

## A Comparative Evaluation of Fluoride Ion Release and Alkalinizing Potential of Recent Restorative Materials: An In Vitro Study.

### Abstract:

**Aim:** To evaluate and compare fluoride ion release and alkalinizing effect by Bulkfill composite (Cention-N), Giomer (Shofu Beautifil II) and Compomer (DyracteXtra)

**Objectives:** To evaluate and compare fluoride ion release and alkalinizing effect of alkaline restorative material, Cention-N, Beautifil II and Dyracte Xtra in neutral and acidic pH solution and to conclude which material has the best alkalinizing and fluoride ion releasing property.

**Materials And Methodology:** Straight hand piece (NSK, Japan), Micro motor (Unicorn Denmat, India), Diamond disc (0.15mm) and diamond finishing burs (Shofu, Japan), Airtor (NSK, Japan), Cention-N (Ivoclar, Lichtenstein), Beautifil II (Shofu, Japan), DyracteXtra (Dentsply, Sirona).

Freshly extracted permanent human mandibular molars (samples). Total number of freshly extracted permanent mandibular molars were 45. Each tooth was sectioned from the CEJ level and the root was discarded. Further, each coronal segment was sectioned into four parts mesiodistally and buccolingually. Thus, a total of 180 samples was obtained from 45 teeth. These samples (n=180) were divided in 3 groups with each group containing 60 samples each. Group A (Cention-N)- 60 samples; Group B (Beautifil II)- 60 samples and Group C (DyracteXtra)- 60 samples. The samples were subdivided into two equal subgroups (n=10) on the basis of pH (acidic pH-4, neutral pH-6.8) of the solution used for testing. The subgroups representing acidic pH were AA, BA, and CA, and subgroups representing neutral pH were AN, BN and CN. Finally, each of the subgroups was further divided into three groups on the basis of duration (7 days, 14 days, and 21 days) for which testing was done.

One-hundred and eighty plastic containers were prepared each containing 5 ml of deionized water/acidic medium. Ten samples from each of the subgroup was stored in each of these plastic containers. After 24 h, the containers were thoroughly shaken; samples were removed; and the storage medium was collected. The samples were then re-immersed in the plastic container-containing fresh 5 mL of deionized water. The same procedure was repeated for 7 days for subgroups -AN7, BN7, CN7, AA7, BA7, and CA7, for 14 days for subgroups -AN14, BN14, CN14 and AA14, BA14, and CA14, and for 21 days for subgroups -AN21, BN21, CN21 and AA21, BA21, and CA21.

The cumulative fluoride ion release and change in pH was assessed at the end of 7 days, 14 days, and 21 days utilizing spectrophotometer and pH meter, respectively. The data thus obtained was statistically analyzed using ANOVA-F, Paired "t", and Unpaired t-test.

**Result:** Cention N showed the highest fluoride ion release as well as alkalinizing potential.

**Conclusion:** All restorative materials released fluoride at all time intervals viz 7, 14 and 21 days. Cention N showed the highest fluoride ion release when compared to Beautifil II and DyracteXtra. All restorative materials showed an increase in pH at all time durations viz 7, 14 and 21 days. Cention N showed the highest pH change or alkalinizing potential followed by Dyracte Xtra and Beautifil II.

**Key-words:** Alkalizing potential, Bioactive materials, Bulk fill composites, Composite resins, Fluoride release

### Introduction:

The continuous progress in field of restorative dentistry and technology has made possible the availability of various direct restorative materials to modern dental practice ranging from Dental amalgam to Glass Ionomer cement (GIC) and now novel composites. Of these, GIC differs for its excellent

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property of release of fluoride ions, which helps in preventing enamel demineralization thereby promoting remineralization, reducing plaque growth and eventually helping to prevent dental caries.[1]

However, GIC lacks flexural strength and hence is not indicated for stress bearing areas.[2] To overcome this, new restorative materials have been introduced combining the properties of fluoride release and superior flexural strength.

“Cention N” is an “alkasite” restorative material which is one of its type. Alkasite refers to a novel category of restorative material, which is similar to compomer or ormocer type of material and is essentially a subgroup of the composite restorative class.<sup>3</sup> This new category of restorative comprises of an alkaline filler, which is capable of releasing acid-neutralizing ions. It is radiopaque and releases fluoride, calcium and hydroxide ions and also exhibits high compressive and flexural strengths.[3]

A new hybrid esthetic restorative material, Beautifil II, a “Giomer”, was introduced with physical properties and biocompatibility of composite resin and added benefits of high radiopacity, fluoride release, and antiplaque effect as that present in glass ionomer cement Beautifil II, is one of this type of Giomer.[4]

Also 'compomer', a polyacid modified composite resin was crafted, that is being sold as a filling material exhibiting the properties of glass ionomer cements and composites. An example of compomer being DyracteXtra.

These recent restorative materials are indicated for posterior Class I and II restorations. They have the ability to release fluoride ions in the oral cavity when the pH drops. This property buffers the drop in pH in the mouth, preventing further caries favorable environment. Thus, this in-vitro study has made a sincere attempt to evaluate and compare the fluoride ion release and alkalizing effect of three recent restorative materials viz Cention N, Beautifil II and DyracteXtra.

### Materials and Method:

Forty five human permanent mandibular molar teeth extracted due to periodontal/orthodontic reasons were collected and selected as per the inclusion and exclusion criteria. Inclusion criteria included non-carious, sound and intact human mandibular molars with normal morphology. Exclusion criteria comprised of teeth with any crack or caries, teeth with developmental anomaly, teeth with any restorations and teeth with any resorptive defects

The selected teeth were cleaned using ultrasonic scaler and then stored in 0.9% normal saline until further use. All the teeth were decoronated at the level of the cemento-enamel junction and the root portion was removed. Each sample was then further sectioned mesiodistally as well as buccolingually in four equal segments to obtain total 180 sample size. Further, a flat-end cylindrical diamond point was used at a speed of 300,000 rpm under continuous air water to prepare the standardized cavities with a depth and width of 2 mm.

These 180 sample segments were randomly divided into the following three equal groups which are as follows:

Group A (Cention-N)- 60 samples

Group B (Beautifil II)- 60 samples

Group C (DyracteXtra)- 60 samples

The cavities in all the groups were restored using Teflon coated composite instruments with the respective restorative materials to be tested. The materials were filled according to the manufacturer's instructions. Further, two layers of nail varnish were used to coat the samples, leaving a margin of 1 mm around the restoration.

These restored 60 samples group was subdivided into two equal subgroups, comprising of 30 samples on the basis of pH (acidic pH-4, neutral pH-6.8) of the solution to be used for testing. The subgroups representing acidic pH were labelled as AA, BA, and CA and subgroups representing neutral pH were labelled as AN, BN and CN respectively.

Finally, each of these subgroups were further divided into three subgroups on the basis of duration (7 days, 14 days, and 21 days) for which testing was done.

One-hundred and eighty plastic containers were prepared each containing 5 ml of deionized water/acidic medium. Ten samples from each of the subgroup were stored in each of these plastic containers. After 24 hours, the containers were thoroughly shaken, samples were then removed and were then reimmersed in the plastic container-containing fresh 5 mL of deionized water. For the acidic medium, Lactic acid solution was used to achieve a pH of 4 in deionised water. The concerned samples were then immersed in 5 mL of acidic medium. The same procedure was repeated for 7 days for subgroups –AN7, BN 7, CN 7, AA 7, BA 7, and CA 7, for 14 days for subgroups –AN14, BN 14, CN 14 and AA 14, BA 14, and CA 14, and for 21 days for subgroups –AN 21, BN 21, CN 21 and AA21, BA21, and CA21.

**Analysis of the Samples:**

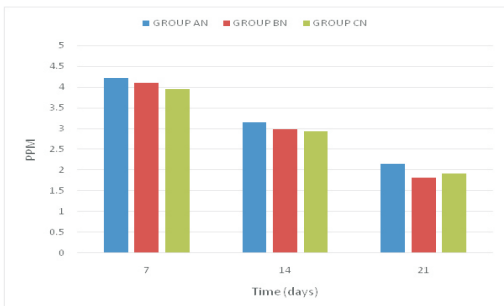
The cumulative fluoride ion release and change in pH was assessed at the end of 7 days, 14 days, and 21 days utilizing fluoride meter and pH meter, respectively. The observations thus obtained were then statistically analysed using ANOVA-F, Paired “t”, and Unpaired t-test.

**Observation and Results:**

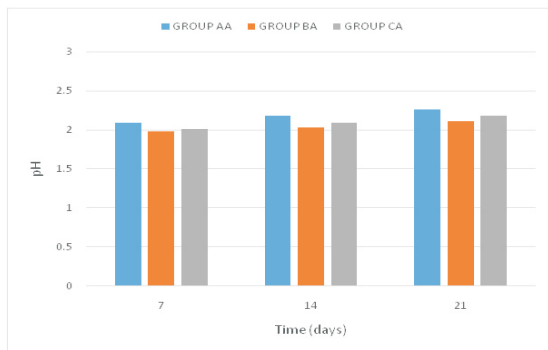
All the samples were incubated in 95% relative humidity environment at 37°C until the period of testing. The cumulative fluoride ion release and change in pH were assessed at the end of 7 days, 14 days, and 21 days. The samples in neutral medium were tested for fluoride ion release and the samples in acidic medium (pH-4) were tested for pH change. The results so obtained were subjected to statistical analysis using ANOVA-F, Paired “t”, and Unpaired t-test.

The mean values of fluoride ion release (ppm) and pH change from different subgroups at 7, 14, and 21 days as depicted in Table 1 and Table 2 respectively.

The probable values of paired t-test between subgroups of Groups AN, BN, CN and AA, BA, CA for fluoride ion release and pH change respectively is depicted in Table 3 and Table 4 respectively.



**Graph 1:** Comparison of mean Fluoride ion concentration among the tested groups



**Graph 2:** Comparison of mean values of pH change among the tested groups

**Table 1:** Mean values of fluoride ion release (ppm) of all the tested 9 subgroups at 7, 14 and 21 days in neutral (N) medium.

DAYS	PARAMETER	GROUP AN	GROUP BN	GROUP CN
7	Ppm	4.22	4.11	3.96
14	Ppm	3.16	2.98	2.93
21	Ppm	2.15	1.82	1.91

**Table 2:** Mean values of pH change of all the tested 9 subgroups at 7, 14 and 21 days in acidic (A) medium.

DAYS	PARAMETER	GROUP AA	GROUP BA	GROUP CA
7	pH	2.09	1.98	2.01
14	pH	2.18	2.03	2.09
21	pH	2.26	2.11	2.18

**Table 3:** Probable values of paired t-test between subgroups for fluoride ion release (\*A statistically significant difference at 0.05 level of significance (P<0.05)).

TIME POINTS (DAY S)	PARAMETER	Probable values of paired t-test		
		AN	BN	CN
7	ppm	0.0001*	0.000*	0.0005
14	Ppm	0.000*	0.000*	0.000*
21	Ppm	0.005*	0.000*	0.001*

**Table 4:** Probable values of paired t-test between subgroups for pH change.(\*A statistically significant difference at 0.05 level of significance (P<0.05))

TIME POINTS (DAY S)	PARAMETER	Probable values of paired t-test		
		AA	BA	CA
7	pH	0.0777	0.0610	0.4598
14	pH	0.7115	0.0589	0.6845
21	pH	0.1429	0.9424	0.2630

**Fluoride Ion Concentration:**

All the materials tested released fluoride ions. The mean values of fluoride ion concentration were compared among 9 subgroups.

The fluoride release in subgroup AN7, AN14 and AN21 was significantly higher when compared to subgroup BN14, BN21 and CN7, CN14 and CN21. However, there was no significant difference between the fluoride release in subgroup AN7 when compared with subgroup BN7 which was for a time period of 7 days. No significant difference was seen amongst subgroups BN14, BN21 and CN14, CN21 which was for a time period of 14 and 21 days respectively.

The fluoride ion release from all tested materials decreased with increasing period of time.

**pH Change:**

All the 9 subgroups tested for pH change showed a statistically significant increase in pH in acidic medium.

An increase in the pH was seen in all materials with the increase in period of time. Subgroups AA7, AA14 and AA21 showed slightly higher pH increase when compared to subgroups BA7, BA14, BA 21. No significant difference was seen in increasing pH among groups AA and CA for all the time periods of 7, 14 and 21 days respectively.

### Discussion:

The present in vitro study made a sincere attempt to evaluate and compare fluoride ion release and alkalizing effect of Bulkfill composite (Cention-N), Giomer (Beautifil II) and Compomer (DyracteXtra).

In the present study, Group A (Cention N) was tested for fluoride ion release for the time durations of 7, 14 and 21 days. The fluoride - ion release concentration (ppm) was found significantly higher viz 4.22, 3.16 and 2.15 for the time period tested for 7, 14 and 21 days respectively, when compared to the other subgroups.

Similar results were achieved by the study of Siddharth Rai *et al* where they compared the fluoride release and recharge capability of Cention N along with the other tested materials.<sup>5</sup> It was observed that Cention N released significantly higher amounts of fluoride and had superior recharge capability. This high release of fluoride ions from Cention N may be attributed to the advanced filler technology used in this material manufacturing.

The contrary findings by Walaa *et al* inferred that Cention N had an inferior fluoride release which can be due to the reason that Cention N lacks a burst effect but constantly releases fluoride over the period may be due to a higher powder/liquid ratio and also a high amount of alkaline glass in its final state.<sup>6</sup>

Regarding the evaluation of the alkalizing potential in the present in - vitro study, Cention N (Group A) showed higher pH change viz 2.09, 2.18 and 2.26 for the time periods 7, 14 and 21 days respectively, in comparison to the other groups tested.

Nupur Gupta *et al* in their research evaluated the alkalizing potential of Cention N and concluded its highest alkalizing potential in accordance to present study.<sup>1</sup> This may be due to the hydroxyl and calcium ions release by alkaline glass fillers from Cention-N, which exerts direct effect on the pH levels in the oral cavity, which attempts to neutralise excess pH due to cariogenic bacterial activity.

In the present study, Group B (Beautifil II) giomer was tested for fluoride ion concentration (ppm) and pH change for the time durations of 7, 14 and 21 days.

In the present study, Group B (Beautifil II) was tested for fluoride ion concentration (ppm) for the time durations of 7, 14 and 21 days. The fluoride ion release concentration (ppm) for Group B were 4.11, 2.98 and 1.82 for the time duration 7, 14 and 21 days respectively. On comparison with other tested groups, the results showed that there was no statistically significant difference when compared with Group C (DyracteXtra) and Group A ( viz 4.22 and 3.96 respectively in fluoride ion release concentration (ppm) at the time duration of 7 days.

Similarly, Group B and Group C had no statistically significant difference in the fluoride ion concentration (ppm) viz 2.98 and 2.93; 1.82 and 1.91 for the time duration of 14 and 21 days respectively.

In contrast to the results obtained in the present study, Dimitrios Dionysopoulos *et al* evaluated the fluoride release in their in vitro study for five restorative materials namely Fuji IX GP, Ketac N100, 3M ESPE, Dyract Extra, Beautifil II and Wave.<sup>7</sup> Among the restorative materials tested, Fuji IX GP released the highest amount of fluoride ions followed by Ketac N100 and Dyract Extra while Beautifil II and Wave did not show any significant difference. This may be due to fact ,GICs release fluoride into an aqueous environment is proposed to comprise two processes. Process I is a short-term reaction which involves rapid dissolution of fluoride from the outer surface into the solution whereas Process II is more gradual and results in a sustained diffusion of fluoride through the bulk cement.

Group B (Beautifil II) was tested for pH change for the time durations of 7, 14 and 21 days. The values of pH in Group B increased for all time durations viz 1.98, 2.03 and 2.11 for 7, 14 and 21 days respectively. On comparing with other tested groups, it was revealed that there was no statistically significant difference seen between Group B (Beautifil II) and Group C (DyracteXtra). However, pH change in Group B (Beautifil II) was significantly lower than Group A (Cention N) viz 1.98, 2.03 and 2.11 at the time durations of 7,14 and 21 days respectively.

Similar results were obtained in the study conducted by Katarina Kelic *et al* that concluded that Beautifil II showed less alkaline pH than Cention N.<sup>8</sup> This is attributed due to

change in diffusion gradient between the material and the immersion medium. The variation in pH for restorative material could be due to different specimen geometry and different specimen media.

In contrast to the results of the present study, Bansal *et al* in vitro study evaluated fluoride release and recharging potential of Conventional Glass Ionomer Cement (Fuji II), Light Cure Resin Modified GIC (Fuji II LC), Giomer (Beautiful II), Compomer (Dyract).<sup>9</sup> It was found initial fluoride release was highest from Conventional GIC followed by Resin Modified GIC, Giomer and Compomer and same was the case in their fluoride recharge capabilities. It may be due to Compomers which contains a mixture of cycloaliphatic dicarboxylic acid dimethacrylate substitute for carboxylic acid and reactive glass fillers. Initially light polymerized material takes up water with time and that the carboxylic groups of the acidic monomer can undergo acid base reaction with metal ions of glass filler. Fluoride release may occur in response to water uptake subsequent to dissolution of the glass filler particles or the ionic reaction on the surface of the glass particles. Glass ionomer formulations can be recharged and release fluoride slowly after exposure to fluoride solutions such as toothpaste and fluoride rinses.

On comparison with other tested groups, the results showed that there was no significant difference between group C and group B in fluoride ion release concentration (ppm) viz 3.96 and 4.11; 2.93 and 2.98; 1.91 and 1.82 at the time duration of 14 and 21 days respectively.

Similar results were observed in in-vitro study done by Sayed Mostafa Mousavinasabet *al.* which compared the amounts of fluoride released from fluoride-containing materials, four glass ionomer cements (Fuji IX, Fuji VII, Fuji IX Extra and Fuji II LC), a compomer (DyractExtra) and a giomer (Beautiful).<sup>10</sup> Here, DyractExtra showed the least amount of fluoride ion release in comparison to the other tested materials. This can be attributed to the porosity of the materials that may have a great influence on the amounts of fluoride release.

In the present study, (DyractExtra) Group C was tested for pH change for the time durations of 7, 14 and 21 days. There was a rise in pH seen in Group C at all time durations viz 2.01, 2.09 and 2.18 for 7, 14 and 21 days respectively. On comparing the results of Group C with other tested groups regarding the pH change, it was seen that Group C (DyractExtra) showed higher pH increase than Group B. This can be attributed due to

the release of ions (Al, Sr) from reactive glass components of the compomer. Moreover, the total fluoride was found to be higher than the free fluoride ion in this compomer that can be one of the factors that neutralizes pH and stops demineralization by buffering the pH.

### Conclusion:

The present in vitro study evaluated and compared the fluoride ion release and alkalizing effect by Bulkfill composite (Cention-N), Giomer (Shofu Beautiful II) and Compomer (DyractExtra).

The following conclusions can be drawn from the present study:

1. All restorative materials released fluoride at all time intervals viz 7, 14 and 21 days.
2. The fluoride ion release from all tested materials decreased with increasing period of time.
3. Cention N showed the highest fluoride ion release when compared to Beautiful II and DyractExtra.
4. All restorative materials showed an increase in pH at all time durations viz 7, 14 and 21 days
5. The increase in pH was seen in all materials with the increase in the period of time.
6. Statistically no significant difference was found in the pH change or alkalizing potential of all the tested restorative materials.
7. Cention N showed the highest pH change or alkalizing potential followed by DyractExtra and Beautiful II.

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