ORIGINAL ARTICLE

Effect of *Myracrodruon urundeuva* (Aroeira) on biofilm control and gingival inflammation after periodontal surgery: A phytochemical and clinical study

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ABSTRACT

Myracrodruon urundeuva M.Allemão, popularly known as Aroeira, has a therapeutic potential characterized by its healing, antimicrobial, and anti-inflammatory effects. The objective was to evaluate the clinical efficacy of 10% aqueous extract of Aroeira bark as a mouth rinse, in controlling biofilm and gingival inflammation after gingivectomy with sufficiently invasive osteotomy. A clinical study was conducted with 20 patients who were selected according to the need for aesthetic clinical crown lengthening. The participants were allocated into two groups with 10 members each. In the control group, patients rinsed with 0.12% chlorhexidine digluconate, and in the test group, 10% aqueous extract of Aroeira. Periodontal clinical parameters such as plaque index (PI), gingival bleeding index (GBI), and probing depth (PD) were collected in the pre- and postoperative periods of 7, 14, and 21 days. The mouthwash based on Aroeira extract showed efficacy, with a reduction in biofilm accumulation and less gingival inflammation in the surgical area during the period of coverage of the substance. The biological and pharmacological properties of Aroeira were shown to be effective for the parameters evaluated, constituting a potential alternative therapeutic agent for the establishment and maintenance of gingival tissue.

Keywords: Gingivectomy, Aroeira, periodontics, *Astronium urundeuva* (M.Allemão) Engl..

INTRODUCTION

The gingival smile is considered a common complaint in the dental surgeon's daily life, since patients have become more demanding, and their expectations have increased regarding esthetics. Thus, the use of new techniques and materials for surgical intervention is an alternative to meet this need (Castro et al. 2010; Pedron et al. 2010; Pinto et al. 2022).

For the resolution of these cases, some techniques can be used to increase the clinical crown, among them, the conventional or sufficiently invasive technique. The first is characterized by the elevation of a mucoperiosteal flap for bone exposure and subsequent osteotomy/osteoplasty, while in the second there is no need for flap elevation (flapless) and the osteotomy is done with the use of micro chisel via the gingival sulcus (Camargo et al. 2007; Joly et al. 2011; Cristóvam et al. 2019; Sousa et al. 2019).

During surgery, the physiological process of the tissue is affected, and to aid tissue repair, excellent oral hygiene is of crucial importance (Castro et al. 2010). In this perspective, among the auxiliary substances in the process of cleaning surgical wounds of the oral cavity, it is commonly prescribed the mouthwash with chlorhexidine digluconate 0.12%, which presents itself as an antimicrobial biocompatible with the tissues of the oral cavity and effective against biofilm, being considered the gold standard of oral antiseptics (Gondim et al. 2010).

However, this substance has some unwanted local side effects, such as supragingival calculus formation, loss of taste, and color change in the dental elements (Almeida et al. 2010; Pegoraro

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et al. 2014). Thus, new alternative measures have been investigated, and phytotherapy has become a field of ample possibilities to solve this problem (Lobo et al. 2010). In periodontics, extracts from medicinal plants have been studied with the objective of replacing chlorhexidine in the chemical control of supragingival biofilm (Emídio et al. 2010; Almeida et al. 2010).

Among the herbal medicines, *Myracrodruon urundeuva* M.Allemão (Sin. Bas. Astronium urundeuva (M.Allemão) Engl.; aroeira do sertão) presents a therapeutic potential that deserves to be highlighted. Research has shown its healing, antimicrobial, and anti-inflammatory effects, as well as protection against alveolar resorption, besides being an abundant and low-cost natural resource, making it a cost-effective alternative in the future (Botelho et al. 2008; Menezes et al. 2010; Machado et al. 2011; Pinho et al. 2012; Mello et al. 2013; James et al. 2017; Bueno et al. 2018; Pires et al. 2018).

Therefore, the aim of this study was to evaluate the clinical efficacy of the 10% aqueous extract of *M. urundeuva* bark as a mouth rinse in controlling biofilm and gingival inflammation after gingivectomy with sufficiently invasive osteotomy.

METHODOLOGY

Type of study, location, and ethical aspects

The research consisted of a controlled clinical study developed at the UFCG/CSTR dental school clinic, where patients in need of aesthetic clinical crown lengthening due to altered gingival contour (Figure 1) were selected. These patients were seen at the PROEPECC Extension Project in Clinical and Surgical Periodontics, linked to the Academic Unit of Biological Sciences - UACB/CSTR. This project was approved by the Research Ethics Committee of the Alcides Carneiro University Hospital/UFCG with consubstantiated opinion no. 3.310.472 and was also registered in the National System for the Management of Genetic Heritage and Associated Traditional Knowledge - SisGen under no A32F280, in compliance with the provisions of Law no. 13.123/2015 and its regulations. The details of the study were explained to the participants and all patients signed a written consent form.

Population and Sample

For this study, the sample was of the non-probabilistic type, for convenience, consisting of 20 patients of both sexes who were attended by the Extension Project in Clinical and Surgical Periodontics of the UFCG Dentistry Course, Patos-PB, Brazil. The study was conducted from July 2020 to August 2021. The sample was based on clinical studies that also analyzed the effectiveness of Aroeira in controlling dental biofilm and gingival inflammation (Botelho et al. 2008; Machado et al. 2011). To calculate the sample size, a pilot study was carried out where the ideal sample size to ensure adequate power for this study was based on the main outcome of the study (continuous quantitative) adopting the following parameters: significance level of 5% ($\alpha = 0.05$), 95% confidence interval, statistical power of 80% ($\beta = 0.20$), allocation ratio of individuals in the studied groups of 1:1 and effect size, estimated based on the data of the pilot study, which involved the inclusion of 5 participants in each group. The G*Power software (version 3.1) was used to calculate the final sample size, consisting of 20 individuals.

The patients were randomly distributed, by drawing lots, into two groups of 10 members each, without the researcher having information about the groups, blindly, according to the type of mouthwash used in the postoperative period. In the positive control group (G1), patients performed postoperative mouthrinses with 0.12% chlorhexidine digluconate (Periogard®) for chemical control of supragingival biofilm. In the test group (G2), the patients used the same mouth rinsing protocol, but with 10% aqueous of Aroeira extract.

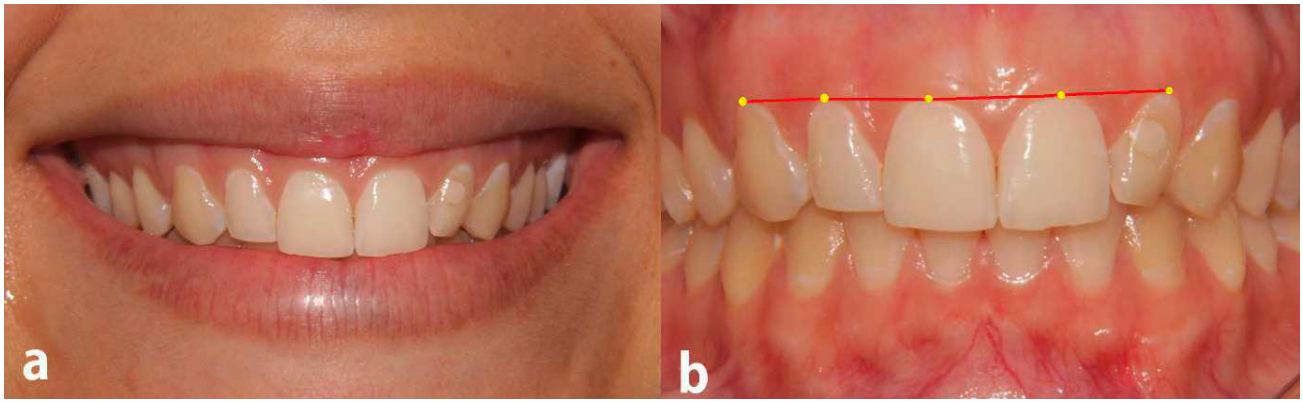


Figure 1. Clinical appearance of the patients selected for the study: need for aesthetic clinical crown lengthening due to alteration in the gingival zenith line.

Inclusion Criteria

All patients met the following inclusion criteria: 1 - Age between 18 and 65 years, both genders; 2 - Systemically healthy and without contraindication for periodontal surgery; 3 - Not pregnant or lactating; 4 - Normal lip position, absence of attachment loss, intermediate periodontal phenotype or Class A2 of De Rouck et al. (2009) (thick gingiva, triangular crown, 3 to 4 mm keratinized mucosa, and long papillae); 5 - non-smoker, and 6 - no previous mucogingival surgical event.

Exclusion Criteria

Patients with: 1 - gingivitis; 2 - periodontitis or previous abscess formation; 3 - use of medication that interferes with periodontal health; 4 - presence of systemic disease; 5 - patients undergoing orthodontic treatment; 6 - patients who do not show up for post-operative evaluations; and 7 - patients who are intolerant to the active ingredient Ibuprofen were excluded from the study.

Botanical Material

In order to make a voucher and to botanically identify the plant species used in the study, the botanical material was collected at 2 pm on March 11, 2019 from a plant located in the Municipality of Patos, PB (7º 34' 50'' S and 37º 16' 30'' W) in the hinterland of the state of Paraíba (Northeast Brazil), an area of anthropized Caatinga, 318 km from the capital city of João Pessoa.

As *M. urundeuva* has a large size, parts of the plant were collected, observing as many characteristics as possible to facilitate identification, such as leaves, branches, and stem. From these materials, a voucher was prepared. The collected plant parts were pressed in newspaper and cardboard to dry in the kiln. The newspaper was changed daily until completely dry to avoid fungal growth.

The botanical identification of this species was performed by the botanist Maria de Fátima Araújo Lucena. The voucher specimen of *M. urundeuva* is deposited in the Herbarium of the Center for Health and Rural Technology at the Federal University of Campina Grande/Campus Patos, PB, under number 7239.

Preparation of *Myracrodruon urundeuva* (Aroeira) extract

The extract was prepared in the Biochemistry Laboratory of the Biological Sciences Unit/CSTR-UFCG. For the preparation of the aqueous extract the methodology described by Ferris (1999) was used with modifications. The bark was collected from the plant and dried in an oven at 40 ºC for 20 h when it was ground in an electric mill until a fine powder consistency was obtained. With the help of a precision balance (Marte®), 50 g of powder was diluted in 500 ml of distilled water. The suspension was left to stand in the absence of light and at room temperature for 24 h, obtaining the aqueous extract at a concentration of 10%, which was used in the research over a period of up to 14 days. Afterwards, the extract was filtered, placed in amber plastic bottles, and stored in a refrigerator until used by the patient.

Phytochemical study of the extract of *Myracrodruon urundeuva*

The phytochemical analysis of the extract was performed at the Phytochemical Laboratory Prof. Dr. Raimundo Braz Filho (IPeFarM/UFPB) and at the Biochemical Laboratory of Faculdade Nova Esperança (FACENE) by Prof. Dr. Maria Denise Leite Ferreira with the collaboration of Dr. Yuri Mangueira do Nascimento.

The extractive solution obtained was evaporated in a rotoevaporator and the phytochemical screening of secondary metabolites present in the aqueous extract of the plant species occurred according to the methodology recommended by Silva et al. (2010) and Nascimento et al. (2020). The evaluate the presence of flavonoids, saponins, alkaloids, tannins, and terpenoid.

Clinical and periodontal parameters evaluated pre- and post-operatively

Some periodontal clinical parameters were observed, in the preoperative evaluation and after 7, 14 and 21 days of the surgical procedure, in which the effect of chlorhexidine and Aroeira extract on biofilm control and gingival inflammation were analyzed (Figure 2). The expert professor examiner



Figure 2. Patient with alteration of the gingival contour in the elements of the 2nd sextant (a), immediate postoperative period (b) and postoperative period of 21 days (c).

in the area was unaware of the type of mouthwash used by the patient.

To evaluate biofilm control (plaque index - PI) and gingival inflammation (probing bleeding index - ISS and probing depth - PD), in the elements involved in the surgical procedure (from 13 to 23), a dichotomous evaluation (yes/no) was used, in which the proportion of sites with stimulated gingival bleeding was calculated when the PC-15 periodontal probe (North Carolina) was inserted with controlled force into the gingival sulcus at four sites, three of which were buccal (mesial, buccal, and distal) and the palatal face (Chapple et al. 2018). Similarly, the proportion of biofilm adhered to the tooth surface was calculated. The probing depth was evaluated by measuring the distance between the gingival margin and the apical end of the gingival sulcus with the same probe reported above. All examinations were performed by a previously calibrated examiner. After each evaluation, prophylaxis was performed to remove the dye from the tooth surface used to highlight the biofilm. The color of the patients' teeth was evaluated before and 21 days after the surgical procedure with the help of a Vita Classic® scale (Vita, Zahnfabrik, Sackingen, Germany), to observe if the mouthwash with Aroeira extract was able to produce any coloration on the tooth surfaces after 14 days of use. All these data were recorded in a specific form prepared for this research.

Surgical procedure

The technique chosen to restore the smile aesthetics of the patients was gingivectomy with sufficiently invasive osteotomy based on the study proposed by Cristovám et al. (2019). The surgical protocol was divided into the following steps: 1) Evaluation of the gingival bleeding index; 2) Evaluation of the plaque index; 3) polishing the stained crowns with prophylactic paste and rubber cup; 4) extra and intraoral antisepsis with chlorhexidine digluconate 2% and 0.12%, respectively; 5) infiltrative terminal anesthesia using the anesthetic mepivacaine with vasoconstrictor Epinephrine; 6) marking of points by probing with the aid of a North Carolina periodontal probe in the region where the incision was made, in which three points were marked on each tooth, using the CEJ as a reference point; 7) Union of the previously marked points with a fine line made with the 15c scalpel; 8) Incision with the 15c scalpel without bevel; 9) Intra-sulcular incision to loosen the gingival fibers; 10) Removal of soft and granulation tissue with Gracey curettes (5/6); 11) Sufficiently invasive osteotomy with ochsenbein chisel; 12) Abundant irrigation with saline solution; 13) Hemostasis; 14) Postoperative instructions.

Postoperative management

The study participants were informed about possible postoperative problems, such as bleeding, pain and discomfort and were prescribed ibuprofen 600 mg tablets to be taken only in case of pain. In the positive control group (G1), patients were instructed to swish 15 ml of 0.12% chlorhexidine digluconate for 1 min twice a day for 14 days. In the test group (G2), the subjects rinsed with 15 ml of *M. urundeuva* extract twice a day for 1 minute for 15 days. For both groups, the first mouth rinse was performed immediately after surgery in the presence of the researcher, the remaining mouth rinses were performed 30 min after morning and evening brushing for a period of 14 days. All patients were individually given a prescription for how to use the mouthwashes. During home use, the Aroeira extract was stored in a refrigerator at a temperature of 15 ºC.

Data Analysis

Data analysis was performed using the IBM SPSS Statistics software (SPSS for Windows, Version 20.0. Armonk, NY: IBM Corp). Initially, descriptive statistics were performed to characterize the sample, which corresponded to the calculation of measures of central tendency and variability for quantitative variables. The assumption of normality of the data for quantitative variables was not confirmed after employing the Shapiro-Wilk test. Therefore, nonparametric tests were used to determine the significance of intergroup and intragroup differences, according to Hannigan and Lynch (2013). The Mann-Whitney test was used to determine significant intergroup differences regarding clinical parameters (GBI, PI, and PD). The significance level was set at $p < 0.05$. An indication of the magnitude of statistical variation was assessed by estimating the effect size (ES) according to Cohen (1994) and Wasserstein (2016). The classification of ES values was done according to Cohen (1994) indicative of ≤ 0.20 a small effect; 0.30-0.70 indicative of a moderate effect; and ≥ 0.80 indicative of a large effect.

RESULTS

Phytochemical results

Phytochemical screening is a resource that allows qualitatively determining the main metabolites present in a plant material, in view of the fact that plant extracts are complex mixtures, allowing one to verify which constituents are more abundant or more easily characterized and, in this sense, guide the extraction and/or fractionation of extracts to obtain the groups of biologically active molecules of interest (Dias 2017; Lucena et al. 2020). In view of this, for *M. urundeuva* extract (Aroeira), the tests performed were positive for flavonoids, alkaloids, terpenes, tannins, while for saponins the result was

Table 1. Phytochemical prospecting of *Myracrodruon urundeuva* extract (Aroeira).

PHYTOCHEMICAL CONSTITUENT	RESULTS
Flavonoids /$AlCl_3$	+
Alkaloids/Mayer Dragendorff	+
Terpenes/H_2SO_4	+
Tannins/$FeCl_3$	+
Saponins	-

+: Present; -: Absent

negative (Table 1).

Clinical results

The study had the participation of 20 patients, who were selected according to the need for aesthetic crown lengthening of elements 13 to 23. The participants were randomly allocated into two groups containing 10 members each. Postoperatively, the control group used mouthwash with 0.12% chlorhexidine, and the test group used mouthwash with 10% aqueous of Aroeira extract. During the period of coverage of the substances, some parameters were evaluated, among them, the SGI, PI, and PD, as shown in Table 2.

According to Table 2, it was found that in the group using chlorhexidine the median reduction after 15 days in GBI, PI and PD was 0.00% (IIQ = 0.00-33.98), 10.15% (IIQ = 0.00-62.65) and 33.33% (IIQ = 5.56-59.11), respectively. As for the group that made use of the aqueous extract of Aroeira, it was observed that the median reduction after 15 days, in GSI, PI, and PD was 0.00% (IIQ = 0.00-44.87%), 68.77% (23.01- 84.47), and 23.96% (IIQ = 0.00-

Table 2. Comparative analysis of clinical parameters in the groups evaluated according to time.

Variables	Aroeira				
	M	SD	M	SD	p-value(1)
GBI					
Before	20.80	17.11	12.88	8.21	0.178
7 days later	34.55	18.43	25.80	22.20	0.210
15 days later	19.55	10.94	11.21	6.83	0.061
21 days later	13.71	12.27	9.12	7.05	0.393
Reduction % (T0 – T15)	14.86	25.83	20.25	28.10	0.595
Reduction % (T0 – T21)	39.29	39.22	28.67	26.74	0.610
PI					
Before	54.56	25.49	39.97	23.99	0.195
7 days later	41.55	13.76	40.05	29.76	0.791
15 days later	41.24	24.86	17.46	14.81	0.014
21 days later	36.21	13.47	17.06	15.16	0.007*
Reduction % (T0 – T15)	26.33	33.82	53.57	34.78	0.075
Reduction % (T0 – T21)	29.57	28.45	53.83	35.12	0.055
OS					
Before	1.45	0.51	1.67	0.61	0.342
7 days later	1.67	0.53	1.90	0.74	0.596
15 days later	1.03	0.27	1.42	0.48	0.116
21 days later	0.89	0.14	1.21	0.37	0.013*
Reduction % (T0 – T15)	32.91	25.50	26.24	22.37	0.493
Reduction % (T0 – T21)	32.91	25.50	28.45	23.00	0.649

48.16%).

When the GSI was evaluated after the 7-day surgery, it was 31.20% when the chlorhexidine mouthwash was used, and 16.65% when the Aroeira extract was used, both with higher values when compared to the patient's initial condition. As for the 15-day postoperative period, represented by the period of coverage of the extract, a reduction in the GSI was observed, with a value of 10.40% being obtained for this parameter, thus evidencing the anti-inflammatory and healing effect of *M. urundeuva* extract. Also, in the 21-day reevaluation, the GSI continued to reduce, being even lower than in the baseline period. There was no significant difference when comparing these data to the chlorhexidine group.

Regarding the PI, the values corresponding to chlorhexidine showed little considerable reduction (reduction T0-T15- 10.15) compared to the participants who rinsed the Aroeira extract (reduction T0-T15- 68.77). Furthermore, when observing the group of patients who used the herbal medicine, there was an increase in the PI after 7 days of the surgical procedure, which can be justified by the presence of a raw region, making mechanical hygiene difficult for the patient. On the other hand, in the 15 and 21-day postoperative periods, a reduction in the values was observed, which were 10.40% and 12.50%, respectively, being even lower than the results evidenced in the pre-surgery period.

When analyzing the PD, higher results were observed in both groups tested after 7 days of the procedure, which can be characterized by the presence of edema and, consequently, a small increase in this parameter during the evaluation, but which was not significant, when compared to the initial values. With the use of the Aroeira extract, there was a reduction in this index in the period of 15 and 21 days, and it was even higher than the initial condition, showing, once again, the anti-inflammatory potential of the extract, reducing the edema that was evaluated through PD. When these results were compared with the control group, no significant difference was evident.

DISCUSSION

Among the herbal medicines of popular use, *M. urundeuva*, known as "aroeira do sertão" has been standing out for its antimicrobial, anti-inflammatory, and healing potential, and for the treatment of skin and mucosa infections (Sá et al. 2009; Napoleão et al. 2012). These pharmacological effects are attributed to the presence of secondary metabolites produced by the plant, which are found mainly in its bark, such as tannins, flavonoids, and alkaloids (Viana et al. 1995).

Among the best studied properties of the Aroeira tree is its antimicrobial effect (Machado and Oliveira, 2014). This therapeutic action could be observed during the use of the extract in the post-surgical period, as an adjunct to the mechanical control of the biofilm, in which it proved to be effective in inhibiting bacterial growth. Such a statement can be verified with the results represented in (Table 2), where the parameter for the GSI showed reduced values in the 15-day postoperative period, the period that was under the coverage of the extract, thus reducing inflammation in the surgical area. Corroborating this, a double-blind randomized clinical trial conducted by Lins et al. (2013) evaluated the effect of mouthrinses based on Aroeira and chamomile extract on plaque control and gingivitis treatment through plaque and gingival bleeding indices. It was observed that the group with Aroeira mouthwash showed lower bleeding rates when compared to the chlorhexidine and chamomile mouthwash.

Thus, these therapeutic actions can be attributed to the presence of bioactive compounds, such as flavonoids, a phytochemical present in the composition of the extract and that presents antimicrobial and anti-inflammatory activities, being able to modulate the action of cellular components involved in the mechanism of inflammation, as for example, the proliferation of T lymphocytes, the production of pro-inflammatory cytokines such as TNF-a and IL-1, and the activity of arachidonic acid pathway enzymes, such as phospholipase A2, cyclooxygenase, and lipooxygenase, contributing to the process of tissue repair (Todorova and Trendafilova 2014).

Regarding the presence of visible plaque on the coronary surfaces and patient brushing, it was observed that even with the surgical wound, the research participants who used the extract managed to have good biofilm control, showing a reduction in the PI values in the 15-day postoperative period, corresponding to 68.77%, when compared to the initial condition, whose value was 33.30%. This control in the plaque index is related to the antibacterial effect that *M. urundeuva* has. In a study conducted by Pires et al. (2019) it was observed that the Aroeira tree presents this property due to its high content of tannins and polyphenols.

Accordingly, a study conducted by Trentin et al. (2013) also observed that the stem bark extracts of *M. urundeuva*, *Anadenanthera colubrina* Brenan, and *Commiphora leptophloeos* J.B.Gillett showed the ability to interfere with the adhesion and biofilm formation of *Pseudomonas aeruginosa*. Both plants studied proved to be rich in tannins, concluding that these constituents can inhibit biofilm formation. The presence of this phytochemical was found in the

extract, and its action is associated with its astringent properties and hemostatic function (Monteiro et al. 2005).

Another study, conducted by Alves and Nascimento (2009), evaluated *in vitro* the antimicrobial, antifungal, and anti-adherent activity of "aroeira-do-sertão", "malva", and guava on dental biofilm microorganisms and oral candidiasis. In the results obtained, the three extracts showed anti-adherent activity, that is, the capacity of the extracts to inhibit the synthesis of glucan by glycosyltransferase, thus suggesting the use of these plants as an alternative means in dental therapy.

When evaluating the probing depth, a small increase of this parameter was observed at 7 days postoperatively, characterized by the presence of edema in the surgical area, a classic sign of inflammation. The use of the extract in the post-surgical period allowed the reduction of bacterial contamination and of the inflammatory process, thus acting on tissue healing. Thus, in the period of 15 and 21 days, the effects obtained with the use of the extract were positive, which can be observed with the results present in Table 2, in which this index showed a reduction in the values, once again showing the therapeutic potential of the substance, reducing the edema that was evaluated through PD.

Smile harmony can be influenced by several aspects, among them, dental alterations, which are related to the color, texture, shape, and size of the clinical crown, as well as periodontal alterations, which are associated with the characteristics of the patient's gingival tissue. In view of this, surgeries for gingival smile correction are promising alternatives, offering patients a better predictability of outcome, reduced morbidity of the surgical procedure, and also an effective healing process, thus promoting aesthetically favorable results (Bertolini et al. 2011).

Tissue repair, which is common to all wounds, consists of a cascade of cellular, molecular, and biochemical events that interact to bring about tissue reconstruction. In the initial phase of the healing process, the blood elements in contact with collagen and substances from the extracellular matrix trigger the release of vasoactive and chemotactic mediators that lead to healing by attracting inflammatory cells to the wound region. Six to seven days after tissue damage, these cells are reduced in number, but still significant for the permanence of the inflammatory process (Campos et al. 2007).

In order to control this inflammation in the post-surgical period, some antimicrobials are commonly prescribed as an adjuvant, among them we can mention chlorhexidine, a mouthwash considered the gold standard in the line of oral antiseptics. However, when used for a long time, adverse effects are caused by this substance (Shaikh et al. 2015). As a result, natural antimicrobials have been gaining popularity, because they are characterized as substances that help control microorganisms, reduce inflammation, control pain, and repair affected tissues (Varoni et al. 2012; Bohneberger et al. 2019).

Thus, from the results obtained with the applicability of this research, it can be observed that *M. urundeuva* had a positive effect on the process of repair and tissue healing in the post-surgical period, provided by the presence of its chemical constituents that have anti-inflammatory, antimicrobial, and antiseptic actions. Thus, this phytotherapic is an effective and less expensive therapeutic alternative. However, more studies must be conducted regarding its phytochemical analysis and pharmacological activities, in order to know its mechanism of action, form of administration, and contraindications, so that in the future it can be made available safely to the population.

In the study proposed by Palmeira et al. (2020), periodontal surgery was performed and mouthwash with 15 ml of aroeira-do-sertão extract was used twice a day for 14 days. When comparing the periods before and after the use of the extract, a reduction in the accumulation of biofilm and less gingival inflammation in the operated area was observed during the period of use of the extract in the form of mouthwash.

CONCLUSION

Given the results of the present study, we conclude that the biological and pharmacological properties of *M. urundeuva* were effective for the parameters evaluated. Thus, the mouthwash based on Aroeira extract showed satisfactory results for the indices of PD, GSI and PI, being similar to that of 0.12% chlorhexidine and even more favorable with regard to tissue repair. In this perspective, this substance is a potential alternative therapeutic agent for the establishment and maintenance of healthy gingival tissue due to its anti-inflammatory and antimicrobial properties provided by the presence of its phytochemical constituents.

AUTHOR' S CONTRIBUTIONS

Conceptualization: C.M.M., J.T.P. and S.C.A.S.; Data curation: C.M.M., A.A.O.F., M.D.L.F., L.S.B.S., and J.N.L.S.; Formal analysis: C.M.M., J.T.P., S.C.A.S., and J.N.L.S.; Investigation: C.M.M., A.A.O.F., M.D.L.F., L.S.B.S., and J.N.L.S.; Methodology: C.M.M., J.T.P., and S.C.A.S.; Project administration: C.M.M., J.T.P., S.C.A.S., and J.N.L.S.; Resources: C.M.M., A.A.O.F., M.D.L.F., L.S.B.S., and J.N.L.S.; Surpervision: C.M.M. and

J.N.L.S.; Validation: C.M.M.; Visualization: C.M.M., A.A.O.F., M.D.L.F., L.S.B.S., and J.N.L.S.; Writing – original draft: C.M.M., A.A.O.F., M.D.L.F., L.S.B.S., and J.N.L.S.; Writing – review & editing: C.M.M., A.A.O.F., M.D.L.F., L.S.B.S., and J.N.L.S.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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