Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 3
Open Access

Comparative Evaluation Of Physical And Anti Cariogenic Properties Of Conventional Properties Of Conventional Glass Inomer Cement Adding Grape Seed Oil And Sesame Seed Oil: An In Vitro Study

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Cite this paper as: Divya Singh, Pooja Kabra, Ekta Choudhary (2024) Comparative Evaluation Of Physical And Anti Cariogenic Properties Of Conventional Properties Of Conventional Glass Inomer Cement Adding Grape Seed Oil And Sesame Seed Oil: An In Vitro Study. *Frontiers in Health Informatics, 13* (3), 4159-4170

ABSTRACT

Aim*: To compare and evaluate the physical and anti-cariogenic properties of conventional glass ionomer cement adding grape seed oil and sesame seed oil.*

Methodology*: 225 samples were prepared for this study. 75 samples for each group. Liquid formulations were prepared by incorporating 3% GS oil and 3% SS oil individually in polyacrylic acid. For compressive strength and fluoride ion release samples were prepared by mixing conventional GIC with modified polyacrylic acid using split teflon mould and for fluoride ointment release 75 premolars were taken and decoronated and embedded in acrylic resin blocks. Then bonding of GIC to dentin surface was performed using slips teflon mould of dimensions 6mm * 4mm. GROUP I: control group, GROUP II: GIC modified by 3%(v/v%) grape seed oil, GROUP III: GIC modified by 3%(v/v%) sesame seed oil.*

Results*: In the present study, compressive strength and shear bond strength were evaluated for samples in the control group, grape seed oil modified group and sesame seed oil modified group. The intercomparison was done among all three groups and it was found to be statistically significant (p-value <0.05) using a one-way ANOVA test. Intercomparison was done for fluoride ion releasing capacity among samples between the 1st day, 7th day and 30th day which was found to be statistically significant (p- value <0.05) using paired t-test. CONCLUSION: Grape seed oil influenced the physical and anti cariogenic properties of conventional glass ionomer cement more than sesame seed oil and control group.*

Keywords: *Conventional glass ionomer cement, modification in conventional GIC, anti cariogenic properties of conventional GIC, Physical properties of GIC, grape seed oil in GIC, sesame seed oil in GIC.*

Introduction

The selection of a direct restorative material depends on factors such as the location and extent of the restoration, patient preferences, and the clinician's judgment to achieve optimal oral health outcomes. One of the most widely used direct restorative materials is glass ionomer cement. GIC is a versatile direct restorative material commonly employed in dentistry. One significant advantage of GIC is its ability to bond chemically to tooth structure, creating a strong and durable connection. (1) This feature helps in reducing microleakage and providing a stable restoration. GIC is also valued for its fluoride-releasing properties, which contribute to the prevention of secondary caries and enhance the remineralization of adjacent tooth structures. (2) Then compressive strength and shear bond strength were measured using universal testing machine and fluoride ion release were measured using spectrophotometer. The data was compiled and subjected to statistical tests.

GIC offers numerous advantages in dentistry but it is also important to acknowledge its limitations and areas for improvement. In load bearing areas it can fracture and it exhibits lower mechanical strength posing concerns in areas of the mouth subjected to moisture during the setting phase. (3)

Recently, the antimicrobial activity of many natural oils has been proven through different in-vitro studies such as olive oil, grape seed oil, sesame seed oil, fenugreek-extracted oil, cinnamon bark oil, copaiba oil, coconut oil and among these oils grape seed oil and sesame seed oil were selected for this study. SS oil and GS oil are selected for the present research due to their already proven health benefits. (4)

Grape seed oil renowned for its antioxidant, antimicrobial, and anti-inflammatory characteristics, grape seed oil plays a significant role in oral health.

Similarly, sesame seed oil contributes to diminishing plaque accumulation and addressing dentin hypersensitivity, leveraging its antibacterial and antioxidant properties. (5) Grape seed oil and sesame seed oil continue to reveal their therapeutic potential, they emerge as valuable natural resources in promoting oral health and advancing dental care practices. There are various studies in which incorporation of sesame seed oil in glass ionomer cement generally improved its mechanical properties with an agreeable color change. (6)

This invitro study was designed to compare the physical and anticariogenic properties of conventional glass ionomer cement adding grape seed oil and sesame seed oil.

Materials and Methods

Total sample size selected was 225 out of which 150 specimens of herbal extract (grape seed oil and sesame seed oil) mixed in conventional glass ionomer cement. (75 samples for estimation of compressive strength and 75 samples for estimation of fluoride ion release) and 75 extracted premolars were taken and then embedded in acrylic resin (for estimation of shear bond strength).

For preparation of grape seed oil and sesame seed oil modified GIC, 3% grape seed oil and 3% sesame seed oil was incorporated in polyacrylic acid individually and then the mixture was kept on magnetic stirrer for 24 hrs to obtain homogenous mix (fig 1). With the utilisation of these different liquid formulations, 3 groups were prepared:

Group I: conventional GIC

Group II: GIC modified by 3% (v/v%) grape seed oil

Group III: GIC modified by 3% (v/v%) sesame seed oil

FIG 1: MAGNETIC STIRRER

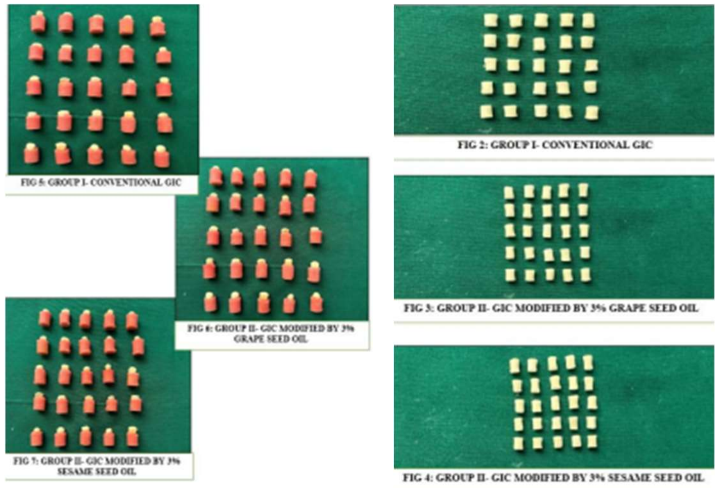


Fig 2-7: sampling

1. **For estimation of compressive strength:** total 75 specimens were taken.

In group I, for preparation of specimen, conventional GIC was mixed with polyacrylic acid and 25 cylindrical shaped specimen of 6mm length and 4mm diameter was prepared in split Teflon mould.

In group II, for preparation of specimen, conventional GIC was mixed with polyacrylic acid and 3% grape seed oil and 25 cylindrical shaped specimen of 6mm length and 4mm diameter was prepared in split Teflon mould.

In group III, for preparation of specimen, conventional GIC was mixed with polyacrylic acid and 3% sesame seed oil and 25 cylindrical shaped specimen of 6mm length and 4mm diameter was prepared in split Teflon mould.

Total 75 specimens were then subjected for thermocycling (500 cycles at 55 degrees Celsius for hot bath and 5 degrees Celcius for cold bath, 20sec for each cycle). After thermocycling, a universal testing machine was used for the measurement of compressive strength.

Compressive load was applied at a crosshead speed of 1mm/min until the material fractured. Then compressive strength (MPa) was calculated through the following equation: CS = 4P/πD2, where P is the maximum applied load at fracture (N) and D is the diameter of the specimen (mm).

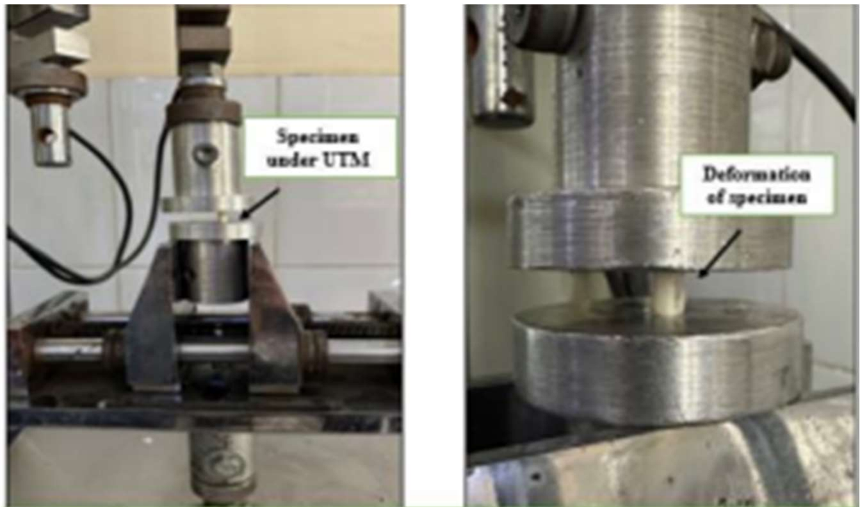


FIG 8: MEASUREMENT OF COMPRESSIVE STRENGTH

2. For estimation of shear bond strength:

75 sound premolar teeth were taken and thoroughly washed under distilled water and scaled using a sharp hand sickle scaler. Teeth were then stored in a solution of 1% chloramine-T at 4°C to inhibit microbial growth. Occlusal surfaces of teeth were removed below the dentin-enamel junction using a diamond disc. Smoothening of the flat dentinal surface was achieved with silicon carbide paper and their roots were mounted in self-cured acrylic resin blocks. Conditioning of the exposed dentin surface was done with polyacrylic acid for 20 sec. bonding of GIC to the conditioned dentin surface was performed using a split Teflon mold of dimension 6mm × 4mm. GIC powder was then mixed with the different liquid formulations separately which were prepared earlier for each test group. The specimens were then stored in distilled water at room temperature for 48 hrs.

For the measurement of shear bond strength, a universal testing machine was used. at a crosshead speed of 1 mm/min with the shearing load directed on the bonding interface, and the shear bond strength (MPa) was calculated as follows:

$\tau = P/\pi r2$, where; τ is shear bond strength, P is the load at failure (N), and r is the radius of the specimen (mm).

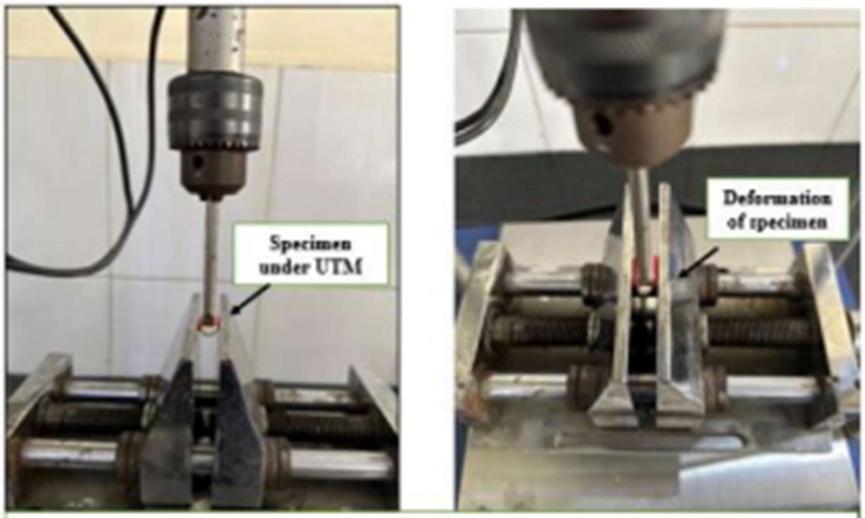


FIG 9: MEASUREMENT OF SHEAR BOND STRENGTH

3. Estimation of fluoride ion release:

A split Teflon mould (6mm length and 4mm diameter) was used for the preparation of fluoride release specimen. A total of 75 specimens were taken, each specimen was placed in a glass vial containing 50mL of deionized water and stored at room temperature till the time of testing. The resulting solution was then analyzed for fluoride on the 1st, 7th, and 30th day by the colorimetric alizarin method as cumulative. In brief, 0.5mL aliquots were removed from each mixture on the specified days, and 1.25mL of acid-zirconyl alizarin reagent was added. After 1 hr, the absorbance was measured at 400nm in a spectrophotometer using quartz cuvettes.

FIG 10: SPECTROPHOTOMETER

Statistical Analysis

In present study, compressive strength was evaluated for study samples in Control group, Grape seed oil modified group and Sesame seed oil modified group. The mean value was found to be highest (105.16±3.3) in control group and lowest (131.04±5.4) in Sesame seed oil modified group. The intercomparison was done among all three groups and it was found to be statistically significant (p-Value≤0.05)using one-way Anova test.

GRAPH 1: COMPRESSIVE STRENGTH

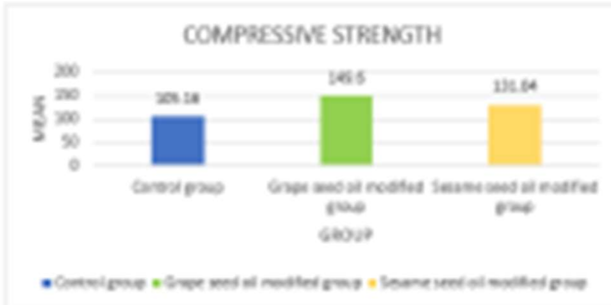


TABLE 1: INTERCOMPARISON AMONG STUDY SAMPLES FOR COMPRESSIVE STRENGTH (ONE-WAY ANOVA)

S.NO.	GROUP (N=25)	MEAN	STD. DEVIATION	STD. ERROR	MINIMUM	MAXIMUM	P-VALUE
1	Control group	105.16	3.223	.645	99.00	111.00	0.002 Significant
2	Grape seed oil modified group	149.60	5.605	1.121	136.00	157.00	
3	Sesame seed oil modified group	131.04	5.481	1.096	120.00	139.00	

shear bond strength was evaluated for study samples in Control group, Grape seed oil modified group and Sesame seed oil modified group. The mean value was found to be highest (6.25±0.5) in Grape seed oil modified group and lowest (4.78±0.5) in Sesame seed oil modified group. The intercomparison was done among all three groups and it was found to be statistically significant (p-Value≤0.05)using one-way Anova test.

GRAPH 2: SHEAR BOND STRENGTH

TABLE 2: INTERCOMPARISON AMONG STUDY SAMPLES FOR SHEAR BOND STRENGTH (ONE-WAY ANOVA)

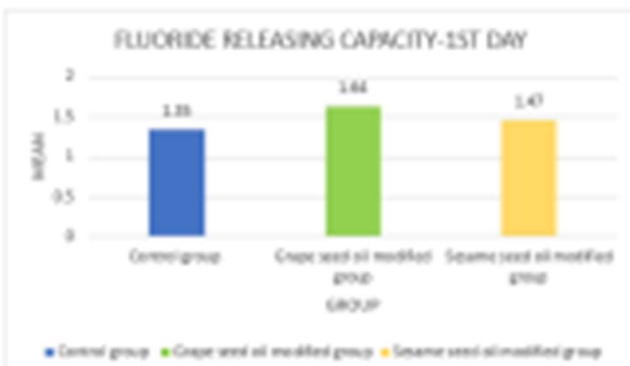
S.NO.	GROUP N=25	MEAN	STD. DEVIATION	STD. ERROR	MINIMUM	MAXIMUM	P-VALUE
1	Control group	4.0908	.74226	.14845	3.00	5.11	0.021 Significant
2	Grape seed oil modified group	6.2572	.50391	.10078	5.10	7.04	
3	Sesame seed oil modified group	4.7816	.52653	.10531	4.01	5.67	

In present study, fluoride releasing capacity was evaluated among study samples of three different groups i.e. control group, Grape seed oil modified group and Sesame seed oil modified group at 1st day. The highest mean value was found to be (1.6452±0.03) in Grape seed oil modified group & lowest (1.3+0.02) in control group.

In present study, fluoride releasing capacity was evaluated among study samples of three different groups i.e. control group, Grape seed oil modified group and Sesame seed oil modified group at 7th day. The highest mean value was found to be (1.6452±0.03) in Grape seed oil modified group & lowest (1.3+0.02) in control group

In present study, fluoride releasing capacity was evaluated among study samples of three different groups i.e. control group, Grape seed oil modified group and Sesame seed oil modified group at 30th day. The highest mean value was found to be (1.91±0.04) in sesame seed oil modified group & lowest (1.61 ±0.25) in control group.

GRAPH 3: FLUORIDE RELEASING CAPACITY AT 1ST DAY



Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
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TABLE 3: FLUORIDE RELEASING CAPACITY AMONG STUDY SAMPLES AT 1ST DAY (Intercomparison)

S.NO.	GROUP	MEAN	STD. DEVIATION	STD. ERROR	MINIMUM	MAXIMUM
1	Control group	1.3592	.02554	.00361	1.31	1.40
2	Grape seed oil modified group	1.6452	.03716	.00525	1.58	1.70
3	Sesame seed oil modified group	1.4744	.02417	.00483	1.42	1.51

GRAPH 4: FLUORIDE RELEASING CAPACITY AT 7TH DAY

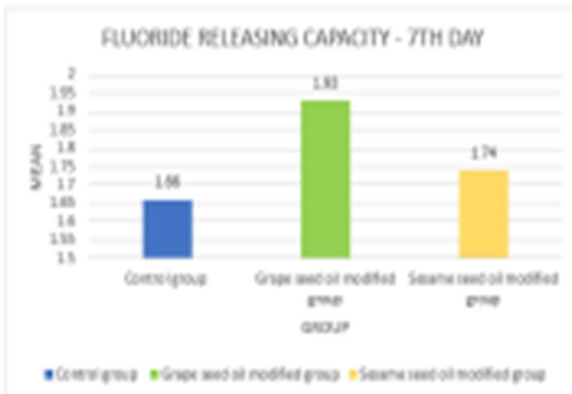

TABLE : 4 FLUORIDE RELEASING CAPACITY AMONG STUDY SAMPLES AT 7th DAY (Intercomparison)

S.NO.	GROUP	MEAN	STD. DEVIATION	STD. ERROR	MINIMUM	MAXIMUM
1	Control group	1.6664	.04329	1.6664	1.31	1.72
2	Grape seed oil modified group	1.9332	.04171	1.9332	1.58	1.98
3	Sesame seed oil modified group	1.7456	.03229	.00646	1.70	1.79

TABLE 5: FLUORIDE RELEASING CAPACITY AMONG STUDY SAMPLES AT 30th DAY (Intercomparison)

S.NO.	GROUP	MEAN	STD. DEVIATION	STD. ERROR	MINIMUM	MAXIMUM
1	Control group vs	1.6130	.25861	.03657	1.31	1.94
2	Grape seed oil modified group	1.8456	.20629	.02917	1.58	2.13
3	Sesame seed oil modified group	1.9168	.04385	.00877	1.80	1.99

fluoride releasing capacity was evaluated among study samples (N=25) of three different groups i.e. control group, Grape seed oil modified group and Sesame seed oil modified group at 1st day, 7th day and 30th day. The mean value was found to be highest at 30th day (1.86+0.04) and was lowest at 1st day (1.34+0.02) in control group.

Results

In the present study intercomparison was done for compressive strength and shear among study sample of all the group and it was found to be statistically significant (p-Value $\leq$0.05) between control group, grape seed oil modified group and sesame seed oil modified group. Grape seed oil modified group was found to be more statistically significant than control group and sesame seed oil group.

On comparing fluoride ion releasing capacity among study sample of all the group, grape seed oil was found to be more statistically significant (p-Value $\leq$0.05) than other groups on day 1st, 7th and 30th but results were found to be statistically non-significant on comparing 1st, 7th and 30th day among all the groups(p-value$\geq$0.05)

Discussion

The current study assessed the effect of these essential oils for modification of glass ionomer cement on physical properties and anti-cariogenic properties. There are many studies done by various authors in which different percentages of essential oils were mixed with polyacrylic acid but 3% has proved to be beneficial to enhance the majority of its properties without compromising its adhesion to the tooth structure as well as its esthetics.(7) This could be due to the incorporation of modifiers; whatever in solution or oil form, adversely affected the physical properties of the parent material. This might be related to the ability of these materials to interfere with the acid-base reaction and prevent some carboxylic groups from participating in the reaction. (8) They are supposed to hinder the acid attack on the glass powder and the leaching of ions from the glass. However, this effect seems to be more pronounced with higher concentrations.(9) Taking this into account 3% concentration of oil was selected for this study.

The null hypothesis was rejected because both 3% grape seed oil and 3% sesame seed oil modified the physical properties and anti-cariogenic properties of GIC. For compressive, shear bond strength and anti cariogenic property, the findings of this study reported statistically significant differences between Conventional GIC, GIC modified by sesame seed oil and GIC modified by grape seed oil. The incorporation of modifiers adversely affected the physical and anti-cariogenic properties of the parent material. Out of both, grape seed oil improves properties of glass ionomer cement more than sesame seed oil and control group.

The potential explanation for that may be multifactorial. This might be related to the ability of grape seed

oil to interfere with the acid-base reaction and prevent some carboxylic groups from participating in the reaction.(10) They are supposed to hinder the acid attack on the glass powder and the leaching of ions from the glass. However, this effect seems to be more pronounced in the grape seed oil group than sesame seed oil and control group. The oil itself may act as an adhesive penetrating and sealing the pores within the formed matrix and thus promoting cohesion and developing a stronger matrix.(11) Cheng-fang Tang et al., demonstrated that transient GSE bio modification may promote remineralization (mostly HA crystals) on the superficial surface of acid-etched demineralized dentine. 15% of GSE preconditioner, without PH adjustment, gave the best results, which may be ascribed to its higher polyphenolic content

Sesame seed oil contains a considerable amount of minerals including calcium which may induce a higher degree of the acid-base reaction. More Ca2+ ion may be available for polysalt bridge formation and cross linking into Ca polyacrylate chains, in that way reinforcing the GIC matrix, and increasing the mechanical properties.(12) Sesame oil may spread within the matrix formed increasing its cohesive strength in terms of more ionic cross-links, interlocking of chains and hydrogen bridges. The addition of sesame oil to the liquid may influence the density of free carboxylic groups necessary for the chemical bond to the tooth structure. The presence of Ca ions in sesame oil might have exhaust some of the carboxylic acids in polysalt bridge formation.(13)

In the present study, the fluoride ion release of grape seed oil-modified GIC is higher than fluoride ion release of conventional GIC and sesame seed oil- modified GIC on 1^{st}, 7^{th} and 30^{th} day. This might be due to the hydrophobic nature of grape seed oil which may aid in dispensing the fluoride- containing glass fillers within the GIC matrix more evenly during mixing.(14) This improved dispersion could potentially enhance the exposure of fluoride ions to the surrounding environment, facilitating their release over time.Grape seed oil may interact with the GIC matrix, influencing the kinetics of the setting reaction or the structure of the material. These interactions could indirectly affect the release of fluoride ions from the glass fillers, although the specific mechanisms would require further investigation.(15)

Low fluoride release in conventional GIC and sesame seed oil-modified GIC could be attributed to glass filler content with fewer monovalent ions cross- linking the polymer chains holding them close together, leading to less water transport and, consequently less fluoride release.(16)

Sayed and Ian et al evaluated the fluoride release by glass ionomer cements, compomer and giomer during 1^{st} week, 14^{th} day and 21 day by using specific fluoride electrode and an ionanalyzer. They concluded that the maximum cumulative fluoride release of 1-7 days was related to fuji VII, followed by fuji IX extra, fuji II LC, dyract extra and beautiful in descending order and this order remained the same until the 21st day.

There are many ongoing studies available that compare the physical and anti- cariogenic properties of grape seed oil and sesame seed oil. So, more studies should be done in this direction for better assessment of the material in vivo.

Conclusion

From the results of this in-vitro study, the following conclusions can be arrived that Grape seed oil when mixed with conventional glass ionomer cement resulted in better compressive strength, shear bond strength and fluoride ion release than sesame seed oil and conventional glass ionomer cement alone. Grape seed oil modified glass ionomer cement can conclusively be recommended as a restorative material. Numerous ongoing studies exist that assess the physical and anti-cariogenic properties of grape seed oil and sesame seed oil. Consequently, additional research in this area is warranted to enhance the in vivo assessment of these tested materials.

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