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ORIGINAL RESEARCH **OPEN ACCESS**

Effect of traditional Peruvian Amazonian beverages on force degradation of orthodontic elastomeric chains: an in vitro study

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ABSTRACT

Background: Orthodontic elastomeric chains may undergo force degradation over time, and exposure to different beverages can modify their mechanical behavior. Traditional beverages from the Peruvian Amazon are widely consumed, but their effect on orthodontic elastomeric chains remains insufficiently studied. **Objective:** To compare the effect of traditional Peruvian Amazonian beverages on force degradation of two brands of orthodontic elastomeric chains. **Methods:** An experimental in vitro study was conducted using 96 gray continuous elastomeric-chain segments, including 48 Morelli® and 48 American Orthodontics® specimens. For each brand, 12 segments were assigned to Uvachado, Chuchuhuasi, 7 Raíces, or distilled water. Residual force was measured with a Dontrix dynamometer at baseline and after 1, 7, 14, and 21 days. Mann–Whitney U, Kruskal–Wallis, Friedman, and Bonferroni-adjusted post hoc tests were applied. **Results:** Both brands showed progressive force reduction over time ($p < 0.001$). In Uvachado, Morelli® decreased from 318.75 g to 158.33 g, whereas American Orthodontics® decreased from 350.00 g to 112.50 g by day 21. Significant between-brand differences were observed for Uvachado at days 7, 14, and 21 (all $p < 0.001$). **Conclusions:** Force degradation increased over time and varied according to beverage and brand. Uvachado produced the greatest force loss, particularly in American Orthodontics® chains.

Keywords: Orthodontics; Elastomers; Dental Materials; Beverages; Mechanical Properties.

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Introduction

Orthodontic tooth movement depends on the application of controlled mechanical forces capable of producing periodontal and alveolar bone remodeling. Elastomeric chains are widely used in fixed orthodontic therapy because they are simple to manipulate, cost-effective, and useful for procedures such as space closure, canine retraction, correction of rotations, and midline adjustment. However, polyurethane-based elastomeric materials do not maintain a constant force throughout use and progressively lose their mechanical effectiveness after activation [1,2]. A systematic review and meta-analysis reported that elastomeric chains may lose approximately 39% of their force within the first 24 hours in vitro and around half of their initial force after three weeks, highlighting force degradation as a clinically relevant limitation of these materials [3].

Force degradation is influenced by several material- and environment-related factors, including manufacturer, chain morphology, initial stretching, storage conditions, temperature, saliva, mechanical loading, oral hygiene products, and exposure to foods or beverages [2,4,5]. Recent experimental evidence has shown that different commercial brands may exhibit distinct patterns of force loss under otherwise similar conditions, which means that the mechanical behavior of one product cannot necessarily be extrapolated to another [2,4]. Likewise, exposure to beverages may modify the residual force of elastomeric chains, although the magnitude and direction of the effect depend on beverage composition and experimental conditions [5,6].

Dietary beverages have therefore become an important factor in laboratory investigations of orthodontic elastomers. Torres-Rosas et al. evaluated two commercial elastomeric chains exposed to Coca-Cola®, coffee, beer, and acidic artificial saliva for 21 days and found progressive force decay over time, with differences according to brand and exposure medium [5]. Blagec et al. subsequently assessed elastomeric chains exposed to beverages with different pH values and reported that force degradation varied significantly among materials and solutions, although pH alone did not explain the observed mechanical changes [6]. Similarly, Nobahari et al. showed that hot beverages produced time-dependent force loss over 28 days, with the largest decrease occurring during the first day [7]. These findings indicate that beverage-related effects are multifactorial and should not be attributed exclusively to acidity.

This issue may have particular relevance in populations where traditional beverages form part of habitual dietary practices. In the Peruvian Amazon, beverages such as Uvachado, Chuchuhuasi, and 7 Raíces are consumed as culturally rooted preparations, frequently obtained through maceration or fermentation processes and containing complex mixtures whose composition differs from that of conventional soft drinks, coffee, or other beverages previously evaluated in orthodontic materials. The thesis underlying the present study identified no published experimental evidence specifically assessing the effect of these three traditional Peruvian Amazonian beverages on orthodontic elastomeric-chain force degradation.

The absence of such evidence limits the ability to determine whether exposure to these beverages could modify the mechanical behavior of elastomeric chains during orthodontic treatment and whether different commercial brands respond similarly under the same conditions. Evaluating this interaction under controlled laboratory conditions may therefore provide material-specific evidence relevant to future clinical and experimental research, without assuming that in vitro findings directly represent intraoral behavior.

Accordingly, the objective of this study was to compare the effect of exposure to traditional Peruvian Amazonian beverages on force degradation of Morelli® and American Orthodontics® elastomeric chains at 1, 7, 14, and 21 days.

Materials and methods

Study design and setting

An experimental, prospective, longitudinal, comparative in vitro study was conducted to evaluate the effect of traditional Peruvian Amazonian beverages on the force degradation of orthodontic elastomeric chains. Two commercially available brands, Morelli® and American Orthodontics® (AO®), were evaluated under four exposure conditions and at repeated measurement times. The experimental procedures were conducted in Trujillo, Peru, after institutional ethical approval in 2025. Reporting was structured according to the principles of the Checklist for Reporting In-vitro Studies (CRIS), developed to improve transparency and reproducibility in dental laboratory research [8].

Experimental units, sample size, and sampling

The study population consisted of gray continuous orthodontic elastomeric chains from two commercial brands: Morelli® (Sorocaba, São Paulo, Brazil) and American Orthodontics® (Sheboygan, Wisconsin, USA). The experimental unit was a segment of elastomeric chain.

Sample size was calculated using a formula for comparison of means. Parameters obtained from a pilot study included a variance of 133.5 in the control group and a minimum detectable difference of 14.0. The calculation resulted in 12 repetitions for each of eight experimental groups, yielding a total sample of 96 elastomeric-chain segments. Forty-eight segments corresponded to Morelli® and 48 to American Orthodontics®. Specimens were selected using non-probability convenience sampling.

Eligibility criteria

Gray continuous elastomeric chains from Morelli® and American Orthodontics® were included when they were obtained in sealed packaging, had not previously been exposed to environmental conditions, and were within the manufacturer-specified expiration date. Segments showing visible defects after cutting or evident deformation were excluded.

Experimental groups

The 48 segments from each brand were divided into four groups of 12 according to the exposure medium: Uvachado (Maritza Medrano Valera, Tarapoto, Peru), Chuchuhuasi (Biomenat, Pucallpa, Peru), 7 Raíces (Biomenat, Pucallpa, Peru), and distilled water (Braun Medical, Lima, Peru) as the control condition. Each group was evaluated at baseline and after 1, 7, 14, and 21 days.

The traditional beverages were obtained from commercial sources after verification of sanitary registration and selection of the most recently available batch, in order to minimize prolonged storage before experimental use.

Study variables and outcome

The primary outcome was residual force of the elastomeric chains, expressed in gram-force (gf). Force degradation was defined as the progressive reduction in residual force during the experimental period. The main independent variables were exposure medium (Uvachado, Chuchuhuasi, 7 Raíces, or distilled water), elastomeric-chain brand (Morelli® or American Orthodontics®), and exposure time (baseline, 1, 7, 14, and 21 days).

Preparation of elastomeric-chain specimens

Gray continuous elastomeric chains were stored in their original packaging at room temperature until specimen preparation. Each experimental segment consisted of five complete links plus half a link at each end to compensate for potential damage associated with previous stretching or cutting, following a previously described experimental approach [9].

Transparent self-curing acrylic plates (Vitacryl) measuring approximately 12 cm in length and 11 mm in thickness were prepared to maintain the elastomeric-chain segments under standardized extension. Holes were created using a multilaminated carbide round bur, and metal pins were inserted to a depth of 7 mm. A distance of 25 mm was maintained between each pair of pins to simulate the approximate distance between a canine bracket and a tube attached to the first permanent molar. Chain segments were cut using a ligature cutter (Best Pli) and positioned on the pins with a Mathews plier (Best Pli).

Beverage exposure protocol

The acrylic plates containing the stretched elastomeric chains were placed in glass containers assigned to each experimental beverage. Specimens were immersed in the corresponding solution for 3 minutes every 12 hours throughout the experimental period. Measurements were obtained after 1, 7, 14, and 21 days of exposure. This intermittent immersion protocol was consistent with previous in vitro research evaluating beverage-related force degradation of orthodontic elastomeric chains [9].

Measurement of residual force

Residual tensile force was measured using a Dontrix orthodontic force gauge (Morelli®), which records force in gram-force. At each predetermined evaluation time, one end of the elastomeric-chain segment was attached to the force gauge and the residual force required under the standardized extension condition was recorded. Measurements were entered into a structured data collection form indicating brand, exposure medium, and evaluation time.

Because the outcome was obtained through direct physical measurement rather than a questionnaire or psychometric instrument, content validity and internal-consistency testing were not applicable.

Statistical Analysis

Data were initially processed using Microsoft Excel. Because the assumption of normality was not met, non-parametric statistical procedures were used. Residual force was summarized using means and standard deviations together with medians and interquartile ranges.

Comparisons between Morelli® and American Orthodontics® chains within each exposure medium and time point were performed using the Mann–Whitney U test. Differences among the four exposure media within each brand and measurement time were evaluated using the Kruskal–Wallis test. When overall differences were statistically significant, post hoc multiple comparisons with Bonferroni adjustment were performed. Changes in residual force over time within each experimental condition were assessed using the Friedman test. Statistical significance was established at $p < 0.05$. Values lower than 0.001 were reported as $p < 0.001$ rather than $p = 0.000$.

Ethical considerations

The study was approved by the Bioethics Committee of Universidad Privada Antenor Orrego through Resolution No. 000387-2025-UPAO. The experiment involved commercially available orthodontic materials and beverages and did not include human participants, identifiable human data, human biological samples, or experimental animals. Therefore, informed consent and the Declaration of Helsinki were not applicable to this study. The thesis reported no conflicts of interest related to the conduct of the research.

Results

A total of 96 elastomeric-chain segments were included in the analysis, comprising 48 Morelli® and 48 American Orthodontics® specimens. Residual force decreased progressively from baseline to day 21 in both brands under all four exposure conditions, with significant within-group changes over time according to the Friedman test (all $p < 0.001$).

At baseline, American Orthodontics® chains showed higher residual force than Morelli® chains under all exposure conditions ($p < 0.05$). At day 1, a significant between-brand difference was observed only for 7 Raíces ($p = 0.023$). At day 7, significant differences were identified for Uvachado ($p < 0.001$), Chuchuhuasi ($p = 0.001$), and distilled water ($p = 0.002$). At day 14, differences remained significant for Uvachado ($p < 0.001$) and Chuchuhuasi ($p = 0.031$), whereas at day 21 only Uvachado showed a significant difference between brands ($p < 0.001$) (Table 1).

For Morelli® chains, residual force differed significantly among exposure media from day 1 onward (day 1, $p = 0.001$; day 7, $p < 0.001$; day 14, $p = 0.014$; day 21, $p = 0.003$), whereas no difference was found at baseline ($p = 0.285$). At day 1, Uvachado and Chuchuhuasi were grouped together, distilled water differed from these conditions, and 7 Raíces showed an intermediate position. At day 21, the median residual force was 150.00 gf for Uvachado and Chuchuhuasi and 175.00 gf for both 7 Raíces and distilled water. Residual force changed significantly over time in every Morelli® exposure group (all $p < 0.001$) (Table 2).

For American Orthodontics® chains, no significant difference among exposure media was observed at baseline ($p = 0.790$). Significant differences were identified at every subsequent evaluation (all $p < 0.001$). Uvachado consistently showed the lowest median residual force from day 1 onward, reaching 112.50 gf at day 21, whereas Chuchuhuasi, 7 Raíces, and distilled water were grouped together in the post hoc comparisons. Force also changed significantly over time within each American Orthodontics® exposure group (all $p < 0.001$) (Table 3)

Discussion

The main finding of this study was that residual force decreased progressively over time in both Morelli® and American Orthodontics® elastomeric chains under all exposure conditions. The magnitude of this reduction varied according to beverage, brand, and evaluation time. Uvachado produced the clearest differential effect, particularly in American Orthodontics® chains, which showed substantially lower residual force than Morelli® at days 7, 14, and 21. In contrast, differences associated with Chuchuhuasi, 7 Raíces, and distilled water were less consistent across time points. These findings indicate that force degradation was not determined by exposure time alone but also by the interaction between the elastomeric material and the surrounding medium.

Table 1. Residual force of Morelli® and American Orthodontics® elastomeric chains according to exposure medium and evaluation time

Exposure medium	Brand	Baseline mean ± SD	p*	Day 1 mean ± SD	p*	Day 7 mean ± SD	p*	Day 14 mean ± SD	p*	Day 21 mean ± SD	p*	p**
Uvachado	Morelli®	318.75 ± 28.45	0.003	258.33 ± 12.31	0.660	193.75 ± 30.39	<0.001	185.42 ± 19.82	<0.001	158.33 ± 16.28	<0.001	<0.001
	AO®	350.00 ± 0.00		256.25 ± 11.31		139.58 ± 16.71		118.75 ± 11.31		112.50 ± 13.06		<0.001
Chuchuhuasi	Morelli®	314.58 ± 29.11	0.002	272.92 ± 12.87	0.546	191.67 ± 24.62	0.001	177.08 ± 27.09	0.031	147.92 ± 19.82	0.182	<0.001
	AO®	352.08 ± 7.22		275.00 ± 0.00		225.00 ± 15.08		191.67 ± 16.28		156.25 ± 18.84		<0.001
7 Raíces	Morelli®	318.75 ± 21.65	0.003	281.25 ± 15.54	0.023	220.83 ± 14.43	0.258	193.75 ± 11.31	0.705	170.83 ± 9.73	0.193	<0.001
	AO®	352.08 ± 7.22		266.67 ± 12.31		229.17 ± 20.87		193.75 ± 28.45		163.25 ± 24.72		<0.001
Distilled water	Morelli®	308.33 ± 22.19	<0.001	72.92 ± 7.22	0.317	250.00 ± 21.32	0.002	210.42 ± 34.47	0.262	168.75 ± 15.54	0.156	<0.001
	AO®	352.08 ± 7.22		275.00 ± 0.00		222.92 ± 12.87		193.75 ± 18.84		160.42 ± 16.71		<0.001

Note: Values are expressed in gram-force (gf). SD, standard deviation; AO, American Orthodontics. *Mann–Whitney U test for between-brand comparisons at each evaluation time. **Friedman test for changes over time within each experimental condition. Statistical significance was established at $p < 0.05$.

Table 2. Residual force of Morelli® elastomeric chains according to traditional beverage and evaluation time

Exposure medium	Baseline median (IQR)	Day 1 median (IQR)	Day 7 median (IQR)	Day 14 median (IQR)	Day 21 median (IQR)	p**
Uvachado	300.00 (25.0)	250.00 (25.0) A	187.50 (25.0) A	175.00 (25.0) A	150.00 (25.0) A	<0.001
Chuchuhuasi	300.00 (12.5)	275.00 (0.0) A	200.00 (25.0) A	175.00 (12.5) A	150.00 (12.5) A,B	<0.001
7 Raíces	325.00 (25.0)	275.00 (25.0) A,B	225.00 (12.5) A,B	200.00 (12.5) A	175.00 (0.0) B	<0.001
Distilled water	300.00 (0.0)	275.00 (0.0) B	250.00 (50.0) B	200.00 (62.5) B	175.00 (25.0) B	<0.001
p*	0.285	0.001	<0.001	0.014	0.003	

Note: Values are expressed in gram-force (gf). IQR, interquartile range. *Kruskal–Wallis test for comparison among exposure media at each evaluation time. **Friedman test for changes over time. Different letters within the same column indicate statistically significant differences according to Bonferroni-adjusted post hoc comparisons ($p < 0.05$).

Table 3. Residual force of American Orthodontics® elastomeric chains according to traditional beverage and evaluation time

Exposure medium	**Baseline, median (IQR)**	**Day 1 median (IQR)**	**Day 7 median (IQR)**	**Day 14 median (IQR)**	**Day 21 median (IQR)**	**p****
Uvachado	350.00 (0.0)	250.00 (12.5) A	150.00 (25.0) A	125.00 (12.5) A	112.50 (25.0) A	<0.001
Chuchuhuasi	350.00 (0.0)	275.00 (0.0) B	225.00 (0.0) B	200.00 (25.0) B	150.00 (25.0) B	<0.001
7 Raíces	350.00 (0.0)	275.00 (25.0) B	225.00 (37.5) B	187.50 (37.5) B	150.00 (37.5) B	<0.001
Distilled water	350.00 (0.0)	275.00 (0.0) B	225.00 (0.0) B	200.00 (25.0) B	150.00 (25.0) B	<0.001
p*	0.790	<0.001	<0.001	<0.001	<0.001	

Note: Values are expressed in gram-force (gf). IQR, interquartile range. *Kruskal–Wallis test for comparison among exposure media at each evaluation time. **Friedman test for changes over time. Different letters within the same column indicate statistically significant differences according to Bonferroni-adjusted post hoc comparisons ($p < 0.05$).

This progressive loss of force agrees with previous evidence showing that orthodontic elastomeric materials undergo substantial mechanical deterioration during sustained activation. Sivaraman et al. observed progressive force decay in elastomeric chains exposed to distilled water, chlorhexidine, and sesame oil over 28 days, demonstrating that both time and immersion medium can modify residual force [10]. Ebrahiminik et al. similarly reported a significant reduction in tensile strength of orthodontic elastomeric ligatures after prolonged exposure to different chemical solutions, supporting the susceptibility of polyurethane-based materials to environmental conditions [11].

The effect of environmental conditions on elastomeric properties is not limited to immersion solutions. Sharma et al. showed that storage temperature influenced the mechanical properties of nonlatex orthodontic modules [12], whereas a systematic review by Javidi et al.

concluded that mouthwash composition can affect force decay in orthodontic elastomeric chains, although the magnitude of deterioration varies considerably among studies and products [13]. Together with the present results, these findings reinforce that mechanical behavior depends on multiple interacting factors rather than on time alone.

The marked reduction observed under Uvachado exposure, especially in American Orthodontics® chains, should be interpreted cautiously. The chemical characteristics of Uvachado were not experimentally measured in this study; therefore, the observed effect cannot be attributed specifically to acidity, alcohol content, fermentation products, or any single component. Contemporary reviews of orthodontic materials indicate that the oral environment can alter physical and mechanical properties through factors such as moisture, temperature, chemical exposure, and changes in material structure [14]. Accordingly, the present findings demonstrate an association between exposure medium and force degradation under the tested conditions, but they do not identify the chemical mechanism responsible for that effect.

The between-brand differences are also consistent with previous experimental evidence. Mousavi et al. found significant differences in initial force, residual force, and force decay among commercial elastomeric-chain brands and demonstrated that American Orthodontics products could show greater force loss than other brands under certain elongation conditions [15]. This supports the observation that manufacturer-related material composition and chain characteristics may influence mechanical performance. However, the present study did not analyze polymer composition, manufacturing process, cross-link density, or exact formulation; therefore, the observed differences between Morelli® and American Orthodontics® should be interpreted as product-specific behavior rather than as evidence of a defined material mechanism.

More broadly, the deterioration of force observed in both brands is consistent with the behavior of orthodontic elastomeric materials described in systematic evidence. Saccomanno et al. reported that intraoral orthodontic elastics and related elastomeric materials undergo loss of strength and elasticity during use, with the rate of deterioration influenced by material characteristics and exposure conditions [16]. Although intraoral elastics are not identical to elastomeric power chains, both are polymer-based orthodontic force-delivery systems whose mechanical stability may decrease over time.

The clinical relevance of this phenomenon lies in the need to maintain an adequate force system during orthodontic space closure. Badran et al. showed in a randomized clinical trial that elastomeric power chains remain clinically useful for space closure, although their biomechanical performance differs from that of nickel-titanium closed-coil springs [17]. The present in vitro findings do not establish that consumption of Uvachado, Chuchuhuasi, or 7 Raíces will necessarily alter treatment outcomes in patients, but they suggest that repeated exposure to certain beverages may contribute to differences in residual force and should therefore be investigated under clinically representative conditions.

The cultural context of the beverages evaluated also distinguishes this study from most previous research on soft drinks, coffee, beer, mouthwashes, or laboratory solutions. Traditional fermented beverages form part of food practices in different Peruvian populations. Rebaza-Cardenas et al. characterized two traditional Peruvian fermented beverages and demonstrated the microbiological complexity associated with fermentation processes [18]. Likewise, Bussalleu et al. documented the cultural relevance of the fermented beverage masato in a Peruvian Amazonian community [19]. These studies do not provide direct information on the composition of Uvachado, Chuchuhuasi, or 7 Raíces, but they support the broader relevance of studying traditional beverages as locally meaningful exposure media rather than assuming that findings from commercial beverages are directly transferable to Amazonian dietary practices.

An important aspect of the present results is that distilled water also produced progressive force reduction. This confirms that part of the degradation is inherent to the elastomeric material under sustained stretching and aging rather than being exclusively caused by the traditional beverages. Therefore, the beverage effect should be interpreted relative to the control condition and not as the sole explanation for force loss. The significant temporal changes observed in all groups support this distinction.

From a clinical perspective, elastomeric chains are routinely used during orthodontic space closure, and clinical studies continue to demonstrate their effectiveness as force-delivery systems. Le et al. reported comparable root resorption and alveolar bone changes between elastomeric chains and nickel-titanium closed-coil springs during canine retraction [20]. Nevertheless, clinical performance depends on maintaining an appropriate force system, and the present findings suggest that environmental exposure could modify

residual force differently according to the chain brand. These results should therefore be regarded as preliminary biomechanical evidence rather than as a basis for recommending avoidance of specific beverages or shortening clinical replacement intervals. Such recommendations would require confirmation in vivo.

Among the strengths of this study were the standardized comparison of two commercially available elastomeric-chain brands, the inclusion of a distilled-water control, the evaluation of three traditional Peruvian Amazonian beverages, the use of 12 experimental units per brand–beverage condition, and repeated measurements extending to 21 days. The use of the same stretching distance and standardized immersion schedule also improved comparability among experimental groups. Furthermore, the statistical analysis incorporated non-parametric procedures appropriate to the distribution of the data and distinguished between comparisons among brands, beverages, and repeated measurements over time.

Several limitations should be acknowledged. First, the in vitro design did not reproduce the full complexity of the oral environment, including saliva, thermal fluctuations, mastication, oral microbiota, enzymatic activity, and intermittent dietary exposure. Second, only two elastomeric-chain brands and one chain configuration were evaluated, limiting extrapolation to other commercially available products. Third, the pH, alcohol concentration, sugar content, titratable acidity, and chemical composition of Uvachado, Chuchuhuasi, and 7 Raíces were not measured; consequently, no specific component can be identified as responsible for the observed changes. Fourth, force was measured with a Dontrix dynamometer rather than a universal testing machine, and the thesis did not report a formal repeatability assessment of the measurement process. Finally, the experiment evaluated mechanical behavior only up to 21 days and did not assess other material properties such as permanent deformation, elongation, surface changes, or polymer degradation.

Future studies should evaluate a broader range of elastomeric-chain brands and configurations, characterize the physicochemical properties of the traditional beverages, and determine whether pH, ethanol concentration, sugars, or other constituents are associated with force degradation. Experimental models incorporating artificial saliva, thermocycling, temperature variation, and mechanical loading would provide a closer approximation to intraoral conditions. Ultimately, in vivo studies are required to determine whether the differences observed under laboratory conditions translate into clinically meaningful changes in orthodontic force delivery, treatment efficiency, or recommended replacement intervals.

Conclusions

Exposure to traditional Peruvian Amazonian beverages was associated with progressive force degradation of both Morelli® and American Orthodontics® elastomeric chains over the 21-day experimental period. The magnitude of force loss varied according to beverage, brand, and exposure time. Uvachado produced the most pronounced degradation pattern in American Orthodontics® chains, whereas Morelli® chains showed lower residual forces particularly after exposure to Uvachado and Chuchuhuasi. These findings indicate that the mechanical stability of orthodontic elastomeric chains may respond differently to beverage exposure depending on the commercial brand under in vitro conditions.

Author Contributions Statement (CrediT)

CNAM: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Visualization, Supervision, Project Administration, and Validation. **CGGR:** Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Visualization, Supervision, Project Administration, and Validation. All authors reviewed and approved the final version of the manuscript.

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Conflict of Interest

The author declares no financial, institutional, professional, or personal conflicts of interest that could have influenced the conduct or publication of this study.

Data Availability

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

References

[1] Thakur SM, Shenoy U, Hazare A, Karia H, Khorgade PR, Nandeshwar N, et al. Evaluation and comparison of force degradation levels between elastomeric chains and active tiebacks with elastic modules during individual canine retraction. Cureus. 2024;16(9):e69110. https://doi.org/10.7759/cureus.69110

[2] Silva Chaves-Filho ACD, Costa AR, Borges LPS, Santos ECA, Crepaldi MV, Vedovello SAS, et al. Force degradation of elastomeric chains after storage time and mechanical brushing. Braz Dent J. 2021;32(4):55-61. https://doi.org/10.1590/0103-6440202104487

[3] Andhare P, Datana S, Agarwal SS, Chopra SS. Comparison of in vivo and in vitro force decay of elastomeric chains/modules: a systematic review and meta analysis. J World Fed Orthod. 2021;10(4):155-162. https://doi.org/10.1016/j.ejwf.2021.07.003

[4] Virdi GK, Prashar A, Kaur G, Jabbal RS, Aggarwal P, Budh S, et al. Force decay behavior of orthodontic elastomeric chains in simulated oral conditions. Cureus. 2024;16(9):e69908. https://doi.org/10.7759/cureus.69908

[5] Torres-Rosas R, Torres-Gómez N, Camero-Leal JA, Jurado C, López-Ravelo H, Argueta-Figueroa L. Force decay and elongation of orthodontic elastomeric chains exposed to different beverages common in the diet: an in vitro study. Dent Med Probl. 2023;60(3):413-420. https://doi.org/10.17219/dmp/148052

[6] Blagec T, Šimunović L, Pili Gjumlić S, Šutej I, Meštrović S. Influence of pH levels and beverage exposure on force decay and color stability of orthodontic elastomeric chains: an experimental study. Saudi Dent J. 2024;36(2):308-314. https://doi.org/10.1016/j.sdentj.2023.11.008

[7] Nobahari M, Safari F, Geramy A, Hooshmand T, Kharazifard MJ, Arab S. Effect of three common hot beverages on the force decay of orthodontic elastomeric chain within a 28-day period: an in vitro study. Korean J Orthod. 2024;54(3):153-159. https://doi.org/10.4041/kjod23.160

[8] Krithikadatta J, Gopikrishna V, Datta M. CRIS Guidelines (Checklist for Reporting In-vitro Studies): a concept note on the need for standardized guidelines for improving quality and transparency in reporting in-vitro studies in experimental dental research. J Conserv Dent. 2014;17(4):301-304. https://doi.org/10.4103/0972-0707.136338

[9] Dehghani M, Alavian N, Noori N, Omidkhoda M. The effect of different soft drinks on the force degradation of conventional and memory orthodontic elastic chains: an in-vitro study. Front Dent. 2023;20:29. https://doi.org/10.18502/fid.v20i29.13347

[10] Sivaraman K, UB R, Prabu N, Deepak A, T N, Sreedharan A. Effects of oil pulling and chlorhexidine mouth rinse on the force decay of orthodontic elastomeric chains: a comparative in vitro study. Cureus. 2024;16(2):e53456. https://doi.org/10.7759/cureus.53456

[11] Ebrahiminik Z, Zanganeh M, Salari B, Fadaee N, Mirshahpanah M. In vitro comparison of the tensile strength of elastomeric ligatures exposed to povidone iodine 1%, chlorhexidine 0.02%, and hydrogen peroxide 5%. Int Orthod. 2021;19(4):685-688. https://doi.org/10.1016/j.ortho.2021.09.009

[12] Sharma S, Singh AK, Batra P, Arora N, Kannan S. Effects of different storage temperatures on the properties of nonlatex orthodontic modules. Indian J Dent Res. 2022;33(4):350-355. https://doi.org/10.4103/ijdr.ijdr_453_22

[13] Javidi P, Bashardoust N, Shekarbaghani A. Evaluation of force decay rate in orthodontic elastomeric chains in the environment of various mouthwashes: a systematic review. Dent Res J (Isfahan). 2023;20:39. PMID: 37180681. https://pubmed.ncbi.nlm.nih.gov/37180681/

[14] Selvaraj M, Mohaideen K, Sennimalai K, Gothankar GS, Arora G. Effect of oral environment on contemporary orthodontic materials and its clinical implications. J Orthod Sci. 2023;12:1. https://doi.org/10.4103/jos.jos_73_22

[15] Mousavi SM, Mahboobi S, Rakhshan V. Effects of different stretching extents, morphologies, and brands on initial force and force decay of orthodontic elastomeric chains: an in vitro study. Dent Res J (Isfahan). 2020;17(5):326-337. https://doi.org/10.4103/1735-3327.294331

[16] Saccomanno S, Quinzi V, Paskay LC, Caccone L, Rasicci L, Fani E, et al. Evaluation of the loss of strength, resistance, and elasticity in the different types of intraoral orthodontic elastics (IOE): a systematic review of the literature of in vitro studies. J Pers Med. 2023;13(10):1495. https://doi.org/10.3390/jpm13101495

[17] Badran SA, Al-Zaben JM, Al-Taie LM, Tbeishi H, Al-Omiri MK. Comparing patient-centered outcomes and efficiency of space closure between nickel-titanium closed-coil springs and elastomeric power chains during orthodontic treatment. Angle Orthod. 2022;92(4):471-477. https://doi.org/10.2319/120721-906

[18] Rebaza-Cardenas TD, Silva-Cajaleón K, Sabater C, Delgado S, Montes-Villanueva ND, Ruas-Madiedo P. "Masato de Yuca" and "Chicha de Siete Semillas" two traditional vegetable fermented beverages from Peru as source for the isolation of potential probiotic bacteria. Probiotics Antimicrob Proteins. 2023;15(2):300-311. https://doi.org/10.1007/s12602-021-09836-x

[19] Bussalleu A, Di-Liberto A, Carcamo C, Carrasco-Escobar G, Zavaleta-Cortijo C, King M, et al. Cultural values and the coliform bacterial load of "Masato," an Amazon Indigenous beverage. Ecohealth. 2020;17(3):370-380. https://doi.org/10.1007/s10393-020-01498-5

[20] Le LN, Ma HN, Do TT, Le KVP. Root resorption and alveolar bone changes in the maxillary canine retraction using NiTi closed-coil springs versus elastomeric chains: a split-mouth trial. J Int Soc Prev Community Dent. 2024;14(4):339-348. https://doi.org/10.4103/jispcd.jispcd_5_24