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Article

Effects of some Peruvian non-distilled alcoholic beverages on dental erosion.

Efecto de algunas bebidas alcohólicas peruanas no destiladas sobre la erosión dental.

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Abstract: Objective: To determine the erosive effect of pieces of permanent teeth exposed to non-distilled alcoholic beverages. **Material and Methods:** This study takes a quantitative approach, with an explanatory scope, descriptive and correlational, with a pure experimental design. The sample consisted of 45 premolar permanent teeth, which were randomly allocated to five sample groups. Every sample group was submerged in dark beer Cuzqueña Negra, wheat beer Cuzqueña de Trigo, lager beer Cerveza Cristal, lager beer Pilsen Callao and physiological saline solution; every solution had a quantity of 110 mL. The experiment was performed for five minutes, with three repetitions every 12 hours over a period of 70 days. The sampling was performed every seven days, using an analytical scale and a data sheet. **Results:** The average weight loss of dental pieces put in dark beer Cuzqueña Negra (pH 4.0) was 239.4456 mg. In lager beer Pilsen Callao (pH 4.6), it was 146.7867 mg. In lager beer Cerveza Cristal (pH 3.7), it was 131.3567 mg. In wheat beer Cuzqueña de Trigo (pH 4.5), it was 121.7122 mg. Lastly, in physiological saline solution (pH 6.8), it was 14.3311 mg. When applied to the sample, the statistical test Student's t-test resulted in a value of $p \approx 0.000$ ($p<0.05$). **Conclusion:** Non-distilled alcoholic beverages caused erosive effects in the pieces of permanent teeth.

Keywords: *beer; dentition, permanent; tooth erosion; pH; alcoholic beverages; Peru.*

Resumen: Objetivo: : Determinar el efecto erosivo en dientes permanentes expuestos a bebidas alcohólicas no destiladas. **Material y Métodos:** Este estudio tiene un enfoque cuantitativo, con alcance explicativo, descriptivo y correlacional, con un diseño puramente experimental. La muestra consistió en 45 dientes permanentes premolares, que fueron asignados aleatoriamente a cinco grupos de muestra. Cada grupo de muestra se sumergió en cerveza Cuzqueña Negra, cerveza Cuzqueña de Trigo, Cerveza Cristal, cerveza Pilsen Callao y solución salina fisiológica; cada solución tenía una cantidad de 110 mL. El experimento se realizó durante cinco minutos, con tres repeticiones cada

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12 horas durante un período de 70 días. El muestreo se realizó cada siete días, utilizando una escala analítica y una hoja de datos. **Resultados:** La pérdida de peso promedio de las piezas dentales colocadas en cerveza negra Cuzqueña Negra (pH 4,0) fue de 239,4456 mg. En la cerveza Pilsen Callao (pH 4,6), fue de 146,7867 mg. En la cerveza Cerveza Cristal (pH 3,7) fue de 131,3567 mg. En cerveza Cuzqueña de Trigo (pH 4,5), fue de 121,7122 mg. Por último, en suero fisiológico (pH 6,8) fue de 14,3311 mg. Cuando se aplicó la prueba estadística t de Student a la muestra dio como resultado un valor de $p \approx 0{,}000$ ($p<0{,}05$). **Conclusion:** Las bebidas alcohólicas no destiladas causaron efectos erosivos en dientes permanentes.

Palabra Clave: *cerveza; dentición permanente; erosión de los dientes; pH; bebidas alcohólicas; Perú.*

INTRODUCTION.

Dental erosion is an irreversible loss of hard dental surface tissue normally caused by a chemical mediated by acid, in which bacteria do not intervene.[1,2] It is usually a progressive and destructive process. It normally goes unnoticed for the patient and the dentist, until it causes sensibility or an aesthetically deterioration of the teeth.[3,4]

Dental erosion occurs when the food or beverages consumed have a pH below the critical value (approximately 5.5 for enamel and 6.5 for dentine). When introduced to the oral cavity they can cause demineralization of the inorganic dental matrix, especially if contact is prolonged and repetitive.[4,5]

Among the habits of contemporanean life, consumption of non-distilled alcoholic beverages, *e. g.* beer, has increased among the young and adult population. Beer has a pH between 3.79 and 4.80.[2,6,7]

In the city of Chachapoyas, as well as in the world, consumption of non-distilled alcoholic beverages, such as beer, has increased exponentially during the last years. This excessive consumption has reached the point of becoming a social concern.[4,8]

As such, the main aim of this study is to determine the erosive effect in pieces of permanent teeth caused by non-distilled alcoholic beverages.

MATERIALS AND METHODS.

The present study employs a quantitative approach, with an explanatory, descriptive and correlational scope, and with a pure experimental design.

The sample consisted of 45 healthy premolar teeth extracted due to odontological reasons; these teeth had been extracted at least 3 months *prior*. Teeth were cleaned using physiological saline solution and brushed to eliminate periodontal tissue. Next, they were conserved in physiological saline solution until the beginning of the experiment.

Teeth were collected in specialized odontological clinics in the city of Chachapoyas in Peru. They were randomly assigned to five sample groups, from A to E.

In Group A, teeth were exposed to Cuzqueña negra dark beer; Group B was exposed to Cuzqueña de Trigowheat beer; Group C was exposed to Cerveza Cristal lager beer; Group D was exposed to Pilsen Callao lager beer. Lastly; Group E was exposed to physiological saline solution.

Later, each sample group was collected in a Pandora's box to avoid getting the groups mixed up. A Pandora's box had 9 divisions where each tooth was placed, likewise the boxes were perforated in strategic points for sampling and to allow disposing of the beverage. Each box was randomly assigned to each group.

The average annual consumption in Peru is 46 liters,[9] which is equivalent to 4 liters per month and 125 mL of beer per day. The exposure of teeth to beer was carried out twice a day with three repetitions each time, using 2 cans of beer (660 mL) which would correspond to the consumption of one day; in order to represent the 46 liters per year, it would take 70 days to complete the experiment.

In order to measure pH, sterile tubes were used, each labelled with the type of beer. At the moment the cans were opened, a digital pH-meter was used. During the experiment, every sample in each Pandora's boxes was exposed to 110 mL of beer for 5 minutes and then

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washed with saline solution for one minute.

The procedure was repeated twice. Afterwards, any surplus was removed using a syringe filled with saline. The procedure was repeated every 12 hours for a period of 70 days. Samples were weighed in an analytical scale before being exposed to beer and after 70 days, once the experimental exposure concluded.

The balance was tared before each measurement. The statistical program SPSS 25.0 (IBM, USA) was used for data analysis. Descriptive and inferential statistics were used for the Student's t-test for paired data and for the Pearson's correlation coefficient, with a significance set at 0.05.

Table 1. pH of non-distilled alcoholic beverages and physiological saline solution used in this study.

Sample Group	Beverages	pH	S.D.
Group A	Dark beer Cusqueña Negra	4.0978	± 0.01986
Group B	Wheat beer Cusqueña de Trigo	4.4989	± 0.00928
Group C	Lager beer Cristal	3.7111	± 0.07817
Group D	Lager beer Pilsen Callao	4.6778	± 0.44100
Group E	Physiological Solution	6.8000	± 0.10000

S.D.: Standard deviation

Table 2. Average weight loss of teeth in each sample group.

	Average weight loss of teeth (milligrams)						
Group	Initial weight Day 1	S.D.	Final weight Day 70	S.D.	Total weight loss	S.D.	Student's t-test *p*-value
Group A: Dark beer Cuzqueña Negra	1097.7556	±93.25197	858.3100	±95.80383	239.4456	±21.74641	
Group B: Wheat beer Cuzqueña de trigo	1104.0556	±169.57372	982.3433	±173.27824	121.7122	±18.98191	
Group C: Lager beer Cristal	1069.4089	±246.44436	938.0522	±240.01202	131.3567	±32.81458	0.00000
Group D: Lager beer Pilsen Callao	1115.0811	±171.71595	968.2944	±173.87244	146.7867	±42.47067	
Group E: Physiological solution	1059.9556	±150.80792	1045.6244	±155.38727	14.3311	±10.15540	

S.D.: Standard deviation

Table 3. Correlation between weight loss of teeth and pH of non-distilled alcoholic beverages and physiological saline solution.

Group	pH	S.D.	Weight loss	S.D. *p*-value	Pearson
Group A: Dark beer Cuzqueña Negra	4.0978	0.01986	239.4456	21.74641	
Group B: Wheat beer Cuzqueña de trigo	4.4989	0.00928	121.7122	18.98191	
Group C: Lager beer Cristal	3.7111	0.07817	131.3567	32.81458	-0.7580.000
Group D: Lager beer Pilsen Callao	4.6778	0.0441	146.7867	42.47067	
Group E: Physiological solution	6.8	0.1	14.3311	10.1554	

S.D.: Standard deviation

RESULTS.

The pH of the non-distilled alcoholic beverages in this study varied between 3.7 and 4.7. (Table 1)

It was observed that the greatest average weight loss of teeth took place for Group A (dark beer Cerveza Cuzqueña Negra), followed by Group D, followed by Group C, followed by Group B. The weight difference was statistically significant. (Table 2)

There is a significant correlation between the variables (p>0.05). There is also a strong negative correlation (-0.758) between pH and average weight loss of teeth. (Table 3)

DISCUSSION.

The average pH among the beers in this study ranged between 3.7 and 4.7, in agreement with Nogueira *et al.*,[6] and de Lana *et al.*,[10] who reported pH values ranging from 3.79 to 4.8 as well as with the values obtained by Charpe *et al.*,[2] Jathanna *et al.*,[11] and Fuentes *et al.*,[12] Thus, the acidity of the beers in these studies are considered to be representative. Furthermore, the pH of the lager beer Pilsen Callao is the same as reported by García *et al.*,[13] in their study that included a variety of Pilsner style beers.

The most differing pH value among the literature was reported by Pachas *et al.*,[8] a pH of 3.0 for the wheat beer Cuzqueña de Trigo. This value differs greatly from the pH of this beer measured in our research (pH= 4.5).

The beer that induced the greatest weight loss of teeth during the experiment was the dark beer Cuzqueña Negra, with an average weight loss of 239.4456 mg. The beer with the least weight loss was the wheat beer Cerveza Cuzqueña de Trigo, with an average weight loss of 121.7122 mg. In the case of the lager beers Pilsen Callao and Cristal, average weight loss was 146.7867 mg and 131.3567 mg, respectively.

In all sample groups there was a significant weight loss of dental pieces, in agreement with the values presented by Grippo *et al.*,[1] de Lana[10] Lissera *et al.*,[14] Antonov *et al.*,[15] and Da Silva *et al.*[16] This shows that both alcoholic and non-alcoholic beverages cause similar injuries to teeth, which present as color changes and dental corrosion.

Consequently, it is concluded that a more frequent consumption of alcoholic beverages causes more dental corrosion and more negative consequences to the oral health.

Moreover, Lissera *et al.*,[14] Rytöma *et al.*,[17] and Medeiros *et al.*,[18] reported that the longer the teeth are exposed to acidic beverages (pH less than 5.5), the greater their weight loss. Additionally, Gonçalves *et al.*,[19] and Medeiros *et al.*,[18] mentioned that in the early stages of the experiment, the corrosive effects, measured as dental weight loss, are not very noticeable. Subsequently, the weight loss of teeth increased every day.

These observations are in agreement with our results, as in the early stages there was no significant weight loss of teeth, however subsequently the corrosive effect was more evident, illustrated by the overall final degree of weight loss of teeth.

The level of significance of the correlation between weight loss of permanent teeth and pH of non-distilled alcoholic beverages, was calculated using Pearson's correlation coefficient, which resulted in a significance less than 0.05 (p<0.05) and a correlation coefficient of -0.758.

These results are in agreement with the results of Moreno *et al.*,[20] that indicated that the progress of dental erosion is affected by the degree of acidity of the beverages. Charpe *et al.*,[2] and Barbour *et al.*,[21] obtained the same results, concluding that less erosive alcoholic beverages have an average pH between 4.3 and 5.5, and more injurious and erosive alcoholic beverages have a lower pH (less than 4.3). These values are within our results. In our study, non-distilled alcoholic beverages with a higher pH (over 4.3), caused less dental corrosion while alcoholic beverages with lower pH (under 4.3), were associated with more dental erosion.

It was concluded that a significant negative correlation between weight loss of pieces of permanent teeth and pH of the non-distilled alcoholic beverages exists. The lower the pH (higher acidity), the higher the degree of erosion of permanent teeth. Our results agree with those of Charpe *et al.*,[2] Barbour *et al.*,[21] Lissera *et al.*,[14] and Haghgoo *et al.*,[22] which concluded that there is a relationship between erosive effect, measured by weight loss of teeth, and the pH of beverages.

The results of the erosive effects on permanent

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teeth imply that the reaction of non-distilled alcoholic beverages provoke irreversible corrosive effects, which has been shown in different ways by experiments conducted by Fuentes,[12] Haghgoo *et al*.,[22] Rytömaa *et al*.,[17] and Medeiros *et al*.[18]

There are limitations to this work, including technological limitations, since currently other methodologies such as morphometry or calcium measurement can be carried out. It is also important to determine the alcoholic percentage or content, the carbon dioxide content and other characteristics of the drink that could cause dental corrosion, in addition to extending the study to other similar beverages that are also marketed in Peru but produced in other countries.

The present study was also limited by the small number of samples. Regarding research methodology, Argibay[23] suggests that the minimal number of samples, observations or replicas in a study is defined by the investigator, depending on available time and money.

CONCLUSION.

It was concluded that beer causes erosive effects in permanent teeth. The dark beer Cuzqueña Negra resulted in the greatest degree of erosion. There is a great negative correlation between weight loss of permanent teeth and pH of the beers.

The lower the pH (higher acidity), the greater the erosion of permanent teeth.

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Authors' contributions: Quispe-Zuta M: Planned the research protocol, supervised the experimental part and its progress, prepared the final report and reviewed the final manuscript. Coronel-Zubiate F: Provided advice to the investigation protocol, participated in the data analysis and in the preparation of the final report. Reviewed the final manuscript. Zelada-Romero H: Provided advice to the investigation protocol, evaluated the experimental process as well monitored the progress of the study. Evaluated the statistical analysis, participated in the preparation of the final report and reviewed the final manuscript. Castillo-Cornock T: Evaluated the statistical analysis, composed the manuscript and reviewed the final manuscript. Farje-Gallardo C: Specialist advisor, reviewed the final report, reviewed the final manuscript. La Serna-Solari P: Reviewed and edited the final report. Arbildo-Vega H: Reviewed the statistics, reviewed the final report.

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