

Full Length Research Paper

# Potassium ion concentration in toothpastes for sensitive teeth on the Ghanaian market

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Tooth sensitivity is a reaction that occurs when the enamel that protects the teeth gets thinner and exposes the underlying layer of dentine. It affects the teeth or exposed root surfaces. This reduces the protection the enamel and gums provide for the teeth. A mode of treatment of sensitive teeth is the use of toothpaste that specifically takes care of sensitive teeth. These toothpastes contain potassium nitrate which acts on the sensitive teeth (or tooth). The purpose of the study is to determine the presence of potassium ion and its concentration in some selected toothpastes for sensitive teeth. Samples from seven different sensitive tooth pastes were prepared. The potassium ion concentration (n=3) from the samples were measured using a Flame Photometry (a chemical technique) at the Chemistry Department of Ghana Atomic Energy Commission (GAEC). Data were analyzed using One-way analysis of variance (ANOVA) from Statistical Package for Social Sciences Software (SPSS, version 22). Potassium ion concentrations in all the samples were within the standard required range of 0.08% to 5%. Enaguard and Sensodyne gel sensitive tooth pastes recorded higher potassium ion concentration values 5.05% and 5.35% respectively and Kojach F-mild the lowest concentration 2.21%. All the seven sensitive tooth pastes would be clinically effective in the treatment of sensitive teeth (or tooth).

**Keywords:** Potassium nitrate, ion, tooth sensitivity, enamel, gingivitis, abrasion.

## INTRODUCTION

Tooth sensitivity is a reaction that occurs when the enamel that protects the teeth gets thinner and exposes the underlying layer of dentine. It is characterized by a short sharp pain arising from exposed dentine in response to stimuli, which can be thermal, osmotic, or chemical that cannot be tagged to any other dental effect or disease<sup>1,2</sup>. About 45%-57% of people in the world get tooth sensitivity and this affects more women than men<sup>3</sup>. Usually, tooth sensitivity is diagnosed when other conditions have been eliminated. Causes of tooth sensitivity include wearing of the teeth due to attrition,

abrasion and erosion<sup>4</sup>. Others are tooth decay, gingivitis, grinding of teeth (bruxism) and plaque buildup.

Tooth sensitivity is based on the hydrodynamic theory that was postulated in the 19th century and widely accepted today. It states that tubular nature of dentine permits fluid movement to occur within the tubule when a stimulus is applied which stimulates pulpal free nerve endings close to the dentine that is transferred to the brain and perceived as a sharp pain<sup>5</sup>.

Various agents have been included in tooth pastes to treat sensitive teeth; these include potassium nitrate, fluoride, silver nitrate, formaldehyde, strontium chloride and others<sup>6,7,8</sup>. Potassium nitrate is a chemical compound with the formula  $KNO_3$  and an alkali metal nitrate. It is also known as saltpeter. Potassium nitrate

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has been used in desensitizing toothpaste to treat tooth sensitivity for a long time now<sup>9</sup>. Potassium ions act by blocking the action of the intradental nerves.

Tooth sensitivity is a major concern because it is very uncomfortable. The knowledge of the concentrations of potassium ions in sensitive toothpastes would enable dental patients select the appropriate and effective paste to successfully treat tooth sensitivity.

Using the hydrodynamic theory, the potassium ions (K<sup>+</sup>) from the potassium nitrate act directly on the nerves by blocking the action potential generated in intradental nerves so that it is not transferred to the brain as pain<sup>10,11</sup>. Delivering potassium ions to the nerves within the pulpal cavity against continuous flow of dentinal fluid would seem to be a problem. In 1986, the American Dental Association Council on Dental Therapeutics granted a seal of acceptance to dentifrices containing 5% potassium nitrate to treat tooth sensitivity<sup>12</sup>. A previous study done in 1995<sup>11</sup> has shown that "potassium ion concentration in the range 0.08% to 0.16% in potassium nitrate around the axons is needed to sustain nerve depolarization.

The purpose of this study is to determine the concentration of potassium ions in some selected toothpastes used in treating sensitive teeth on the Ghanaian Market.

## MATERIALS AND METHODS

This is a cross-sectional laboratory based study. The materials used for the study indicated in Table 1 were seven sensitive toothpastes. The manufacturers and the country of origin of the selected tooth paste after market survey are also indicated in Table 1.

The market survey was carried out in shops selected randomly and located in different suburbs of the Greater Accra region. The results of the survey indicated that these seven sensitive tooth pastes studied were the most common brands on the Market.

### Determination of Potassium ion Concentration

Specimens from the samples of selected different toothpastes for sensitive teeth were prepared for the measurements of potassium ion concentration. The measurements of potassium ion concentration was measured (n=3) using a chemical technique referred to as the Flame Photometre at the Chemistry Department of the Ghana Atomic Energy, Kwabenya-Accra.

The Flame Photometre technique for the measurements is based on the principle that an alkali metal salt drawn into a non-luminous flame will ionize, absorb energy from the flame and emit light of a certain wavelength as the excited atoms decay to the unexcited ground state. The emitted light is converted to a voltage which can be recorded<sup>13,14</sup>. The intensity of emission is proportional to the concentration of the element in solution.

## Statistical Analysis

Data was analyzed using One-way analysis of variance (ANOVA) from Statistical Package for Social Sciences Software (SPSS, version 22).

## RESULTS

The means and the standard deviations of the potassium ion concentration in the different toothpastes for sensitive teeth are summarized in Table 2. The potassium ion concentration in two of the specimens was above the required standard value of 5% and five were below but above the minimum required value of 0.08%. Enaguard and Sensodyne gel recorded the highest potassium ion concentration of 5.05% and 5.35% respectively while Kojach-F (mild) recorded the lowest potassium ion concentration of 2.21%.

There was significant differences ( $p < 0.05$ ) in potassium ion concentration between the different toothpastes for sensitive teeth. The comparison of the potassium ion concentration of the different toothpastes brands is shown in Fig. 2.

## DISCUSSION

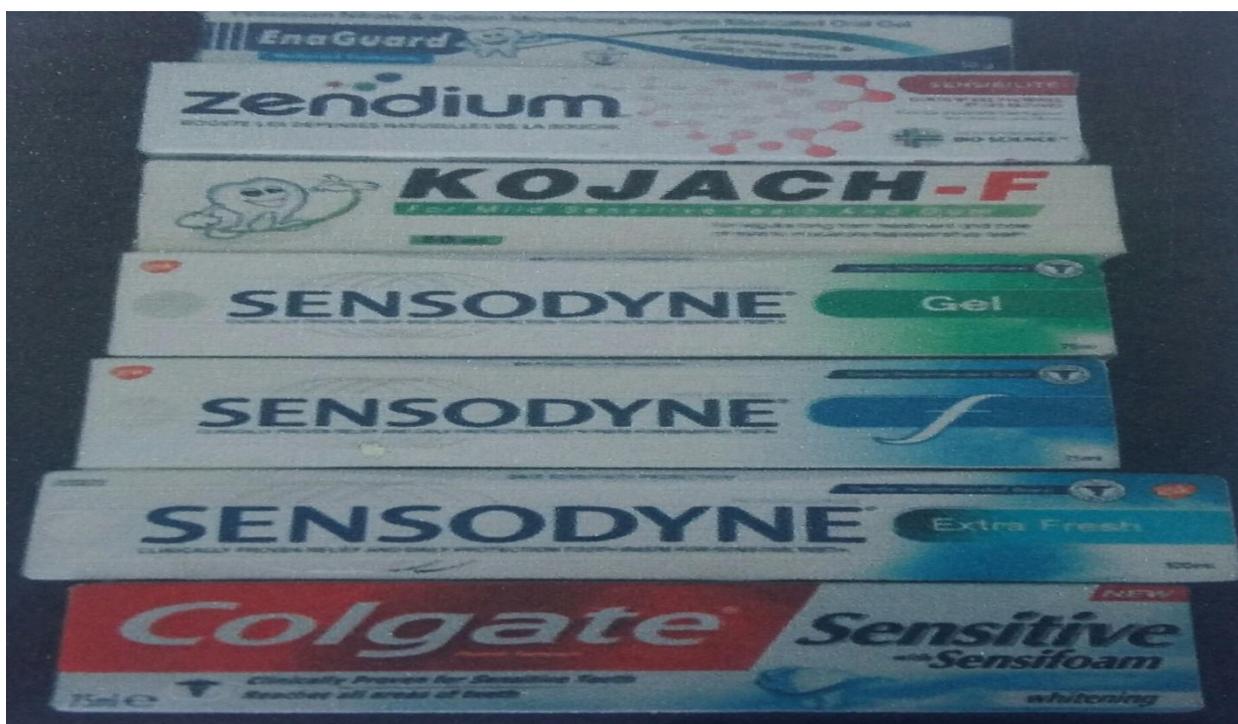
Dentinal hypersensitivity is a very dominant dental problem and its prevalence ranges from 8% to 57% in the adult population<sup>15, 16</sup>. It has been reported to be widespread in 20–30 year olds and then increases when these people are in their 50s<sup>17</sup>. It can be expressed as a short sharp pain due to osmotic, thermal, tactile and mechanical stimuli, which occurs as a result of brushing of teeth, eating sweet and sour foods, and drinking hot or cold water, when in contact to the exposed dentin<sup>18, 19</sup>. Toothpaste with desensitizing agents can normally be used to treat most cases when brushing ones' teeth<sup>20</sup>. Currently, potassium nitrate is mostly used as a desensitizer in toothpastes sold in various countries. Other desensitizing agents used currently in clinical trials include salts of potassium such as citrate<sup>21</sup>, chloride<sup>21</sup>, oxalate<sup>22, 23, 24</sup>.

A number of sensitive toothpastes on the Ghanaian market have been reported to be ineffective in the treatment of tooth sensitivity. The present study was undertaken to determine potassium ion concentration in toothpastes for sensitive teeth found on the Ghanaian market. The sensitive toothpastes were analyzed and their manufacturers were indicated in Table 1 which contained information of their ingredients such as potassium nitrate. Enaguard was the only one which had its percentage written on it as 5%.

The results from the study as indicated in Table 2 demonstrates that potassium ions concentration in all the toothpastes determined by a chemical technique (Flame Photometry) contained required standard amounts of

**Table1.** Selected sensitive tooth pastes studied.

Sensitive tooth paste	Manufacturer	Country of origin
Enaguard	Pregen Exports	India
Zendium sensitive	Unilever	Holland
Kojach-F mild	Unilever	Nigeria
Sensodyne Gel	GlaxoSmithKline	United States of America
Sensodyne F	GlaxoSmithKline	United States of America
Sensodyne Extra Fresh	GlaxoSmithKline	United States of America
Colgate sensitive	Colgate	United Kingdom



**Fig. 1** Sensitive toothpastes studied.

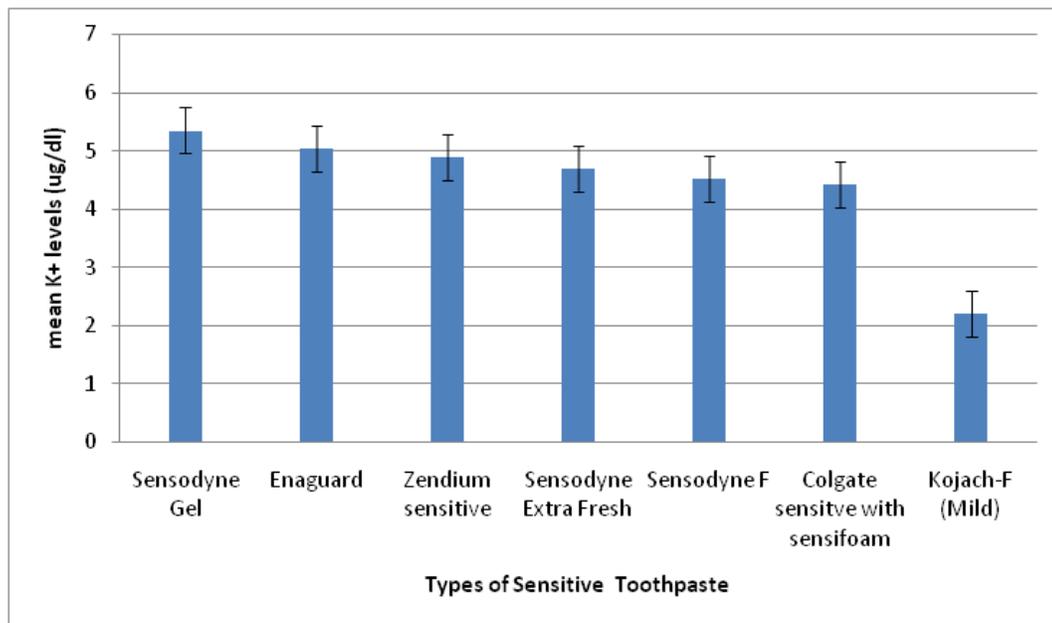
potassium ions, and well above the lower limit of 0.08%, the minimum concentration needed to sustain nerve depolarization as reported in a previous study<sup>7</sup>. Comparing the concentrations of potassium ions in all the sensitive tooth pastes studied, there were significant differences between the values.

The maximum amount of potassium ions in two of the toothpastes studied were in agreement with the 5% amount proposed in 1986 by the American Dental Association Council on Dental Therapeutics<sup>8</sup> in dentifrices containing potassium nitrate to treat tooth sensitivity.

Enaguard and Sensodyne Gel exceeded the upper limit of the standard value of 5%. These toothpastes would be clinically effective in treating sensitive teeth compared to the others. Though it may be rare, care must be taken with the use of these toothpastes with high potassium ion concentration, since they could have the possibility of increasing patients potassium levels. This may result in abnormal heart rhythm, cardiac arrest or intestinal ulcerations. Kojach F-mild recorded the lowest potassium ion concentration of 2.21% and may clinically be effective in treating milder forms of sensitive teeth (or tooth).

**Table 2.** Mean potassium ion concentration of various toothpastes.

TOOTHPASTE	Potassium ion concentration (%)
Enaguard	5.05(0.186)
Zendium sensitive	4.89(0.092)
Kojach-F (mild)	2.21(0.070)
Sensodyne Gel	5.35(0.064)
Sensodyne F	4.53(0.012)
Sensodyne Extra Fresh	4.71(0.023)
Colgate sensitive with sensifoam	4.43( 0.110)



**Fig. 2.** Comparison of the potassium ion concentration of the sensitive toothpastes brands.

## CONCLUSION

All the sensitive toothpastes studied contained adequate concentration of potassium ions. They may be effective in treating sensitive teeth, particularly Enaguard and Sensodyne which recorded higher concentration of potassium ions.

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