

# Does mouthwash degrade the force of orthodontic latex elastics?

Sri Suparwitri, Niswati Fathmah Rosyida, Ananto Ali Alhasyimi

Department of Orthodontics, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia

## Article Info

### Article history:

Received Mar 26, 2022

Revised Aug 18, 2022

Accepted Sep 6, 2022

### Keywords:

COVID-19

Force degradation

Medicine

Mouthwash

Orthodontic latex elastics

## ABSTRACT

With the surge of COVID-19 pandemic, orthodontists have recommended the use of mouthwashes. However, this product frequently contains ingredients that can modify the mouth's pH and elastic force. This study examined the influence of mouthwashes on latex elastic force deterioration. One hundred orthodontic latex elastics (1/4") were separated into five groups: control, zinc sulfate 0.2%, chlorhexidine 0.2%, sodium fluoride 0.2%, and povidone-iodine 1%. The samples were stretched to 19.05 mm, stored in artificial saliva solutions, and incubated. Groups 2–5 tested mouthwashes for 60 seconds every 12 hours and then reverted to artificial saliva. Force was measured using a five-times-activated tension gauge. Elastic force was tested at five-time intervals: baseline, 1, 6, 12 and 24 hours. The statistical analysis included two-way ANOVA and the Tukey post-hoc test. Results showed statistical differences for the time intervals and force degradation of orthodontic latex elastics ( $p < 0.05$ ). The majority of force loss occurred within six hours of extension and immersion. Mouthwashes had no influence on the reduction in elastic force ( $p > 0.05$ ). The force degradation of orthodontic latex elastics was unaffected by mouthwashes. The lowest force degradation was generated by povidone-iodine, followed by zinc sulfate, sodium fluoride, and chlorhexidine.

*This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.*



## Corresponding Author:

Ananto Ali Alhasyimi

Department of Orthodontics, Faculty of Dentistry, Universitas Gadjah Mada

Bulaksumur, Caturtunggal, Depok, Sleman, Yogyakarta, Indonesia

Email: [anantoali@ugm.ac.id](mailto:anantoali@ugm.ac.id)

## 1. INTRODUCTION

When it comes to aesthetic dentistry, orthodontic treatment has become one of the most popular procedures. It is used to correct malocclusion, to provide a healthy occlusion and an aesthetically pleasing appearance [1], [2]. Elastics have long been used in orthodontics to help in the transfer of force to the teeth by orthodontic mechanics. Compared to non-latex elastics, latex elastics possess better flexibility, greater force, a lower price, and the ability to rebound to their original dimensions after substantial deformation. To produce latex elastic materials, natural rubber, an elastomer having a 3D reticulate structure formed by cross-links, is utilized [3]. Over 20 different types of latex elastics are currently used in orthodontic treatment. Orthodontists select appropriate elastics based on force, personal experience, and habit. Elastics reportedly exert force at a 300% extension of their diameter, but the validity of this claim has been questioned, and its force levels vary depending on its size [4], [5].

Contrary to their extensive usage in the field, the mechanical qualities of orthodontic latex elastics (OLEs) are poorly understood. After being loaded over its stress limit, latex elastic becomes fatigued at the weak places due to the lack of homogeneity on the inside or surface of the latex elastic. Dynamic fatigue also develops due to friction between the molecular chains [6]. Owing to the physical and chemical characteristics of latex, orthodontic elastics get fatigued, and force relaxation results in force deterioration [7]. These

characteristics are influenced by material-related elements, such as force decay, and oral environmental factors, such as saliva composition, intraoral pH, temperature fluctuations, and food texture [8]–[10]. Hence, force degradation must be maintained within acceptable limits to achieve effective orthodontic tooth movement.

With the emergence of the COVID-19 pandemic in early 2020, the use of oral rinses or mouthwashes have been advised for orthodontic patient's due to the vulnerability of the virus to oxidation. Maintaining proper oral hygiene is difficult for these individuals; hence, efficient antibacterial agents, such as mouthwash, must be used to prevent the development of white spot lesions and stop the advancement of existing demineralization [11], [12]. However, mouthwashes include compounds that can influence orthodontic elastic force by altering the pH of the oral environment. The force degradation of orthodontic elastic chains has been the subject of several investigations. Omidkhoda *et al.* [13] proved that mouthwashes influence the force decay of orthodontic elastic chains, but Sufarnap *et al.* [14] stated that mouthwashes containing sodium fluoride have no negative impact on force degradation and permanent deformation of orthodontic elastomeric chains. Nevertheless, information about the effect of mouthwashes on the force decay of OLEs is lacking. Here, the effects of mouthwashes on the force decay of OLEs in in vitro conditions were compared throughout different periods of time. The hypothesis is that mouthwashes increase the force decay of OLEs.

## 2. RESEARCH METHOD

Ethical clearance for this experimental laboratory study was obtained from the Ethical Commission of Dentistry, Faculty of Dentistry, Universitas Gadjah Mada with a number 00693/KKEP/FKG-UGM/EC/2021. Samples of OLEs (American Orthodontics, USA) with 1/4 inch size were kept in sealed plastic packets in a cool, dark environment and used before their expiration dates. A total of 100 sets of elastics were tested at a time using 10 jig boards as shown in Figure 1, each of which had 10 pairs of pins spaced 10 millimeters apart. Each of the following five groups consisted of 20 sets of elastics: control group, the samples rinsed in zinc sulfate 0.2%, the samples rinsed in chlorhexidine 0.2%, the samples rinsed in sodium fluoride 0.2%, and the samples rinsed in povidone–iodine 1%. All the samples were stretched to a diameter of 19.05 mm (three times their initial diameter), kept in artificial saliva solutions with pH values of 7, and maintained at body temperature in an incubator ( $37\pm 1^\circ\text{C}$ ). The samples from groups 2–5 were put into the test mouthwashes three times a day for 60 seconds at 0, 12, and 24 hours. After each immersion, the samples were placed back into the artificial saliva. After a consistent reading was established within 4–5 seconds using an orthodontic dynamometer tension meter force oral gauge, a blinded and trained examiner measured the force magnitudes at a diameter of five times the diameter of the activation (31.75 mm) (MedKraft, USA). The force created by the elastics was measured at five different time intervals including baseline (before the experiment), 1, 6, 12, and 24 hours. Two-way analysis of variance (ANOVA) was used to statistically determine any differences across groups. Tukey's honest significant difference test was then applied to evaluate significant differences between groups. A p-value of less than 0.05 was regarded as statistically significant. Statistical product and service solutions (SPSS) version 21 was employed for the analyses (SPSS Inc, Chicago, Illinois).

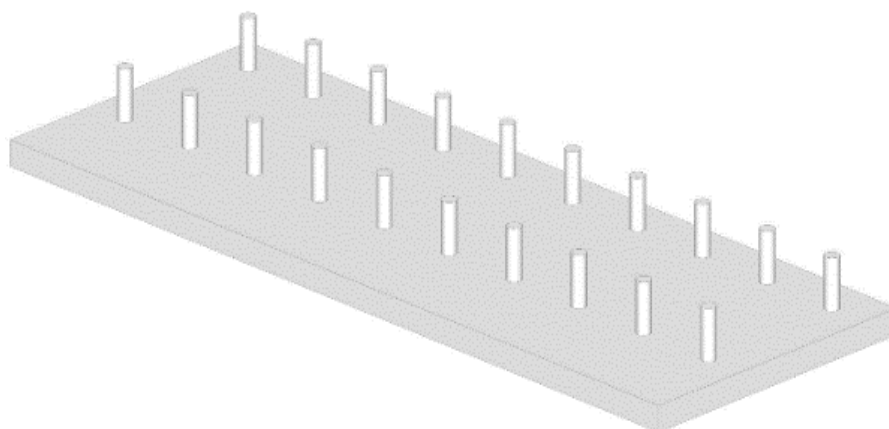


Figure 1. Acrylic jig boards with 10 pairs of pins spaced 10 millimeters apart

### 3. RESULTS AND DISCUSSION

The influence of four different mouthwashes (zinc sulfate, chlorhexidine, sodium fluoride, and povidone–iodine) on the force loss of OLEs was investigated at five distinct time intervals. Statistical differences were observed for the time intervals and force degradation of OLEs ( $p < 0.05$ ). In terms of the average force loss, the majority of force degradation occurred within the first six hours after extension and immersion. Force extension relaxation slowed down after 12 hours in all the groups, and this phenomenon could be explained by a range of forces appropriate for most clinical applications as shown in Tables 1-3 and Figures 2-3.

ANOVA results showed that the effect of mouthwashes on elastic force reduction was not statistically significant ( $P > 0.05$ ). The elastic strength of latex orthodontics at 6–12 hours in all groups showed the most drastic decrease in force value as presented in Table 3 and Figure 3. When the groups were evaluated individually, the chlorhexidine group had the lowest force value at 24 hours, followed by sodium fluoride, zinc sulfate, control, and povidone–iodine groups.

Table 1. Mean and standard deviations of orthodontic elastic force (gram force) in different solutions at different times

Immersion	Baseline	1 hour	6 hours	12 hours	24 hours
Control	222.3 (20.3)	183.8 (18.5)	140.6 (18.9)	126.3 (13.9)	121.5 (11.3)
Zinc sulfate	221.8 (19.8)	184.7 (19.2)	139.7 (17.8)	125.7 (12.8)	120.3 (12.8)
Chlorhexidine	222.8 (20.2)	180.1 (17.8)	132.4 (17.3)	121.6 (15.7)	116.4 (10.3)
Sodium fluoride	223.1 (20.1)	184.9 (18.7)	135.1 (14.9)	121.9 (16.5)	117.1 (11.9)
Povidone–iodine	220.9 (19.8)	186.1 (19.2)	141.2 (15.6)	128.9 (16.1)	124.3 (13.1)

Table 2. Two-way ANOVA test results of orthodontic elastic force (gram force) in different solutions at different times

Variable	F	p-value
Immersion solutions	771.827	0.002*
Observation time	1983.037	0.000*
Immersion solutions*Observation time	22.856	0.015*

\*Significant differences between groups ( $p < 0.05$ )

Table 3. Orthodontic elastic loss percentage (%) at different time intervals

Immersion	0–1 hour	1–6 hours	6–12 hours	12–14 hours
Control	17.56	23.49	10.71	3.96
Zinc sulfate	17.19	24.45	10.07	4.01
Chlorhexidine	18.91	26.67	8.33	4.13
Sodium fluoride	17.49	27.02	10.37	3.97
Povidone- iodine	15.45	24.19	9.21	3.51

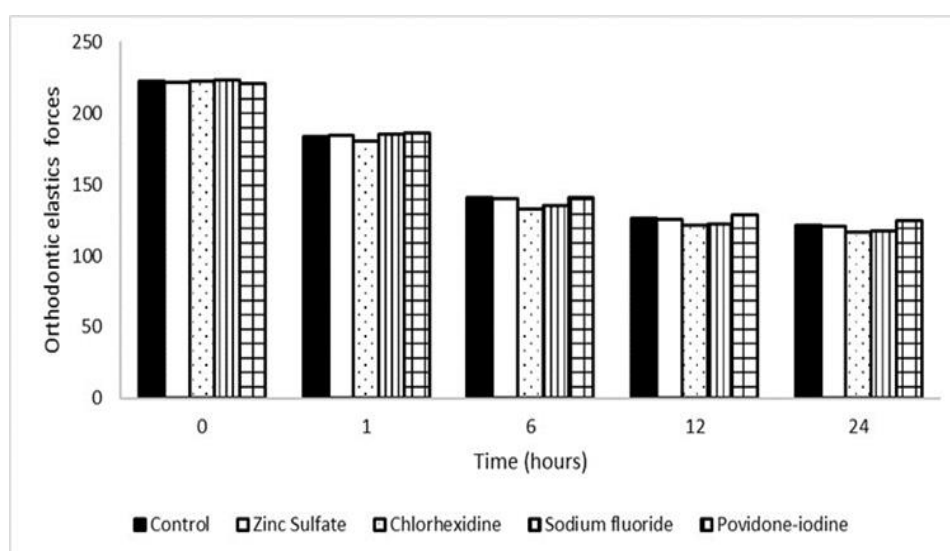


Figure 2. Orthodontic elastic forces curves in different solutions at different times

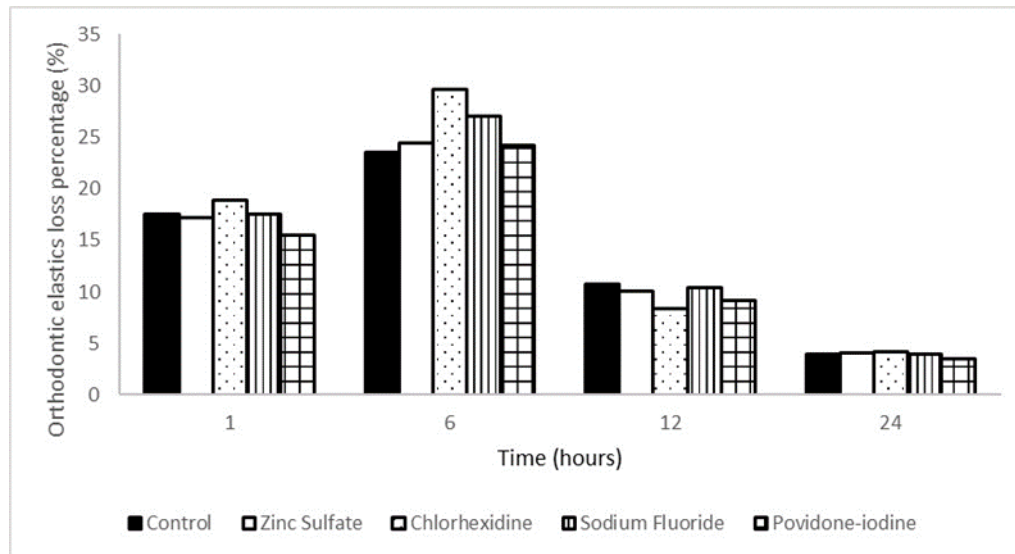


Figure 3. Force decay percentage (%) curves over time (hours) of orthodontic elastics in different solutions

Elastics for orthodontics are essential sources of force transmission to the teeth and are thus frequently employed in the orthodontic field. Albeit effective, the force created by these materials is progressively reduced over time, making them unsuitable for certain applications [15]. Previous study stated that the mechanical and environmental parameters that contribute to the force degradation of various orthodontic elastics [8]. Owing to their frequent usage by orthodontic patients, especially during COVID-19 pandemic, the influence of mouthwashes on orthodontic elastics must be analyzed.

Four common mouth rinses (betadine gargle, chlorhexidine, zinc sulfate, and sodium fluoride) were chosen for evaluation. Using a tension gauge, the force decay pattern of OLEs that were exposed to these mouthwashes was measured and compared to that of an OLE that was immersed in artificial saliva. No significant differences were found between the mouthwash groups and the control group in terms of force loss over time. This means that none of the test mouthwashes have a negative effect on the force loss of OLEs. OLE force reduction occurs due to several factors. One of which is the nature of latex to absorb water. In this study, the elastic was immersed in liquids such as artificial saliva and mouthwashes. Microstructural damage can occur due to the filling of the spaces in the latex matrix and cause intermolecular damage to the rubber [16]. Its intermolecular bonds may also be disrupted by the chemicals in the mouthwash acting as potent plasticizers [17]. When the OLE is immersed in the liquid for a long time, the latex absorbs much water, and the force value greatly decreases. OLE stretching can also decrease the force strength due to the breakage of latex secondary bonds that increases over time and results in primary bond rupture manifested as strength loss [18]. This phenomenon is in agreement with the result that the force value of OLE at 24 hours is the smallest among those for the other groups.

The type of mouthwash had no significant effect on decreasing the tensile strength of OLE. This finding agrees with a previous study, which stated that mouthwash does not influence the tensile strength reduction of orthodontic intermaxillary elastics [16]. Soaking OLE in mouthwashes three times a day for 60 seconds is not sufficient to reduce its force strength [17]. OLE tensile strength can be diminished by environmental conditions that plasticize the crosslinked polymers and reduce the flexibility of the material, resulting in fatigue and strength loss over time [9], [18].

The elastic strength of latex orthodontics at 6–12 hours in all groups showed the most drastic decrease in force value. Force extension relaxation occurs radically within the first 3 hours after extension, and a gradual degradation happens from 6 to 12 hours [19]. When stretched for the first time, the rubber experiences initial stress relaxation in the form of strength reduction when pulled at a constant strain. Owing to clinical patterns, force extension relaxation was not investigated in periods more than 24 hours. In clinical practice, patients are typically instructed to replace the elastics after 1 day of use [3].

The OLE immersed in the chlorhexidine solutions had the lowest force value than among all the samples. Chlorhexidine has a slightly acidic pH that varies from 5.5 to 6.0 [20]. Acid solutions accelerate the degradation of elastic chains, resulting in a decrease in released force [21], [22]. An environment with acidic conditions has a large number of  $H^+$  free radicals. The  $-COO^-$  group transforms to  $COOH$  due to the presence of  $H^+$  free radicals, thereby causing a loss of attractive force between the  $-COO^-$  and  $NH_3$  groups. This condition can cause the breakage of molecular protein bonds and consequent protein denaturation. The

polyisoprene double bond is also destroyed due to the carbon electrons and H<sup>+</sup> free radical bond. This process can damage the orthodontic elastic molecular structure [23]–[25]. Furthermore, active components found in chlorhexidine (cationic molecule) can bind to the OLE surface and aid in its breakdown [26].

According to the findings of the current investigation, mouthwash did not significantly enhance the force decay of OLE. This is congruent with the findings of the Pithon et al. study, which discovered that mouthwash has no effect on the force degradation of orthodontic chain elastics [27]. Ramazanzadeh *et al.* [28] investigated the effects of sodium fluoride mouth rinse on the elastic characteristics of several elastomeric chains and determined that daily usage of sodium fluoride mouth rinse had no influence on the force degradation required to attain typical orthodontic pressures. Another studies found that the use of 0.2% chlorhexidine, 0.2% persica, 0.2% sodium fluoride, and 0.2% chlorhexidine and sodium fluoride mouthwashes had no negative effect on the force degradation of elastomeric chains [29], [30].

Owing to the lack of comparable *in vivo* investigations, a comprehensive analysis cannot be performed on the current findings. *In vitro* studies have the drawback of inability to reproduce the changes in intraoral temperature, acidity as a result of consuming various foods, and other dynamic environments of the oral cavity. Although *in vitro* research can be useful, the findings must be translated with caution. Despite its limitations, the present work provides new information for orthodontists on issues crucial for patients with OLEs, such as the use of mouthwashes especially during the COVID-19 pandemic. As a result of force decay and irreversible distortion, orthodontic elastics should be replaced every 12 hours in the clinical setting.

#### 4. CONCLUSION

Within the limitations of the study, it can be concluded that the force loss of OLEs increased with prolonged immersion in liquid. Mouthwashes did not affect the force degradation of OLEs. Povidone–iodine generated the lowest force decay, followed by zinc sulfate, sodium fluoride, and chlorhexidine. Only one type of elastic (latex) was used in this investigation to compare the force decay patterns produced by various mouthwashes. Consequently, it is suggested to assess the response of various elastic materials to various types of mouthwash.

#### ACKNOWLEDGEMENTS

This study was fully funded by *Hibah Dana Masyarakat* Faculty of Dentistry, Universitas Gadjah Mada in the fiscal year of 2021.




#### REFERENCES

- [1] V. Indriasari, S. Suparwitri, C. Christnawati, and A. A. Alhasyimi, "Different effects of soybean isoflavone genistein on transforming growth factor levels during orthodontic tooth movement among young and old rabbits," *F1000Research*, vol. 8, pp. 1–14, Jun. 2020, doi: 10.12688/f1000research.21211.2.
- [2] A. A. Alhasyimi, N. F. Rosyida, and M. S. Rihadini, "Postorthodontic relapse prevention by administration of grape seed (vitis vinifera) extract containing cyanidine in rats," *European Journal of Dentistry*, vol. 13, no. 04, pp. 629–634, Oct. 2019, doi: 10.1055/s-0039-3401440.
- [3] I. G. A. W. Ardani, B. Susanti, and I. Djaharu'ddin, "Force degradation trend of latex and nonlatex orthodontic elastics after 48 hours stretching," *Clinical, Cosmetic and Investigational Dentistry*, vol. 10, pp. 211–220, Oct. 2018, doi: 10.2147/CCIDE.S173648.
- [4] S. Beattie and P. Monaghan, "An in vitro study simulating effects of daily diet and patient elastic band change compliance on orthodontic latex elastics," *The Angle Orthodontist*, vol. 74, no. 2, pp. 234–239, 2004, doi: 10.1043/0003-3219(2004)074<0234:AIVSSE>2.0.CO;2.
- [5] M. L. Kersey, K. E. Glover, G. Heo, D. Raboud, and P. W. Major, "A comparison of dynamic and static testing of latex and nonlatex orthodontic elastics," *Angle Orthodontist*, vol. 73, no. 2, pp. 181–186, 2003, doi: 10.1043/0003-3219(2003)73<181:ACODAS>2.0.CO;2.
- [6] E. Braga, G. Souza, P. Barretto, C. Ferraz, and M. Pithon, "Experimental evaluation of strength degradation of orthodontic chain elastics immersed in hot beverages," *Journal of Indian Orthodontic Society*, vol. 53, no. 4, pp. 244–248, Oct. 2019, doi: 10.1177/0301574219867540.
- [7] P. Kanchana and K. Godfrey, "Calibration of force extension and force degradation characteristics of orthodontic latex elastics," *American Journal of Orthodontics and Dentofacial Orthopedics*, vol. 118, no. 3, pp. 280–287, 2000, doi: 10.1067/mod.2000.104493.
- [8] C. A. Farmasyanti, I. N. K. Dewi, and A. A. Alhasyimi, "Potency of bilimbi fruit (Averrhoa bilimbi L.) leaf extract as corrosion inhibitors of stainless steel orthodontic wires," *Journal of International Dental and Medical Research*, vol. 11, no. 2, pp. 634–638, 2018.
- [9] I. B. Narmada, N. T. Sudarno, A. Sjafai, and Y. Setiyorini, "The influence of artificial salivary pH on nickel ion release and the surface morphology of stainless steel bracket-nickel-titanium archwire combinations," *Dental Journal (Majalah Kedokteran Gigi)*, vol. 50, no. 2, pp. 80–85, Jun. 2017, doi: 10.20473/j.djmk.v50.i2.p80-85.
- [10] P. Pudyani, F. Safitri, and A. Alhasyimi, "Effect of orthodontic sealant containing antimicrobial selenium on the shear bond strength of orthodontic bracket," *Journal of Orofacial Sciences*, vol. 10, no. 2, pp. 96–100, 2018, doi: 10.4103/jofs.jofs\_16\_18.
- [11] S. K. Saputra, D. Sutanty, C. A. Farmasyanti, and A. A. Alhasyimi, "The effect of the addition of propolis to resin-modified





- glass ionomer cement bracket adhesive materials on the growth inhibition zone of *Streptococcus mutans*,” *F1000Research*, vol. 8, pp. 1–17, Jul. 2020, doi: 10.12688/f1000research.20717.2.
- [12] A. P. Nugraha, D. Rahmadhani, M. S. Puspitaningrum, Y. Rizqianti, V. Kharisma, and D. S. Ernawati, “Molecular docking of anthocyanins and ternatin in *Clitoria ternatea* as coronavirus disease oral manifestation therapy,” *Journal of Advanced Pharmaceutical Technology and Research*, vol. 12, no. 4, pp. 362–367, 2021, doi: 10.4103/japtr.japtr\_126\_21.
  - [13] M. Omidkhoda, R. Rashed, and N. Khodarahmi, “Evaluation of the effects of three different mouthwashes on the force decay of orthodontic chains,” *Dental Research Journal*, vol. 12, no. 4, pp. 348–352, 2015, doi: 10.4103/1735-3327.161453.
  - [14] E. Sufarnap, K. I. Harahap, and T. Terry, “Effect of sodium fluoride in chlorhexidine mouthwashes on force decay and permanent deformation of orthodontic elastomeric chain,” *Padjadjaran Journal of Dentistry*, vol. 33, no. 1, pp. 74–80, Mar. 2021, doi: 10.24198/pjd.vol33no1.26370.
  - [15] M. P. Dittmer, A. P. Demling, L. Borchers, M. Stiesch, P. Kohorst, and R. Schwestka-Polly, “The influence of simulated aging on the mechanical properties of orthodontic elastomeric chains without an intermodular link,” *Journal of Orofacial Orthopedics/Fortschritte der Kieferorthopädie*, vol. 73, no. 4, pp. 289–297, Aug. 2012, doi: 10.1007/s00056-012-0086-z.
  - [16] M. Macedo *et al.*, “Evaluation of latex and non-latex intermaxillary elastics strength degradation when submitted to the use of chlorhexidine,” *Orthodontic Waves*, vol. 80, no. 2, pp. 65–70, 2021, doi: 10.1080/13440241.2021.1908749.
  - [17] M. B. Evangelista, D. W. Berzins, and P. Monaghan, “Effect of disinfecting solutions on the mechanical properties of orthodontic elastomeric ligatures,” *Angle Orthodontist*, vol. 77, no. 4, pp. 681–687, Jul. 2007, doi: 10.2319/052806-213.
  - [18] L. Yang, C. Lv, F. Yan, and J. Feng, “Force degradation of orthodontic latex elastics analyzed in vivo and in vitro,” *American Journal of Orthodontics and Dentofacial Orthopedics*, vol. 157, no. 3, pp. 313–319, Mar. 2020, doi: 10.1016/j.ajodo.2019.03.028.
  - [19] D. J. Fernandes, G. M. A. Fernandes, F. Artese, C. N. Elias, and A. M. Mendes, “Force extension relaxation of medium force orthodontic latex elastics,” *The Angle Orthodontist*, vol. 81, no. 5, pp. 812–819, Sep. 2011, doi: 10.2319/120810-709.1.
  - [20] S. S. M. Al-Obaidy, G. M. Greenway, and V. N. Paunov, “Enhanced antimicrobial action of chlorhexidine loaded in shellac nanoparticles with cationic surface functionality,” *Pharmaceutics*, vol. 13, no. 9, pp. 1–15, Sep. 2021, doi: 10.3390/pharmaceutics13091389.
  - [21] A. Khaleghi, A. Ahmadvand, and S. Sadeghian, “Effect of citric acid on force decay of orthodontic elastomeric chains,” *Dental Research Journal*, vol. 18, pp. 1–7, 2021, [Online]. Available: <http://www.ncbi.nlm.nih.gov/pubmed/34322207%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC8314966>.
  - [22] R. Bescos *et al.*, “Effects of chlorhexidine mouthwash on the oral microbiome,” *Scientific Reports*, vol. 10, no. 1, p. 5254, Dec. 2020, doi: 10.1038/s41598-020-61912-4.
  - [23] S. Kohjiya and Y. Ikeda, *Chemistry, manufacture and applications of natural rubber*, 2nd ed. Cambridge: Woodhead Publishing, 2021.
  - [24] A. Basik, J.-J. Sanglier, C. Yeo, and K. Sudesh, “Microbial degradation of rubber: Actinobacteria,” *Polymers*, vol. 13, no. 12, pp. 1–27, Jun. 2021, doi: 10.3390/polym13121989.
  - [25] T. Zheng, X. Zheng, S. Zhan, J. Zhou, and S. Liao, “Study on the ozone aging mechanism of natural rubber,” *Polymer Degradation and Stability*, vol. 186, p. 109514, Apr. 2021, doi: 10.1016/j.polymdegradstab.2021.109514.
  - [26] P. Andhare, S. Datana, S. S. Agarwal, and S. S. Chopra, “Comparison of in vivo and in vitro force decay of elastomeric chains/modules: A systematic review and meta analysis,” *Journal of the World Federation of Orthodontists*, vol. 10, no. 4, pp. 155–162, Dec. 2021, doi: 10.1016/j.ejwf.2021.07.003.
  - [27] M. M. Pithon, D. A. Santana, K. H. Sousa, and I. M. A. O. Farias, “Does chlorhexidine in different formulations interfere with the force of orthodontic elastics?,” *The Angle Orthodontist*, vol. 83, no. 2, pp. 313–318, Mar. 2013, doi: 10.2319/061312-493.1.
  - [28] B. A. Ramazanzadeh, A. Jahanbin, N. Hasanzadeh, and N. Eslami, “Effect of sodium fluoride mouth rinse on elastic properties of elastomeric chains,” *Journal of Clinical Pediatric Dentistry*, vol. 34, no. 2, pp. 189–192, Dec. 2009, doi: 10.17796/jcpd.34.2.v2871152x5124142.
  - [29] A. Mirhashemi, N. Farahmand, A. Saffar Shahroudi, and M. S. Ahmad Akhoundi, “Effect of four different mouthwashes on force-degradation pattern of orthodontic elastomeric chains,” *Orthodontic Waves*, vol. 76, no. 2, pp. 67–72, Jun. 2017, doi: 10.1016/j.odw.2016.11.007.
  - [30] A. H. Mirhashemi, N. H. Khameneh, K. Shahpoorzadeh, and A. S. Shahroudi, “Comparison of force decay pattern in orthodontic elastomeric chains and NiTi closed coil springs, affected by five different mouthwashes: An in vitro Study,” *Dentistry 3000*, vol. 9, no. 1, pp. 1–11, 2021, doi: 10.5195/d3000.2021.158.

## BIOGRAPHIES OF AUTHORS







**Sri Suparwitri**    is an Associate Professor from the Universitas Gadjah Mada. She has an interest in aging in orthodontic research. She has lectured at state, national and international levels, and has published research articles in several international journals. She also an author and reviewer of several international peer reviewed papers. She can be contacted at email: [suparwitri\\_fkg@ugm.ac.id](mailto:suparwitri_fkg@ugm.ac.id).



**Niswati Fathmah Rosyida**     is an Assistant Professor from the Universitas Gadjah Mada. She is interested in the research of biomaterial, orthodontic tooth movement, orthodontic retention and relapse, and cephalometrics. She has published research articles in several international journals and has been a reviewer in several international journals. She can be contacted at email: [niswatifathmah.fkg@ugm.ac.id](mailto:niswatifathmah.fkg@ugm.ac.id).



**Ananto Ali Alhasyimi**     is an Assistant Professor from the Universitas Gadjah Mada. He has interest in orthodontic clinical research, biological tooth movement, finite element analysis, orthodontic retention and relapse research. He has lectured at state, national and international levels, and has published research articles in several international journals. He also an author and reviewer of several international peer reviewed publications about orthodontics, biomechanics and biological tooth movement. He can be contacted at email: [anantoali@ugm.ac.id](mailto:anantoali@ugm.ac.id).