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Review Article

Potential of Strawberry (*Fragaria x annanasea*) Extract as Whitening Agent for Discolored Teeth

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Abstract:
The Bleaching technique has long been applied in dentistry. Strawberry (*Fragaria x annanasea*) is a non-dental material that can be used for natural bleaching. The strawberries contain ellagic acid and malic acid which can whiten teeth. Other ingredients found in strawberries also have a low pH so they can whiten teeth better when compared to other fruits. Strawberries also give bad side effects, namely increased tooth sensitivity. This research aims to explain the potential of strawberry (*Fragaria x annanasea*) extract as a whitening agent against discolored teeth. Based on reference sources obtained from journals, textbooks, and websites accessed through the databases of Google Scholar, Science Direct, EBSCO, and PubMed (National Library of Medicine, Bethesda, MD, USA) and searched for the keywords "Bleaching, Strawberries (*Fragaria x annanasea*), and Discoloration." The types of journals taken are scientific and descriptive journals published from 2010 – 2020 and dental material textbooks from 2010 – 2020. The research concludes that the use of strawberry (*Fragaria x annanasea*) fruit extract can provide a whitening effect on teeth that have changed color and is the best solution compared to synthetic tooth whiteners. In addition, strawberries also provide side effects, namely increased tooth sensitivity.

Key Words: strawberry (Fragaria X Annanasea), extract, whitening, teeth changed color

Introduction:

In the era of globalization as it is today, aesthetics is one of the things that people care about [1]. Technological developments make patients begin to understand and care about oral health and the desire to have a perfect smile. Teeth are one of the determining factors of aesthetics apart from having a function in the masticatory process. The outermost surface of the tooth is the enamel, the next layer is dentin and the innermost layer is the pulp [2].

Tooth enamel may become discolored, and the discoloration can be either physiological or pathological. Physiological discoloration that occurs in teeth can be caused by age, because the dentin layer is thicker, due to the formation of secondary and reparative dentin. The pathological discoloration is divided into two, namely extrinsic and intrinsic. Extrinsic discoloration can be caused by deposits on the outer surface of the teeth. Meanwhile, tooth discoloration is intrinsically caused by factors from within the pulp tissue [3].

For almost a century, dentists have performed teeth whitening procedures, also known as bleaching. Dental bleaching is a dental treatment that is popular among the public and continues to grow for aesthetics. Bleaching materials are widely used, there are natural bleaching agents and chemical bleaching agents. The chemical bleaching agent commonly used is hydrogen peroxide which is believed to be able to remove chromatic particles (dental particles that readily absorb dyes) on the teeth [4]. Hydrogen peroxide is indicated for removing stains on vital and non-vital teeth. Teeth whitening in non-vital teeth can be performed using external, internal techniques, or a combination of these two techniques. Vital teeth whitening can be performed with any type of

product that can be used at home or work. One of the side effects that can occur after the bleaching procedure is increased tooth sensitivity. Overall, bleaching products are safe for use on humans. The teeth whitening process will certainly produce a very good aesthetic aspect so that it will improve the appearance of a person. Therefore, usually, workers in the entertainment sector often want to whiten their teeth bleached such as presenters, broadcasters, reporters, artists, models, singers, or people who will attend big events such as weddings, etc [4].

The use of natural ingredients is popular nowadays because many advantages can be taken when using natural materials, for example, it is safer, cheaper, and easier to obtain when compared to chemicals [5]. Strawberries (*Fragaria x annanasea*) are one of the natural ingredients that can now be used to whiten teeth that have changed color because strawberries contain ellagic acid (ellagic acid) and malic acid (melic acid) which can whiten teeth. Other ingredients found in strawberries (*Fragaria x annanasea*) also have a low pH, so they have a better ability to whiten teeth when compared to other fruits [6].

Yulita et al. (2019), stated that strawberry extract with a concentration of 100% and 75% was sufficient to give until day 5 (to get an intensity score = 1), while strawberry extract with a concentration of 50% and 25% took longer to reach an intensity score = 1. Strawberry extracts with concentrations of 100% and 75% were sufficient to give until the fifth day (getting an extension score <2), while 50% and 25% strawberry extracts took longer to reach an extension score of <2 [3]. Karmawati et al. (2020), showed that the effect of a strawberry extract with 100% concentration on the disappearance of extrinsic stains did not even take up to 5 days of treatment for some respondents, because the respondents' staining score had reached 0 before the 5th day. It can be concluded that strawberry fruit extract with a concentration of 100% can clean extrinsic stains on teeth effectively within 2 to 4 days. Based on this background, writing an article with a literature review study is interesting to study more deeply to know the potential of strawberry extract (*Fragaria x annanasea*) as a whitening agent for teeth that have changed color [7].

Method:

This study was conducted based on reference sources/references obtained from journals, textbooks, and websites accessed through databases of Google Scholar, Science Direct, EBSCO, and PubMed (National Library of Medicine, Bethesda, MD, USA) and searched for the keywords "Bleaching, Strawberries (*Fragaria x annanasea*), and Discoloration." The types of journals taken are scientific and descriptive journals published from 2010 – 2020 and dental material textbooks from 2010 – 2020.

Result:

Teeth Whitening (Dental Bleaching)

Teeth whitening is a conservative and effective method of lightening discolored teeth and has been practiced in dentistry for centuries. During development, careful observation and research on various materials and techniques enabled the dentistry profession to introduce effective, safe, and predictable methods for whitening teeth. Carbamide Peroxide ($CH6N2O3$) and Hydrogen Peroxide ($H2O2$) are types of active peroxides used for extra coronal teeth whitening procedures. Sodium Perborate ($NaBO3$) is the main ingredient used as an intracoronal tooth bleaching agent. Carbamide peroxide or urea hydrogen peroxide is in the form of crystals or crystalline powder. Chemically, carbamide peroxide is composed of 3.5 parts of ($H2O2$) and 6.5 parts of urea. Sodium perborate has a white powder-like texture and is available as a monohydrate, trihydrate, or tetrahydrate. Monohydrate and tetrahydrate are widely used for intracoronal bleaching with ($H2O2$). Hydrogen peroxide produces reactive oxygen species (ROS) compounds. Therefore, the level of toxicity possessed by ($H2O2$) is influenced by the amount of ROS produced [8].

Types of Bleaching Treatment:

1. Non-Vital Teeth

Trauma to the teeth is very diverse. Each pulp will have a different response. The pulp may persist, necrotic, or developmental abnormalities in the root canal. Sometimes clinically this abnormality is not visible, so it is necessary to do a dental X-ray first. Teeth that have been treated with root canals are suspected to be one of the reasons for discoloration due to blood products contained in the dentinal tubules, which can be caused by trauma or post-endodontic therapy. There are two types of bleaching techniques for non-vital teeth namely external techniques and internal

techniques. Bleaching with an external technique using a single-tooth tray is performed on discolored teeth after years of endodontic treatment. An external technique was used to prevent damage to the composite filling. Bleaching with internal techniques is done by applying Hydrogen Peroxide to the pulp. To increase its chemical reaction, heat or light can be applied. This technique is known as the Thermocatalytic Technique. External techniques and internal techniques can be done in combination [4].

2. Vital Teeth

Bleaching of vital teeth can be done with the in-home technique and in-office technique. In-home technique treatments carried out outside the clinic and dentists have given special consideration before this application. This technique uses a fitted-tray and carbamide peroxide concentrate 10% overnight. This technique is most often used and is one of the most effective. The in-office technique is carried out in a dental clinic by a dentist and uses hydrogen peroxide with a concentration of 15-40%. Hydrogen Peroxide must be in contact with the outer surface of the enamel and soft tissues must be protected throughout the procedure. A hydrogen peroxide gel is then applied to the tooth surface for approximately three to four minutes, according to the manufacturer's instructions [4]. Generally, the indications for vital teeth bleaching techniques are similar to nonvital teeth bleaching techniques with patient preference, cost, convenience, and difficulty in removing the discoloration that determine the choice of treatment or combination of treatments. Indications for intrinsically vital teeth bleaching include discoloration due to aging, trauma, or certain medications. Bleaching of vital teeth is also often indicated before and after restorative treatment to harmonize the color of the restorative material with the natural teeth [9].

Bleaching mechanism

The process of teeth whitening is not fully understood. Research shows that bleaching agents penetrate intact enamel and dentin into the pulp in 5 to 15 minutes. The whitening process is designed to allow oxidizing agents to penetrate the teeth to allow a chemical reaction to occur and remove chromatic particles. Carbamide peroxide penetrates ~~into~~ the teeth and is broken down into urea and hydrogen peroxide. Urea further decomposes into ammonia and carbon dioxide. The role of urea is to extend the shelf life of the product. Hydrogen peroxide decomposes into oxygen and water and liberates the chemically reactive free radical perhydroxyl (HO2) with great oxidative power. 10% carbamide peroxide corresponds to about 3.5% hydrogen peroxide. Therefore, 20% carbamide peroxide is equivalent to 7% hydrogen peroxide, and 30% carbamide peroxide is equivalent to about 10% hydrogen peroxide. Peroxide not only removes discoloration from inside the tooth but also changes the color of the dentin [4].

Strawberries (*Fragaria x annanasea*)

Strawberries are a rich source of vitamin C and several other antioxidant compounds. Strawberry fruit and leaves are efficacious as natural skin whiteners, and teeth enamel whiteners and prevent tartar build-up [5]. The popularity of strawberries as a fruit plant is primarily the result of are unique aroma, sweet taste, bright color, and nutritional value. These quality characteristics are largely determined by the metabolic composition of the fruit. For example, strawberries are known to be a valuable source of polyphenolic compounds, mainly flavonoids. Approximately 70% of the total phenolics accumulated in ripe fruit correspond to proanthocyanidins (PAs), anthocyanins, flavonols, and other phenolics (i.e., p-coumaric acid, ellagic acid) representing concentrations of 20%, 3 and 7%, respectively [10].

Strawberry (*Fragaria x annanasea*) content

Strawberries contain ellagic acid and malic acid which can whiten teeth. Ellagic acid is a derivative of gallic acid found in strawberries, usually present in the form of ellagitannins as esters of dhipenic acid analogs with glucose. (Figure1). High levels of ellagic acid are preserved in food products such as jams and juices. The daily intake is estimated at 90 mg and has antioxidant and antiviral properties that can be used as food additives [11].

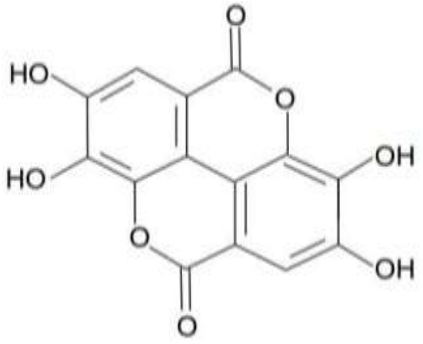

Figure 1 Chemical Structure of Elegic Acid [11].

Ellagic acid is anticarcinogenic and antimutagenic of phenolic compounds which is also very important for cardiovascular disease. Ellagic acid is phenolic compound found in very high amounts in strawberries. Strawberries contain a higher amount of ellagic acid than other fruits [12].

Strawberry Working Mechanism as Whitening

Larasati et al. (2012) explained that the reaction that occurs in this compound is the oxidation of ellagic acid so that electrons can bind to substances that can cause color changes in the enamel [13]. The electronegative difference between O and H+ in the OH- group, which is greater than CO and OH in the COOH group, causes this group to be more easily broken down and produces H+ radicals. The H+ radicals formed then bind to 3 tertiary C molecules contained in the discolored tooth enamel. This bond causes electron conjugation disturbances and changes in energy absorption in organic molecules, subsequently; organic molecules are formed, so that the enamel is an unsaturated structure. After the H+ radical is released, the ellagic acid releases 4 OH radicals which can disrupt the unsaturated structure of the enamel into a saturated structure with a lighter color [13]. 16 maxillary and mandibular anterior teeth each and all samples had extrinsic staining. Samples were randomly divided into 4 groups, each group consisting of 8 teeth treated with strawberry extract with concentrations of 100%, 75%, 50%, and 25%. After 5 minutes, the teeth were rinsed and dried. The study was conducted in vitro for five consecutive days with treatment

Discussion:

The use of natural ingredients is popular nowadays because many advantates can be taken when using natural materials, for example, it is safer, cheaper, and easier to obtain when compared to chemicals. Purnamasari et al. (2010) said that research using natural ingredients is widely carried out because it is considered very useful where since ancient times our society has believed that natural ingredients can treat various diseases and rarely cause adverse side effects compared to drugs made from synthetic materials. One of the natural ingredients that can be used in human daily life is for example strawberries. [5][14].Edhi quoted by Hertanto stated that the rate of dissolution of enamel is influenced by the degree of acidity (pH), acid concentration, dissolving time, and the presence of ions such as calcium and phosphate. The enamel demineralization condition occurs when the pH of the solution is lower than 5.5 [15].

Retnosari quoted by Hertanto said that the presence of electrons released by ellagic acid in strawberries resulted in unpaired electrons binding to free radicals from the organic and inorganic matrix of teeth to achieve stability [15]. The reaction between oxygen free radicals with the organic and inorganic matrix of tooth enamel causes demineralization of enamel, thus causing a decrease in enamel hardness [15]. The malic acid content in strawberries can whiten teeth [16]. Lower quoted by Yuniarti said that chemically, acid is a substance that in water can produce hydrogen ions (H+) [17]. The acid will be ionized into hydrogen ions and the remaining ions of the acid are negatively charged. Some of the acids found in everyday life include malic acid. The basic nature of acids is corrosive, reacts with metals to form H2, has an acidic taste, and produces H+ ions in water [17].

Margaretha quoted by Yuniarti explained that the reaction that occurs between malic acid and the substance which causes staining on teeth is the oxidation reaction of malic acid. The reaction releases electrons which can bind to substances causing discoloration of the enamel [17]. The difference in electronegativity between O and H+ in the OH- group is greater when compared to CO- and OH- in the COOH group and causes it to break more easily and produce H+ radicals. The H+ radicals formed then bind to 3 tertiary C molecules found in discolored tooth enamel. This bond results in impaired electron conjugation and changes in energy absorption in the enamel organic molecules so those enamel organic molecules with an unsaturated structure are formed. After the H+ radical is released, malic acid releases 4 OH- radicals which can disrupt the unsaturated structure of the enamel into a saturated structure with a lighter color [17]. Santoso and Hapsari cited by Yuniarti said that apart from being able to whiten teeth, strawberries can also cause tooth erosion [17].

Yulita (2019) compared the effectiveness of strawberry extract with concentrations of 100%, 75%, 50%, and 25% in cleaning extrinsic stains on teeth. The sample used in this study were 32 anterior permanent teeth that had been extracted, consisting of 16 maxillary and mandibular anterior teeth each and all samples had extrinsic staining. Samples were randomly divided into 4 groups, each group consisting of 8 teeth treated with strawberry extract with concentrations of 100%,

75%, 50%, and 25%. After 5 minutes, the teeth were rinsed and dried. The study was conducted in vitro for five consecutive days with treatment twice a day. The intensity score and stain extension score were measured using the Lobene Stain Index. All samples experienced a decrease in intensity and extension scores, the largest decrease in intensity and extension scores was obtained from strawberry extract with a concentration of 100%. A significant decrease in the intensity score occurred on the third day and continued until the fourth and fifth days, while a significant decrease in the extension score occurred on the fourth day and continued until the fifth day. Four groups of strawberry extract concentration gave a decrease in scores that distinguished the frequency of treatment.The higher the concentration, the smaller the frequency of the decrease in the score, while at low concentrations the decrease in the score requires more frequency [3]. This research is in line with previous research conducted by Karmawati et al. (2015), where the application of crushed strawberries carried out for 5 consecutive days can significantly reduce the staining score [18].

Karmawati (2020), said that the effect of a strawberry extract with a concentration of 100% on the disappearance of extrinsic stains did not even take up to 5 days of treatment for some respondents, because the respondent's staining score had reached 0 before the 5th day. It can be stated that strawberry fruit extract with a concentration of 100% can remove extrinsic stains on teeth effectively within 2 to 4 days. Karmawati's research used 31 people with upper and lower teeth abnormalities. anterior teeth with extrinsic stains as samples. Data were collected by applying strawberry extract with a concentration of 100% on the surface of the anterior teeth, left for 5 minutes, then brushed and rinsed with water. This procedure is carried out 2 times a day for 5 consecutive days. Changes in extrinsic staining were measured using the Lobene Stain Index which measures the intensity and area of the stain, as well as a combined score of the two. The average combined score with measurements using the lobeline staining index for extrinsic staining before being given strawberries was 22.4. The score decreased every day from day 1 to day 5 of treatment. The biggest decrease in the average Combined Score occurred on the 2nd day, from a score of 20.0 on the 1st day to 14.6 on the 2nd day with a percentage decrease of 35.0%. The statistical test showed a significant result of 0.000 reducing the intensity score and area score from the 2nd day to the 5th day [7].

Radhakrishnan (2021) stated that whitening tooth enamel with strawberry fruit extract with a concentration of 2% can efficiently and effectively whiten the surface without significant adverse effects on the enamel surface. This in vitro study was conducted using 15 specimens. The specimens were cut at the cementoenamel junction to obtain the crown portion and stored in saline until further experimental procedures were performed. The specimens were then immersed in a tea solution for 24 hours, then they were removed and measured using a reflectance spectrometer to record basic color variables (pre-bleaching). The labial surfaces of the specimens were exposed to 2% strawberry fruit extract for 5 minutes each using a cotton tip applicator which was refilled every minute. They were then rinsed and stored in artificial saliva at room temperature for 24 hours and subsequently subjected to a reflectance spectrometer to obtain a post-bleaching variable color [19].

Juanita (2019), stated that 10% strawberry extract gel has the same potential as 10% carbamide peroxide to reduce extrinsic discoloration of composite resins. This research is a laboratory experimental study using 40 molded composite resins with a diameter of 8 mm and a thickness of 2 mm. Samples were immersed in the coffee solution for 7 days to get color changes and examined with the shade guide VITAPAN classic® and adobe photoshop CS4 Version 11.0 using the CIEL*a*b method. The color-changing samples were randomly divided into two groups of 20 samples each. Group, I was treated with 10% strawberry extract gel for 8 hours every day for 12 consecutive days and group II as a control group was given 10% carbamide peroxide in the same way as a group I. The study showed significant color changes in each group. According to the Friedman test ($p<0.05$), in group I there was no significant difference in color change when compared to group II based on the results of the Mann-Whitney test. 10% strawberry gel or 10% carbamide peroxide cannot return the composite resin color to baseline [20].

Conclusion:

The use of strawberry fruit extract can provide a whitening effect on discolored teeth and is the best solution compared to synthetic tooth whiteners. The higher the concentration of strawberry fruit extract, the higher the teeth whitening will be.

Nevertheless, strawberries can also cause side effects, namely increased tooth sensitivity.

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