corrosion potential, nickel release, and biocompatibility. Angle Orthod 2002;72:222-37.
11. Walker MP, White RJ, Kula KS. Effect of fluoride prophylactic agents on the mechanical properties of Nickel-Titanium-based orthodontic wires. Am J Orthod Dentofacial Orthop 2005;127:662-9.
12. Chan-Blanco Y, Vaillant F, Perez AM, Reynes M, Brillouet JM, Brat P. The noni fruit (Morinda citrifolia L.): A review of agricultural research, nutritional and therapeutic properties. J Food Compost Anal 2006;19:645-54.
13. Anugweje KC. Micronutrient and phytochemical screening of a commercial Morinda citrifolia juice and a popular blackcurrant fruit juice commonly used by Athletes in Nigeria. World Rural Obs 2015;7:40-8.
14. Assi RA, Darwis Y, Abdulbaqi IM, Khan AA, Vuanghao L, Laghari LH. Morinda citrifolia (Noni): A comprehensive review on its industrial uses, pharmacological activities and clinical trials. Arabian J Chem 2015;10:691-707.
15. Soni V, Vyas N, Sharma A, Patel P, Mishra J, Sharma L. Mechanical properties and surface characterization of stainless steel orthodontic wire following fluoridated and non-fluoridated treatment. Eur J Biomed Pharma Sci 2015;2:1203-10.
16. Brar AS, Singla A, Mahajan V, Jaj HS, Seth V, Negi P. Reliability of organic mouthwashes over inorganic mouthwashes in the assessment of corrosion resistance of NiTi arch wires. J Indian Orthod Soc 2015;49:129-33.
17. Glang J, Falk W, Westendorf J. Effect of Morinda citrifolia L. fruit juice on gingivitis/periodontitis. Mod Res Inflamm 2013;2:21-7.
18. Yonekura Y, Endo K, Iijima M, Ohno H, Mizoguchi I. In vitro corrosion characteristics of commercially available orthodontic wires. Dent Mater J 2004;23:197-202.
19. Danaei SM, Safavi A, Roinpeikar SM, Oshag M, Iranpour S, Omidkhoda M, et al. Ion release from orthodontic brackets in 3 mouthwashes: An in-vitro study. Am J Orthod Dentofacial Orthop 2011;139:730-4.