In Vitro Evaluation of Quercetin-Quinidine Extract on Absorbable Sutures

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Abstract

Introduction: Sutures are classified into two types: absorbable sutures and non-absorbable sutures. For any suture to be effective, the tensile strength must be properly restored. This study focuses mainly on two sutures namely, Vicryl and PGA. Quercetin and Quinidine were taken to analyze the effect it has on the above mentioned sutures. The aim of the study is to find the influence of the compounds quercetin and quinidine on absorbable sutures PGA and Vicryl.

Materials and Methods: Moringaoleifera and green tea leaves, were dried and powdered with a mortar and pestle. The powder was combined with alcohol and shaken for 24 hours. Quinidin-Quercetinethanolic extract was created. Both quercetin (flavonoid) and quinidine (alkaloid) were tested for antioxidant and anti-inflammatory properties. Sutures coated with quercetin-quinidine extract were immersed in artificial saliva at ph 4.4., and 7.2 respectively and analyzed for their tensile strength at day 0 and day 7.

Results: The anti-inflammatory property of the extracts is found to be 65% which is lower than the control group diclofenac at 95%. The antioxidant property of the extract (75%) is lesser than the value exhibited by the control group, ascorbic acid (95%). By comparing the tensile strength after 7 days of incubation in artificial saliva, it is noted that Vicryl has a lesser degradation rate than PGA.

Conclusion: This study reveals that the components quinidine and quercetin have a significant role to play in the degradation potential of absorbable suture materials.

Key words: Sutures, Quinidine, Quercetin, PGA, Vicryl.

1. Introduction

Sutures are materials, both synthetic and organic, that are used to close wounds in tissues, notably after an operative procedure. An effective suture must be easy to handle, a firm knot-tying property and must be resistant to infection when administered with an antibacterial

agent (Byrne and Aly, 2019). Sutures are classified into two types: absorbable sutures and non-absorbable sutures. Non-absorbable sutures generally include materials like silk and polybond which cannot be metabolized by the human body. However, absorbable sutures are made from polyglycolic acids which can be naturally absorbed by the body. Other advantages of using absorbable suture over the non-absorbable ones is that it causes lesser discomfort for the patient and a lower frequency of wound exposure. (Chill et al., 2022)

With some procedures, like cardiovascular surgeries, there is limited connective tissue response, and the strength of the suture is considered necessary for the wound to close properly (Hollman et al., 1997). For any suture to be effective, the tensile strength must be properly restored. This study focuses mainly on two sutures namely, Vicryl and PGA. Two food components, Quercetin and Quinidine were taken to analyze the effect it has on the above mentioned sutures. The flavonoid, quercetin, is predominantly available in shallot flesh and onions. Thus might be differently absorbed because of the different types of sugar attached to the molecule. (Hollman et al., 1999). In vitro evidence suggests that quercetin has anticancer mechanisms ranging from antioxidant to antiproliferative, pro-apoptotic, cell signaling effects, and growth factor suppression, as well as potential synergism with some chemotherapeutic agents.(Choi et al., 2001)(Braganhol et al., 2006)(Aalinkeel et al., 2008). Quinidine, on the other hand, is an alkaloid which is most frequently found in the bark of cinchona trees. It is an enantiomer of the drug quinine and is often used to treat arrhythmia and malaria (Brodsky, 1996; Choi et al., 2001). It is also used in treatment of Brugada syndrome, short QT syndrome and idiopathic ventricular fibrillation (Serdoz et al., 2019). These two compounds, quercetin and quinidine were specifically chosen because they are one of the most frequently consumed products and the aim of the study is to:

- To prepare the quercetin-quinidine extract and coat in on the suture materials
- To identify the anti-oxidant and anti-inflammatory properties of the extract
- To analyze the coverage of the extract on the suture materials using a SEM
- To test the extent of degradation by testing the tensile strength at day 1
- To test the extent of degradation by testing the tensile strength at day 7 by soaking in artificial saliva.

2. Materials and Methods

Ethanolic extract preparation: Moringaoleifera and green tea leaves were dried and pulverized with a mortar and pestle. 50g of this powder was combined with 100ml of alcohol and shaken for 24 hours. Quinidine-Quercetinethanolic extract was created. Likewise, an ethanolic extract of quinidine was created. The absorbable sutures (PGA and PG 610) were coated in a mixture of the extracts (25 mg/ml alkaloids and 75 mg/ml flavonoids) and then analyzed using the immersion dip method. Both quercetin (flavonoid) and quinidine (alkaloid) were examined for antioxidant and anti-inflammatory activities. Ascorbic acid/vitamin C served as the anti-oxidant control group. This was selected based on its higher nutrient content and tissue healing and collagen formation properties.

Fig1. MoringaOleifera leaves

Fig2. Quinidine and Quercetin extract used for coating

Artificial Saliva Preparation

1L of artificial saliva was prepared using 0.355g of sodium bicarbonate, 0.231g of potassium hydrogen phosphate, 40 ml of 1.0M hydrochloric acid, 0.072g of sodium sulfate, IM hydrochloric acid, 8.035g of sodium chloride, . 0.225 of potassium chloride, 0.311g of magnesium chloride, 0.292g of calcium chloride and 6.118g of Trizma Base in a mixture. The saliva was kept aside in two beakers in a pH of 7.4 and 4.4

Coating on the Absorbable Sutures

The Vicryl and PGA sutures were cut into 6 pieces of 10.5 cm and 1.5cm equally. They were then soaked in the quercetin-quinidine extract for 24 hours. The longer threads were then taken to test the tensile and degradation property of the suture. The sutures were then divided into the following groups:

Group I - uncoated Vicryl suture
Group II - uncoated PGA suture
Group III - PGA suture at pH 4.4 coated with quercetin-quinidine extract
Group IV - PGA suture at pH 7.2 coated with quercetin-quinidine extract
Group V - vicryl sutures at pH of 4.4 coated with quercetin-quinidine extract
Group VI -vicryl suture at pH 7.2.coated with quercetin-quinidine extract

Assessment of the Antioxidant Property

The free radical scavenging method of,-diphenyl—picrylhydrazyl (DPPH) is used to determine the antioxidant capacity of extracts. All synthesized compounds were dissolved separately and serially diluted in a 0.004% methanolic DPPH solution. After 30 minutes of incubation at 37°C, the absorbance was measured with a spectrophotometer.

Assessment of the Anti-Inflammatory Property

Anti-inflammatory property of the compound was found using the Bovine Serum Albumin test. The artificial saliva created in the lab was used to create the oral environment in which the sutures were placed. This presence either increases or decreases the activity of flavonoids and alkaloids, specifically quercetin and quinidine, which are naturally present in the food we eat. Through SEM image analysis, the amount of coating of the sutures with a mixture of quercetin and quinidine extract was compared to the control group. Tensile strength and degradation of sutures after coating were measured and tabulated from day one to day seven. The final SEM and tensile strength values were tabulated and analyzed.

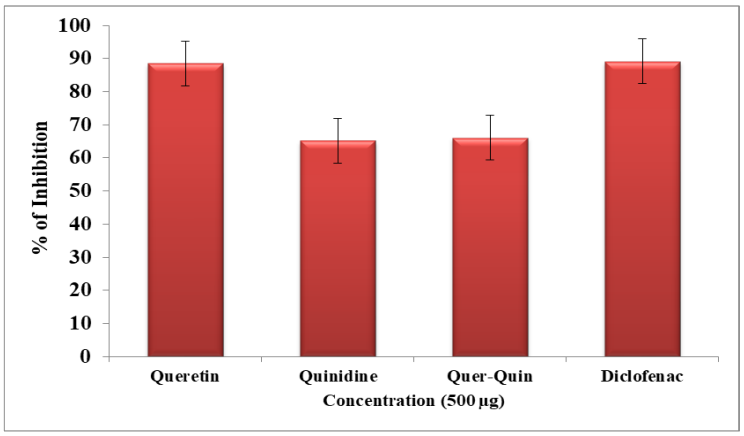
SEM Analysis

The SEM images were taken using JEOLIT 800 FESEM and were coated with platinum sputter coater to make a sample conductive nature. The suture was cut into 1cm to confirm that the coating of PGA and Vicryl with an ethanolic extract of a quercetin-quinidine mixture is uniform.

Evaluation of the tensile strength of the sutures

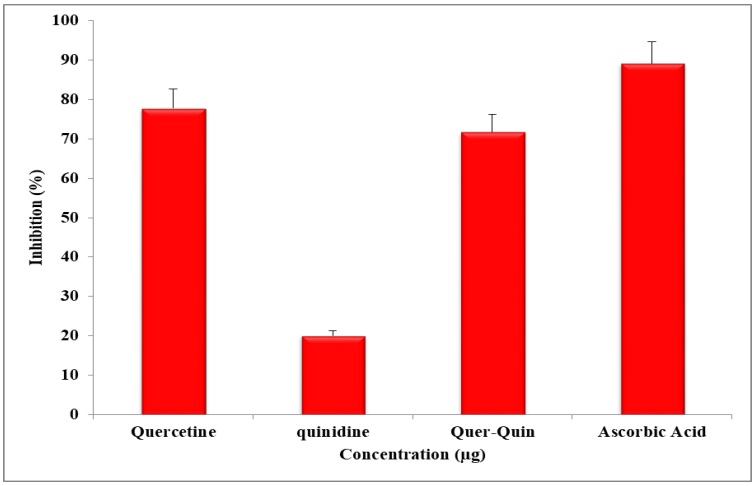
The tensile strength test was performed with an Instron E3000 ETM. Tensile force was applied to the sutures at 0.5 mm/min cross head speed. The suture fracture was noticed, and the highest force in newtons was recorded. The control group was lower than that of the PGA coated group, which is consistent with Vicryl's findings. The coated sutures were stored in artificial saliva at two different pH levels, 7.7 and 4.4, corresponding to pediatric and adult patients.

3. Results



Graph 1. Anti-inflammatory properties of the Alkaloid and Flavonoid exhibited by plotting the concentration of compounds against % of inhibition

Graph 1 shows the anti-inflammatory property of the quercetin-quinidine which is at 65%. Compared to the anti-inflammatory property of quercetin which is at 90% and quinidine at 65%, the control group has a higher value of 95%. It can be inferred that the addition of quinidine to the alkaloid had reduced the anti-inflammatory response by 25%.



Graph 2. Antioxidant properties of quinidine, quercetin and the mixture of the compounds compared with the control group Ascorbic acid

As shown in the 2nd graph, the antioxidant property of the alkaloid quinidine is at 20% and that of the flavonoid quercetin, is at 75%. By mixing the alkaloid and the flavonoid, there is an apparent increase in the antioxidant activity observed and though it is 50% more than the antioxidant property of quinidine, it is lesser than that of the control group Ascorbic acid (95%).

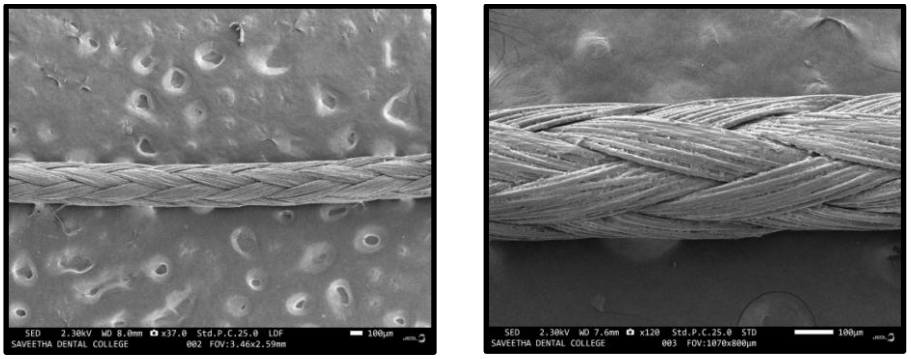


Figure 3.SEM images of quercetin and quinidine coated on Vicryl at day 1 and day 7

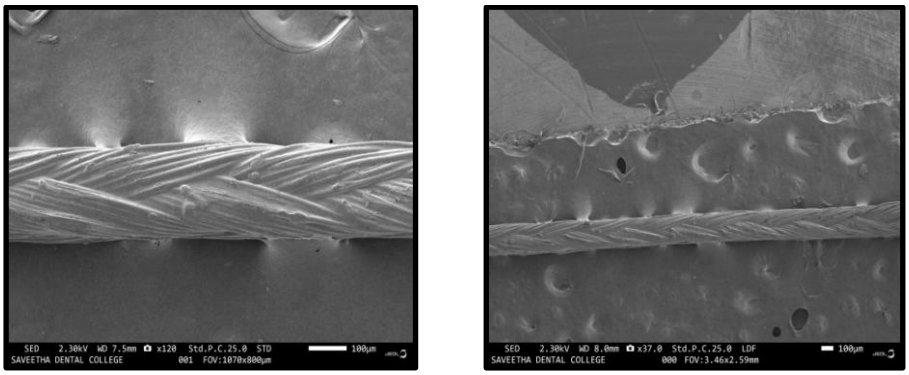


Figure 4.SEM images of quercetin and quinidine coated on PGA at day 1 and day 7

The SEM pictures demonstrate that the coating was applied evenly. It depicts the photos of the coated groups. The coated group has an extra film layer on top. It denotes that the materials are applied with a layer of alkaloid and flavonoid.

Table 1. The tensile strength value of uncoated suture materials at day 1

Groups	Specimen	Maximum Force [N]	Tensile stress at tensile strength [MPa]	Tensile strain at break [%]
I	Vicryl (uncoated)	21.83	3400.61	17.73
II	PGA (uncoated)	9.28	1437.78	23.14
III	PGA at 4.4 pH	9.76	1520.16	21.09
IV	PGA at 7.4 pH	9.88	1544.41	22.74
V	Vicryl at 4.4 pH	17.56	2742.16	12.32
VI	Vicryl at 7.4 pH	21.26	3318.89	10.7

Table 2. The tensile strength value of coated suture materials at day 7

Groups	Specimen Label	Tensile strength at break [%]
I	Vicryl (uncoated)	3319.91
II	PGA (uncoated)	1343.43
III	Coated PGA at 4.4 pH	1467.57
IV	Coated PGA at 7.4 pH	1456.67
V	Coated vicryl at 4.4 pH	2709.08
VI	Coated vicryl at 7.4 pH	3273.07

According to the results displayed in table 1, the tensile strength of the vicryl suture had decreased in both pH 4.4 (2742.16 MPa) and pH 7.4 (3318.89 MPa) when compared to the original, uncoated tensile strength of the suture (3400.61 MPa) at day 1. The sutures were placed in the saliva for 7 days and then was tested for the extent of the tensile strength. It was found that the tensile strength further decreased to 2709.08 MPa and 3273.07 MPa at pH 4.4 and 7.4 respectively (table 2). The PGA sutures had a tensile strength of 1437.78 MPa before it was coated with the quercetin-quinidine extract. At day 1, the tensile strength increased to 1520.16 MPaat 4.4 pH and 1544.41 MPa at 7.4 pH (table 1). At day 7, the uncoated PGA suture's strength (1343.43 MPa) decreased than at a day 1 but the coated PGA sutures displayed a slight increase when compared with the day 7 uncoated PGA suture, at pH 4.4 (1467.57 MPa) and pH 7.4 (1456.67 MPa) (Table 2).

Table 3. Statistical Significance of the experiment data tabulated

Group	Specimen Label	P value
II, III & IV	PGA	0.031
I, V & VI	Vicryl	0.012

The statistical data obtained was analyzed using SPSS software. Using the one-way ANOVA method, the p value was found to be <0.05 which means the data is statistically significant.

4. Discussion

Absorbable sutures are stitches constructed of materials that the body may absorb spontaneously over time. They're constructed of materials like the fibers lining animal intestines or synthetic polymers that dissolve quickly in the body. Superior tensile strength, good knot security, excellent handling characteristics, minimal tissue reaction, absence of allergenic properties, resistance to infection, and eventual absorption when tissue repair has reached satisfactory levels are all generally accepted characteristics of an ideal suture material (Turner et al., 1973). The tensile strength of a material is defined as the maximum force a suture can withstand before it breaks (Marturello et al., 2014). Vicryl exhibited the highest tensile strength of the two sutures tested in the study. However, in a research using Ringer's lactate solution, PGA demonstrated no significant change in tensile strength from day 0 to day 13. The explanation for this might be that in the current investigation, saliva solution was utilized and incubated at 37 degrees Celsius, which was not done in the previous study. (Moore and Hill, 1996; Turner et al., 1973). Both groups are compared to clinically

proven drugs, namely diclofenac for anti-inflammatory purposes and ascorbic acid for antioxidative purposes. A previous study showed that the flavonoid quercetin showed good anti-inflammatory properties. There is no statistical significance between the control and test groups, but the cumulative effect is clearly increased in antioxidative and anti-inflammatory properties (Varshini et al., 2022). Other studies which involved the study of sutures and flavonoid-alkaloid extracts showed similar results to the current study (Harini.B et al., 2022). They proved that the tensile strength of PGA was higher than Vicryl and it showed an improved antioxidant and anti-inflammatory activity.

5. Conclusion

This study reveals that the components quinidine and quercetin have a significant role to play in the degradation potential of absorbable suture materials. It also indicates that these materials have a strong influence on pain management and wound healing and the addition of quinine and quercetin has significantly reduced the anti-inflammatory property.

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