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EFFECT OF ALCOHOLIC AND ENERGY DRINKS ON THE SHEAR BOND STRENGTH OF ORTHODONTIC BRACKETS: PROPOSED GUIDELINES

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Abstract

Background. Bracket bond failure is a common challenge in orthodontic practice that may prolong treatment duration and increase clinical workload. Hence, this study aimed to evaluate the effect of alcoholic and energy drinks on the shear bond strength (SBS) of orthodontic brackets bonded to bovine enamel.

Methods. An in vitro experimental design was conducted using sixty bovine teeth randomly assigned into three groups ($n = 20$): artificial saliva (control), alcoholic beverage (San Miguel Pale Pilsen, 5% ABV), and energy drink (Cobra). The teeth were bonded with Optimus Metal Twin Brackets using the Ormco Enlight Light-Cure Adhesive System after surface etching with 37% phosphoric acid for 30 seconds. All specimens were stored in artificial saliva at 37°C between immersion cycles to simulate intraoral conditions. Samples underwent cyclic immersion four times daily for five minutes over 21 days. SBS was measured using a Universal Testing Machine (Instron 4467), and data were analyzed using One-Way Analysis of Variance (ANOVA) and Tukey's post-hoc test at a 0.05 level of significance.

Results. Significant differences in SBS were found among the groups ($p < .001$). The artificial saliva group demonstrated the highest mean SBS (6.65 ± 0.29 MPa; 95% CI: 6.51–6.78), followed by the alcoholic beverage group (4.99 ± 0.19 MPa; 95% CI: 4.90–5.08), representing a 25.0% reduction compared to the control. The energy drink group exhibited the lowest mean SBS (3.88 ± 0.11 MPa; 95% CI: 3.83–3.93), representing a 41.6% reduction compared to the control. One-Way ANOVA confirmed a statistically significant difference among groups, $F\,(2,57) = 895.71$, $p < .001$. Post-hoc pairwise comparisons confirmed that all groups differed significantly from each other ($p < .001$), with a very large effect size ($\eta_p^2 = 0.969$). The mean SBS values for the alcoholic (4.99 MPa) and energy drink (3.88 MPa) groups fell below the clinically acceptable threshold of 5.9–7.9 MPa, indicating an increased risk of clinical bracket failure.

Conclusion. Alcoholic and energy drinks significantly reduce the shear bond strength of orthodontic brackets and may increase the risk of bracket debonding during treatment. These findings underscore the importance of targeted dietary counseling, advising patients to limit the consumption of both beverages to minimize treatment interruptions, clinical visits, and bracket failure. Further studies using different beverages, bracket materials, and in vivo conditions are recommended.

Keywords: *alcoholic beverages; bracket debonding; energy drinks; orthodontic brackets; orthodontic materials; shear bond strength.*

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Research Highlights

What is the current knowledge?

- Bracket bond failure is a frequent clinical challenge that prolongs treatment duration and increases clinical workload.
- Acidic beverages, including cola and energy drinks, may reduce bond strength by approximately 30–40%, while alcoholic solutions with high ethanol content can result in reductions exceeding 40%.
- The shear bond strength (SBS) of orthodontic brackets is a critical parameter for clinical success, with a minimum range of approximately 5.9 to 7.9 MPa considered clinically acceptable.
- Previous studies have largely focused on international beverage brands, with limited investigation of locally consumed Filipino beverages.

What is new in this study?

- This study provides localized evidence on the effects of commonly consumed Filipino beverages (an alcoholic beverage and an energy drinks) on orthodontic bracket shear bond strength.
- The research employs a controlled in vitro model with cyclic immersion over 21 days, simulating real-life consumption frequency.
- The findings demonstrate that energy drinks produce a greater reduction in shear bond strength (41.6%) compared to alcoholic beverages (25.0%), providing clinically actionable evidence for patient counseling.
- The study develops evidence-based proposed clinical guidelines for orthodontic patients and practitioners in the Philippine setting.

INTRODUCTION

Orthodontic treatment relies heavily on the successful bonding of brackets to enamel, as adequate shear bond strength (SBS) ensures stable appliance performance and consistent force transmission while still allowing safe bracket removal without enamel damage (Mandall et al., 2018; Emms & Brierley, 2025). Bracket bond failure remains a frequent clinical challenge that directly affects treatment efficiency, extends treatment duration, and increases clinical workload. The researcher's clinical observations of repeated bracket detachments requiring additional rebonding appointments served as the primary motivation for this study.

One significant factor that affects adhesive stability is exposure to various beverages. Numerous studies indicate that acidic, sugary, and alcoholic drinks can chemically degrade orthodontic adhesives and reduce SBS (Sultan et al., 2023; Šimunović et al., 2022; Madrid-Troconis et al., 2025). Acidic beverages, including cola and energy drinks, may reduce bond strength by approximately 30-40% (Sajadi et al., 2014; Iosif et al., 2022; Fusco et al., 2021), while alcoholic solutions with high ethanol content can result in reductions exceeding 40% (Singh et al., 2018; Palani Swamy et al., 2018).

In the Philippines, energy drinks are widely consumed, particularly among youth aged 13 to 35, who constitute approximately 65% of consumers according to the Philippine Food and Drug Administration. This consumption is primarily driven by academic pressures, as a large number of university students use these beverages to cope with study demands and exams (Zidan et al., 2024). Alcohol consumption is also a significant part of Filipino culture, especially during social gatherings and celebrations (Yandug et al., 2023). A 2021 Department of Health survey found that 40.1% of Filipino adults reported past 30-day alcohol use (Department of Health, 2021). Despite this high consumption, the impact of popular Filipino alcoholic beverages and energy drinks on orthodontic bracket SBS has not been extensively investigated.

The beverages included in this study—representative alcoholic beverage and energy drink—were selected based on their high popularity and frequent consumption among Filipinos, particularly adolescents and young adults who commonly undergo orthodontic treatment. Both beverages possess chemical properties that may compromise orthodontic bracket adhesion: alcoholic beverages contain ethanol that may weaken resin materials, whereas energy drinks are acidic and high in sugar content, potentially reducing shear bond strength.

This paper is structured as follows: the methodology section details the experimental design, sample, instruments, and procedures employed; the results section presents the objective findings; the discussion interprets these findings in relation to existing literature; and the conclusion offers clinical recommendations and directions for future research.

LITERATURE REVIEW

Orthodontic Brackets and Adhesive Systems

Orthodontic brackets are key components of fixed orthodontic appliances and are available in various designs and materials to facilitate controlled orthodontic tooth movement (Mundhada et al., 2023). Brackets are available in various types depending on clinical needs and aesthetic considerations, including non-self-ligating metal brackets, self-ligating brackets, hybrid brackets combining ceramic and metal components, and tooth-colored brackets constructed from ceramic, glass, or composite materials (Koaban et al., 2025). The effectiveness of orthodontic treatment depends not only on the brackets but also on the adhesive that secures them to the teeth. Resin-modified glass ionomer cement (RMGI) and composite resin are the most common options for bonding orthodontic brackets (Subramanian et al., 2025). During bonding, resin tags penetrate the etched enamel surface, which are crucial for micromechanical retention (Bhandari et al., 2019; Sahu et al., 2024). The quality of this micromechanical interlocking directly influences the bond strength and longevity of the bracket-enamel interface (Emms & Brierley, 2025).

Shear Bond Strength and Clinical Acceptability

In dentistry, shear bond strength (SBS) refers to the maximum force an adhesive connection can sustain without failure (EL-Awady et al., 2024). Bond failures remain one of the most significant challenges in orthodontic practice. A recent systematic review and meta-analysis of randomized controlled trials reported bracket failure rates ranging from 5.95% to 15.0% for resin-modified glass ionomer cement and 3.4% to 25.0% for conventional resin adhesives (Sevindik et al., 2026).

A minimum range of approximately 5.9 to 7.9 MPa is generally considered clinically acceptable based on the seminal work of Reynolds (1975), and this threshold has been widely adopted in subsequent research (Cruz et al., 2021). Maintaining SBS within this range ensures that brackets can withstand masticatory and orthodontic forces without frequent debonding, which would otherwise prolong treatment and increase patient visits. Factors influencing SBS include adhesive type, curing method, enamel surface preparation, and environmental conditions such as moisture contamination and thermal cycling (Mandall et al., 2018; Subramanian et al., 2025).

Effects of Acidic Beverages on Bond Strength

Numerous studies have established the detrimental effects of acidic beverages on orthodontic bond strength. The primary degradation mechanism involves hydrolytic degradation of the resin matrix, wherein acidic solutions break ester bonds in the Bis-GMA polymer network, leading to the leaching of unreacted monomers and filler particles (Fusco et al., 2021). Simultaneously, enamel demineralization occurs through the formation of soluble calcium complexes, creating a weak boundary layer at the enamel surface that reduces mechanical interlocking (Iosif et al., 2022; Madrid-Troconis et al., 2025). This dual action—resin degradation and enamel erosion—synergistically compromises the bracket-adhesive-enamel complex.

Iosif et al. (2022) demonstrated that Red Bull energy drink significantly reduced SBS through acidic erosion, with reductions ranging from 30% to 40% after 14 days of cyclic immersion. Similarly, Fusco et al. (2021) found that Red Bull compromised bracket integrity through both surface softening and subsurface degradation. Sajadi et al. (2014) reported that acidic soft drinks could reduce bond strength by approximately 30–40%, with the most pronounced effects observed in beverages with pH values below 4.0. Sultan et al. (2023) further confirmed the pH-dependent effects of various beverages on adhesive integrity, demonstrating that beverages with higher acidity and sugar content produced greater reductions in SBS.

Energy drinks, in particular, pose a significant risk due to their low pH (typically 2.5–3.5) and high sugar content, which promotes both direct chemical degradation and secondary bacterial acid production (Šimunović et al., 2022). The cyclic consumption pattern typical of energy drink users—frequent sipping over extended periods—increases the cumulative exposure time and exacerbates the degradation process (Zidan et al., 2024). In the Philippine context, Cobra Energy Drink is one of the most popular brands among students and young professionals, yet no studies have evaluated its specific effects on orthodontic bond strength.

The Philippine Context and Research Gap

In the Philippines, energy drink consumption has been reported among university students and young adults, with academic demands and the need to maintain alertness identified as important reasons for consumption (Zidan et al., 2024). Alcohol consumption is also a significant part of Filipino social practices, particularly during gatherings and celebrations (Yandug et al., 2023). Despite the reported consumption of these beverages, their potential effects on orthodontic bracket shear bond strength have not been extensively investigated in the Philippine setting.

Despite this level of consumption and the established global evidence on the effects of beverages on orthodontic bond strength, limited research has specifically investigated the effects of commonly consumed alcoholic and energy beverages on orthodontic bracket SBS in the Philippine setting. Most previous research has focused on internationally available beverages, leaving a gap in localized evidence relevant to the Filipino population. Furthermore, the comparative effects of alcoholic and energy beverages on orthodontic bracket bond strength have not been extensively evaluated under controlled conditions simulating repeated exposure. This study addresses these gaps by: (1) evaluating the effects of an alcoholic beverage and an energy drink on orthodontic bracket SBS; (2) comparing the magnitude of SBS reduction between alcoholic and energy beverages; (3) employing a cyclic immersion protocol to simulate repeated daily exposure; and (4) providing evidence-based considerations for dietary counseling of orthodontic patients in the Philippine setting.

METHODOLOGY

Design

This study adopted quantitative experimental research specifically a post-test randomized controlled in vitro design. The independent variable was the type of beverage—alcoholic beverage (5% ABV), energy drink, or artificial saliva (control). The dependent variable was the shear bond strength (SBS), measured in megapascals (MPa). Conducting the study in vitro ensured that differences in shear bond strength could be attributed solely to the type of beverage exposure, as all other conditions were strictly controlled.

Environment

The study was conducted at an accredited research institution equipped with a Universal Testing Machine (Instron 4467) and a thermostatically controlled incubator, from April to August 2025. All experimental procedures were conducted in compliance with institutional biosafety and laboratory safety regulations (BSL-2 protocols). The selection of this facility was based on the availability of specialized equipment necessary for shear bond strength testing and the capacity to maintain controlled environmental conditions throughout the experimental period.

Data Sources

The beverages selected for this study were chosen as representative alcoholic and energy beverages based on reported consumption patterns in the Philippine setting. A commercially available alcoholic beverage containing 5% alcohol by volume (ABV) was used as the representative alcoholic test medium, while a commercially available energy drink was used as the representative energy-drink test medium. The pH of each beverage was measured daily using a calibrated digital pH meter, with mean values of pH 4.2 ± 0.1 for the alcoholic beverage and pH 3.2 ± 0.1 for the energy drink.

The sample size was based on a large effect size reported by Oncag et al. (2005), with a significance level of $\alpha = .05$, a desired statistical power of 90%, and three experimental groups. A total of 60 bovine teeth were used, with 20 specimens allocated to each group. Bovine teeth were selected because of their similarity to human enamel in terms of chemical composition, hardness, and surface characteristics, making them an acceptable substitute for human enamel in in vitro adhesive research (Santos et al., 2018).

All bonding procedures were performed by a single operator using a standardized protocol, including an etching time of 30 seconds, rinsing time of 15 seconds, air-drying time of 5 seconds, primer application for 3 seconds, curing time of 40 seconds per bracket, and curing light intensity of 1000–1200 mW/cm².

Shear bond strength (SBS) testing was performed using a Universal Testing Machine (Instron 4467) with a 100-N load cell, a constant crosshead speed of 1 mm/min, and a chisel-edge rod with a 1-mm radius. The exposure protocol consisted of 4 daily immersion cycles of 5 minutes each over 21 consecutive days. Following each immersion cycle, the specimens were rinsed and stored in artificial saliva at 37 °C until the next exposure. This protocol was adapted from previously published in vitro studies using repeated beverage exposure and immersion periods of approximately 14–21 days (Santos et al., 2018).

Data Analysis

Descriptive statistics (mean, standard deviation) were computed for each group. Normality was assessed using the Kolmogorov–Smirnov test (D = 0.114, p = 0.052) and homogeneity of variances using Levene's test F (2,57) = 4.475, p = .016). One-Way Analysis of Variance (ANOVA) was performed to determine significant differences among the three groups, followed by Tukey's post-hoc test for pairwise comparisons. A significance level of $p < 0.05$ was set for all statistical tests. All analyses were performed using IBM SPSS Statistics version 23 for Windows.

Ethical Considerations

Ethical approval was obtained from the Institutional Biosafety Committee of the researchers' institution prior to the commencement of the experiment (Protocol No. [BLINDED] - 2025-014, Date: March 15, 2025). As this was an in vitro study using extracted bovine teeth obtained from abattoirs (by-products of the food industry), no human participants were involved, and informed consent was not required. All experimental procedures were conducted in compliance with institutional biosafety and laboratory safety regulations.

RESULTS

A total of 60 bovine teeth specimens were randomly allocated into three groups (n = 20 per group): artificial saliva (control), alcoholic beverage (5% ABV), and energy drink. All specimens completed the 21-day immersion protocol and were successfully tested for shear bond strength (SBS).

Table 1 presents the standardized baseline reference value and the mean SBS values after 21 days of cyclic immersion for each group. The control group demonstrated the highest mean SBS (6.65 ± 0.29 MPa), followed by the alcoholic beverage group (4.99 ± 0.19 MPa), while the energy drink group exhibited the lowest mean SBS (3.88 ± 0.11 MPa). Relative to the control group, the alcoholic beverage group showed a 25.0% reduction in SBS, while the energy drink group showed a 41.6% reduction.

Table 1.

Average Shear Bond Strength (MPa) at Baseline and After 21 Days of Immersion

Immersion Media	n	Shear Bond Strength	
		Baseline (MPa)	After Immersion (MPa)
Artificial Saliva	20	6.62 ± 0.11	6.65 ± 0.29
SM Pale Pilsen 5%	20	6.62 ± 0.11	4.99 ± 0.19
Cobra Energy Drink	20	6.62 ± 0.11	3.88 ± 0.11

Note. *The baseline value represents a standardized reference value and was not obtained from pre-immersion testing of the same specimens because shear bond strength testing is destructive.*

Prior to conducting parametric tests, normality was assessed using the Kolmogorov–Smirnov test ($D = 0.114$, $p = .052$), indicating that the data met the assumption of normal distribution. Homogeneity of variances was assessed using Levene's test F (2,57) = 4.475, $p = .016$), indicating that the assumption of homogeneity was violated; however, ANOVA is considered robust to violations when sample sizes are equal ($n = 20$ per group).

A One-Way Analysis of Variance (ANOVA) was conducted to determine whether there were significant differences in shear bond strength among the three immersion groups. The results, presented in Table 2, revealed a statistically significant effect of immersion media on SBS, $F(2,57) = 895.71$, $p < 0.001$, $\eta p^2 = 0.969$.

Table 2.

One-Way ANOVA for Shear Bond Strength after Immersion

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value	Partial Eta Squared
Immersion Media	77.48	2	38.74	895.71	<.001	.969
Error	2.47	57	.043			
Total	79.94	59				

Note: CI = confidence interval. All comparisons were statistically significant at p < 0.001. Mean difference = difference between group means.

Following the significant ANOVA result, Tukey's Honestly Significant Difference (HSD) post hoc test was conducted to determine which pairs of immersion groups differed significantly in shear bond strength. The results are presented in Table 3.

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Table 3 presents the pairwise comparisons among the three immersion groups. All pairwise comparisons were statistically significant ($p < .001$). The mean difference between the artificial saliva and energy drink groups was the largest (2.77 MPa), followed by the artificial saliva and alcoholic beverage groups (1.66 MPa), and the alcoholic beverage and energy drink groups (1.11 MPa). All 95% confidence intervals for the mean differences did not cross zero, confirming the statistical significance of all pairwise comparisons.

Table 3.

Tukey's Post-Hoc Test for Pairwise Comparisons of Shear Bond Strength

Immersion Media	Mean Difference	*p*-value	95% CI of the Mean Difference	
			Lower Bound	Upper Bound
Artificial Saliva vs Alcoholic Beverage	1.66	.000	1.50	1.81
Artificial Saliva vs Energy Drink	2.77	.000	2.61	2.92
Alcoholic Beverage vs Energy Drink	1.11	.000	0.95	1.27

Note: CI = confidence interval. All comparisons were statistically significant at $p < 0.001$. Mean difference = difference between group means.

Figure 1.

Mean Shear Bond Strength across the Three Groups After 21 Days of Cyclic Immersion.

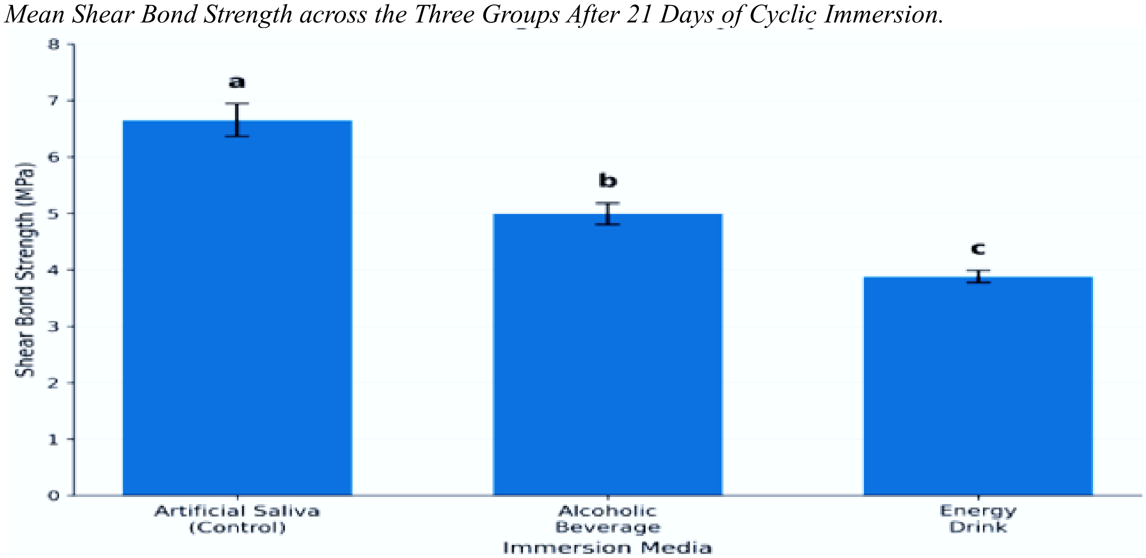

Figure 1. Mean Shear Bond Strength (MPa) of Orthodontic Brackets After 21 Days of Cyclic Immersion. Error bars represent standard deviations (SD). Bars labeled with different letters (a, b, c) indicate statistically significant differences at $p < 0.001$ (Tukey's HSD post-hoc test).

DISCUSSION

The present study investigated the effect of an alcoholic beverage and an energy drink on the shear bond strength (SBS) of orthodontic brackets bonded with the Ormco Enlight Light-Cure Adhesive System. The findings demonstrated statistically significant differences among the three immersion groups. Specimens immersed in artificial saliva exhibited the highest mean SBS (6.65 ± 0.29 MPa), followed by the alcoholic beverage group (4.99 ± 0.19 MPa), whereas the energy drink group showed the lowest SBS (3.88 ± 0.11 MPa). Relative to the artificial saliva group, SBS was reduced by 25.0% following alcoholic beverage exposure and by 41.6% following energy drink exposure. These findings indicate that, under the conditions of this in vitro study, both beverage types adversely affected bracket bond strength, with the energy drink producing the greatest reduction.

The higher SBS observed in the artificial saliva group was expected because artificial saliva provides a relatively controlled aqueous environment without the acidic and alcoholic components present in the test beverages. Artificial saliva is commonly used as a control medium in in vitro orthodontic studies because it provides a standardized environment for evaluating changes in adhesive performance. The mean SBS of 6.65 MPa observed after immersion remained within the range commonly cited as clinically acceptable for orthodontic bracket adhesion, supporting satisfactory bond performance under the control conditions.

The reduction in SBS following exposure to the alcoholic beverage is consistent with previous investigations demonstrating that ethanol-containing environments can adversely affect resin-based materials. Kazak et al. (2020) reported that ethanol may penetrate the resin matrix and cause plasticization of polymer chains, thereby reducing the mechanical properties of resin materials. Similarly, Tanthanuch et al. (2022) demonstrated that alcoholic beverages can decrease the hardness of resin composites and contribute to surface degradation. However, Vorachart et al. (2022) reported minimal changes in SBS following beer exposure. Differences in beverage composition, alcohol concentration, adhesive materials, exposure duration, and testing methodology may account for the variation between their findings and those of the present study. The present results therefore suggest that repeated exposure to an alcoholic beverage may contribute to reduced orthodontic bracket bond strength under the experimental conditions used.

The greatest reduction in SBS was observed in the energy drink group. This finding is consistent with previous studies reporting that acidic beverages can adversely affect orthodontic adhesive systems. Iosif et al. (2022) demonstrated that acidic energy drinks can contribute to enamel demineralization and weakening of the adhesive interface, resulting in reduced bracket bond strength. Likewise, Fusco et al. (2021) reported a significant reduction in orthodontic bracket adhesion following exposure to an energy drink. The greater reduction observed in the present study may be related to the acidic nature of the energy drink and its potential to promote chemical degradation at the enamel–adhesive interface. Under the conditions tested, the energy drink therefore produced a greater reduction in SBS than the alcoholic beverage.

The findings are also consistent with the Material Degradation Theory, which served as the theoretical foundation of this investigation. According to this theory, exposure to chemical agents may alter the structure and mechanical properties of polymer-based materials. Acidic environments may promote degradation at the material interface, while ethanol may contribute to plasticization and changes in the resin matrix. These chemical effects may reduce the mechanical integrity of the adhesive system and consequently decrease bracket bond strength. The progressive reduction in SBS observed from the artificial saliva group to the alcoholic beverage group and then to the energy drink group is consistent with the proposed role of chemical exposure in material degradation.

From a clinical perspective, the findings support the importance of dietary counseling during orthodontic treatment. Frequent consumption of energy drinks and alcoholic beverages may contribute to reduced bracket bond strength and may increase the risk of bracket debonding. Bracket failure can result in additional clinical appointments and may contribute to prolonged treatment. Therefore, orthodontists may consider advising patients to limit frequent consumption of these beverages during orthodontic treatment, particularly when repeated exposure is expected.

The study possesses several strengths. First, the experimental procedures were standardized through the use of bovine teeth, a single adhesive system, the same bracket type, a standardized immersion protocol, and controlled laboratory conditions. Second, the use of a Universal Testing Machine (Instron 4467) with standardized testing parameters provided consistent measurement of shear bond strength. Third, the study provides evidence from a controlled experimental model using beverage types relevant to the Philippine setting, thereby contributing to the limited local evidence concerning beverage exposure and orthodontic bracket bond strength.

Despite these strengths, several limitations should be acknowledged. As an in vitro study, the experimental conditions could not fully reproduce the complex oral environment, including salivary buffering capacity, pellicle formation, temperature fluctuations, masticatory forces, biofilm formation, and individual drinking behaviors. Furthermore, only one orthodontic adhesive system, one bracket design, and two beverage types were evaluated. Therefore, the findings should not be generalized to other adhesive systems, orthodontic materials, beverage formulations, or clinical conditions without further investigation. In addition, the standardized immersion protocol does not represent the full variability of beverage consumption patterns in daily life.

Overall, this study provides evidence that repeated exposure to an alcoholic beverage and an energy drink was associated with reduced orthodontic bracket SBS under the tested in vitro conditions, with the energy drink producing the greater reduction. The findings provide a basis for dietary counseling regarding frequent consumption of these beverages during orthodontic treatment. Further research using different adhesive systems and bracket materials, as well as thermocycling and in vivo clinical conditions, is warranted to determine the clinical significance of these findings and to evaluate the long-term effects of repeated beverage exposure on orthodontic bracket survival.

CONCLUSION

This study concluded that exposure to both an alcoholic beverage and an energy drink significantly reduced the shear bond strength of orthodontic brackets bonded with the Ormco Enlight Light-Cure Adhesive System under the tested in vitro conditions. The artificial saliva group demonstrated the highest mean shear bond strength (6.65 ± 0.29 MPa), followed by the alcoholic beverage group (4.99 ± 0.19 MPa), while the energy drink group exhibited the lowest mean shear bond strength (3.88 ± 0.11 MPa). Compared with the artificial saliva group, the alcoholic beverage and energy drink groups showed reductions of 25.0% and 41.6%, respectively. The findings indicate that beverage type significantly influenced bracket shear bond strength, with the energy drink producing the greatest reduction. These findings support the study objectives and suggest that frequent exposure to these beverages may adversely affect orthodontic bracket bond strength under conditions similar to those simulated in this study. The results may assist orthodontists in providing evidence-based dietary counseling to patients during active orthodontic treatment.

PROPOSED CLINICAL GUIDELINES

Based on the findings of this in vitro study, the following proposed clinical considerations are presented for orthodontists and patients:

Energy drinks consumption. Patients undergoing active orthodontic treatment should be counseled to limit frequent consumption of energy drinks. In the present study, repeated exposure to the energy drink resulted in a 41.6% reduction in shear bond strength, with a mean SBS of 3.88 ± 0.11 MPa after 21 days of cyclic immersion.

Alcoholic beverage consumption. Patients should be counseled to moderate and limit frequent or prolonged exposure to alcoholic beverages during orthodontic treatment. In this study, the alcoholic beverage group demonstrated a 25.0% reduction in shear bond strength, with a mean SBS of 4.99 ± 0.19 MPa.

3. Dietary counseling. Dietary counseling regarding beverage consumption should be incorporated into routine orthodontic patient education, particularly for patients who frequently consume energy or alcoholic beverages.

4. Clinical monitoring. For patients reporting frequent consumption of these beverages, orthodontists may consider closer monitoring of bracket integrity and early signs of bracket debonding during treatment.

These proposed guidelines are intended as evidence-informed clinical considerations based on the controlled in vitro conditions of the present study and should not be interpreted as definitive clinical protocols. Further in vivo and longitudinal studies are needed to determine whether the observed reductions in shear bond strength translate into increased bracket failure under actual clinical conditions.

RECOMMENDATIONS

Based on the findings of this study, the following evidence-based guidelines are proposed:

For Clinical Practice (Orthodontists and Patients). Since energy drink exposure resulted in a 41.6% reduction in shear bond strength and produced the lowest mean SBS among the three groups, orthodontists should advise patients to limit frequent consumption of energy drinks during active orthodontic treatment. Since exposure to the alcoholic beverage (5% ABV) resulted in a 25.0% reduction in SBS, patients should likewise be advised to moderate alcohol consumption and limit frequent or prolonged exposure. These recommendations should be interpreted in the context of the in vitro conditions of the present study.

For Health and Regulatory Policy. The Department of Health (DOH) and Food and Drug Administration (FDA) may consider the findings of this localized study when developing oral health education initiatives for orthodontic patients. Such initiatives may include dietary counseling materials, school- and community-based oral health education, and collaboration with orthodontic professional organizations to promote awareness of the potential effects of frequent beverage exposure on orthodontic materials.

For Theory. The findings of this study support the Material Degradation Theory, which proposes that chemical exposure can alter the structure and mechanical properties of polymer-based materials. The progressive reduction in SBS observed across the artificial saliva, alcoholic beverage, and energy drink groups is consistent with the proposed role of chemical exposure in adhesive degradation. Future theoretical models may consider beverage pH, ethanol concentration, and exposure duration as potential factors influencing orthodontic adhesive degradation.

For Education and Training. Dental and orthodontic educators should incorporate evidence concerning beverage-related effects on orthodontic adhesive materials into undergraduate and postgraduate education. Training programs may emphasize dietary counseling skills to help practitioners communicate evidence-based recommendations regarding frequent consumption of alcoholic and energy drinks during orthodontic treatment. Continuing professional development (CPD) courses in orthodontic materials science may also include updated evidence concerning the chemical degradation of adhesive materials. Patient education materials, including pamphlets, posters, and digital media, may be developed in appropriate local languages to improve patient understanding.

For Future Research. Future studies should investigate these findings under clinically relevant and in vivo conditions and evaluate additional beverage types and orthodontic adhesive systems. Longitudinal clinical studies are needed to determine whether reductions in SBS observed in laboratory settings translate into differences in clinical bracket survival. Further investigations should also examine different bracket materials, adhesive systems, beverage compositions, and exposure frequencies and durations. Studies incorporating thermocycling, salivary buffering, mastication, and other oral environmental factors are recommended to better simulate clinical conditions.

List of Abbreviations

ANOVA – Analysis of Variance
MPa – Megapascal
ORMCO – Orthodontic Research Manufacturing Company
SBS – Shear Bond Strength
SD – Standard Deviation
UTM – Universal Testing Machine

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the Institutional Biosafety Committee of the researchers' institution prior to the commencement of the experiment (Protocol No. [BLINDED] - 2025-014, Date: March 15, 2025). As this was an in vitro study using extracted bovine teeth obtained from abattoirs (by-products of the food industry), no human participants were involved, and informed consent was not required. All experimental procedures were conducted in compliance with institutional biosafety and laboratory safety regulations.

Consent for publication

Not applicable.

Availability of data and materials
The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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Declaration of Generative AI and AI-assisted Technologies
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Competing Interests
The authors declare that they have no competing interests.

Author's contributions
- Conceptualization: G.A.A.A.
- Methodology: G.A.A.A.
- Formal Analysis: G.A.A.A.
- Writing – Original Draft: G.A.A.A.
- Visualization: G.T.P.
- Project Administration: G.A.A.A.

References

Bhandari, D. P. K., Anbuselvan, G. J., & Karthi, M. (2019). Evaluation of resin penetration depth in enamel surface for orthodontic bonding exposed to five types of enamel conditioning methods: A scanning electron microscopic study. *Journal of Pharmacy & Bioallied Sciences*, *11*(Suppl 2), S221–S227. https://doi.org/10.4103/JPBS.JPBS_301_18

Cruz, I. D. S., Tomaz, A. F. G., Moreno, M. C., De Araújo, R. M., De Medeiros Alves, A. C., Pereira, H. S. G., & Caldas, S. G. F. R. (2021). Clinically acceptable values of shear bond strength of orthodontic brackets bonded on enamel: An integrative review. *Research, Society and Development*, *10*(4), e11110413927. https://doi.org/10.33448/rsd-v10i4.13927

EL-Awady, A. A., ElHabbak, K. S., Mohamed, H. R., Elwan, A. E., Adly, K. S., Abdalla, M. A., Kamal, E. M., & Alameldin, A. L. (2024). Effect of different primers on the shear bond strength of orthodontic brackets bonded to reinforced polyetheretherketone

(PEEK) substrate. *Dentistry Journal*, *12*(6), 188. https://doi.org/10.3390/dj12060188

Emms, G., & Brierley, C. (2025). Optimization of orthodontic bond strength to defective enamel. *Orthodontic Update*, *18*(1), 46–48. https://doi.org/10.12968/ortu.2025.18.1.46

Fusco, A., Ahmed, S., Link, J., Al-Talib, T., & Abubakr, N. H. (2021). Performance of different orthodontic brackets after exposure to dietary components: An in vitro pilot study. *Open Journal of Stomatology, 11*(9), 341–348. https://doi.org/10.4236/ojst.2021.119030

Iosif, C., Cuc, S., Prodan, D., Moldovan, M., Petean, I., Badea, M. E., Sava, S., Tonea, A., & Chifor, R. (2022). Effects of acidic environments on dental structures after bracket debonding. *International Journal of Molecular Sciences*, *23*(24), 15583. https://doi.org/10.3390/ijms232415583

Kazak, M., Tiryaki, M., Turkes Basaran, E., & Benderli Gokce, Y. (2020). Evaluating the effects of different beverages with daily consumption habits on the wear of restorative materials. *Odontology, 108*(4), 636–645. https://doi.org/10.1007/s10266-020-00498-9

Koaban, A. M., Alwadai, J. M., & Alghamdi, A. M. (2025). Recent advances in orthodontic brackets: From aesthetics to smart technologies. *Cureus*, *17*(6), e85385. https://doi.org/10.7759/cureus.85385

Madrid-Troconis, C. C., Molina-Perez, S., & Redondo-Rico, M. L. (2025). Effects of Coca-Cola drink on hard dental tissues, restorative materials and orthodontic appliances: State of the art. *Revista Facultad de Odontología Universidad de Antioquia*, *37*(1), e357892. https://doi.org/10.17533/udea.rfo.v37n1e357892

Mandall, N. A., Hickman, J., Macfarlane, T. V., Mattick, R. C. R., Millett, D. T., & Worthington, H. V. (2018). Adhesives for fixed orthodontic brackets. *The Cochrane Database of Systematic Reviews, 4*, CD002282. https://doi.org/10.1002/14651858.CD002282.pub2

Mundhada, V. V., Jadhav, V. V., & Reche, A. (2023). A review on orthodontic brackets and their application in clinical orthodontics. *Cureus, 15*(10), e46615. https://doi.org/10.7759/cureus.46615

Oncag, G., Tuncer, A. V., & Tosun, Y. S. (2005). Acidic soft drinks effects on the shear bond strength of orthodontic brackets and a scanning electron microscopy evaluation of the enamel. *The Angle Orthodontist*, *75*(2), 247–253. https://angle-orthodontist.kglmeridian.com/view/journals/angl/75/2/article-p247.xml

Palani Swamy, U. K., Amravai, A. R., Mandadi, S. R., & Habeeb, A. (2018). Effect of alcoholic beverages on shear bond strength of composites to enamel. *Journal of conservative dentistry : JCD, 21*(5), 542–545. https://doi.org/10.4103/JCD.JCD_180_18

Reynolds, I. R. (1975). A review of direct orthodontic bonding. *British Journal of Orthodontics*, *2*(3), 171–178. https://doi.org/10.1080/0301228X.1975.11743666

Sahu, N. J., Panwar, P. S., Dhanak, N. R., Samir, P. V., Najeeb, A., & Rayast, D. (2024). In vitro investigation of resin tag lengths of three commercially available pit and fissure sealants. *Journal of Pharmacy & Bioallied Sciences*, *16*(Suppl 3), S2212–S2214. https://doi.org/10.4103/jpbs.jpbs_150_24

Sajadi, S. S., Eslami Amirabadi, G., & Sajadi, S. (2014). Effects of two soft drinks on shear bond strength and adhesive remnant index of orthodontic metal brackets. *Journal of Dentistry (Tehran, Iran)* *11*(4), 389–397. https://www.sid.ir/en/VEWSSID/J_pdf/101720140404.pdf

Santos, C. N., De Souza Matos, F., De Mello Rode, S., Cesar, P. F., Nahsan, F. P. S., & Paranhos, L. R. (2018). Effect of two erosive protocols using acidic beverages on the shear bond strength of orthodontic brackets to bovine enamel. *Dental Press Journal of Orthodontics*, *23*(6), 64–72. https://doi.org/10.1590/2177-6709.23.6.064-072.oar

Sevindik, C. N., Barmak, A. B., Rossouw, P. E., & Javed, F. (2026). Comparison of Bracket Adhesion Failure Rates with Resin-Modified Glass Ionomer Cement Versus Conventional

Resin Adhesives: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Dentistry Journal, 14*(6), 384. https://doi.org/10.3390/dj14060384

Singh, J., Joshi, A., Manjooran, T., Raghav, S., Gautam, A., & Patel, J. H. (2018). An in vitro evaluation of shear bond strength of orthodontic brackets after mouth rinse. *The Journal of Contemporary Dental Practice*, *19*(7), 862–866. https://doi.org/10.5005/jp-journals-10024-2348

Subramanian, A. K., Russo, D., Marrapodi, M. M., Ronsivalle, V., Uzunçıbuk, H., Cicciù, M., & Minervini, G. (2025). Comparative analysis of orthodontic adhesives for bracket bonding reliability: A systematic review. *Journal of Contemporary Orthodontics*, *9*(1), 7–20. https://doi.org/10.18231/j.jco.2025.003

Sultan, H., Kamran, A. K., Almoammar, S., & Al Jearah, M. M. (2023). pH effects of soda, brew, and citrus on adhesive bond strength of orthodontic brackets to the enamel: Scanning electron microscopy and adhesive remnant index analysis. *Journal of Biomaterials and Tissue Engineering*, *13*(4), 588–593. https://doi.org/10.1166/jbt.2023.3287

Šimunović, L., Blagec, T., Vrankić, A., & Meštrović, S. (2022). Color stability of orthodontic ceramic brackets and adhesives in potentially staining beverages-in vitro study. *Dentistry Journal*, *10*(7), 115. https://doi.org/10.3390/dj10070115

Tanthanuch, S., Kukiattrakoon, B., Jantaravisoot, J., Chanaphai, C., Areewong, C., & Ampawa, N. (2022). Degradability of bulk-fill resin composites after cyclic immersion in different distilled alcoholic beverages. *Journal of Esthetic and Restorative Dentistry, 34*(4), 661–669. https://doi.org/10.1111/jerd.12848

Vorachart, W., Sombuntham, N., & Parakonthun, K. (2022). The effect of beer and milk tea on the shear bond strength of adhesive precoated brackets: An in vitro comparative study. *Heliyon*, *8*(8), e10260. https://doi.org/10.1016/j.heliyon.2022.e10260

Yandug, J. S. G., Ponce, F. D., & Ong, A. K. S. (2023). Application of conjoint analysis and 5Ps marketing mix in identifying customer preference of alcohol consumption among youths in the Philippines. *Foods*, *12*(7), 1401. https://doi.org/10.3390/foods12071401

Zidan, S., Mohamed, H. S., Al-Jabri, M. M., Fayed, S. A. E. H., Farag, A. A. W., & Ali, Y. M. (2024). Patterns and factors influencing high-energy beverage consumption among university students. *The Malaysian Journal of Nursing*, *16*(Suppl 1), 47–55. https://doi.org/10.31674/mjn.2024.v16isupp1.005

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