

Original Paper

# *Adenostoma fasciculatum*, California Chamise: Chemistry and Use in Skin Conditions

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## Key Words

*Adenostoma fasciculatum* · California chamise · Greasewood · Monoterpenoids · Phytosterols

## Abstract

*Adenostoma fasciculatum* is used traditionally to treat skin conditions such as eczema. The plant was found to contain monoterpenoids, including hydroquinone and geraniol. Other terpenoids were found, including the triterpenoids 7 $\alpha$ -hydroxybaruol and glutinol, the diterpenoids thalianol and thaliandiol as well as the steroids suberosol and campesterol. The new compound, 7 $\alpha$ -hydroxybaruol, was further analyzed by two-dimensional nuclear magnetic resonance (NMR) imaging, <sup>13</sup>C NMR and high-resolution high-performance liquid chromatography combined with mass spectrometry. A balm was made from the plant with olive oil and bees wax. Several patients tried the balm and reported improvements in Adams disease, eczema symptoms and seborrhea within 1 week.

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## Introduction

*Adenostoma fasciculatum* (Hook. & Arn., Rosaceae) is called chamise or greasewood and is a very common plant in the chaparral of California. The plant grows as a large bush, up to 4 m tall, with short 5- to 13-mm, needle-like leaves. The flowers are very small, about 3 mm in diameter. *A. fasciculatum* is reported to burn very readily during bush fires, perhaps due to the presence of hydroquinone in the plant.

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*A. fasciculatum* has been used in the treatment of skin conditions by California Indians [1]. Various Indian tribes, including the Chumash, use this plant. In the old days, whale oil, bear grease, eel oil and similar oils were used to make a chamise balm for the skin. These oils and greases are no longer available.

The plant is known to contain flavonoids and other compounds [2–4]. Various monoterpenoids and monoterpenoid glycosides have been identified from the plant, including p-coumaric acid, ferulic acid, syringic acid, vanillic acid, p-hydroxybenzoic acid, hydroquinone and arbutin [5]. In addition, umbelliferone (a coumarin) and phlorizin (a chalcone) were found [5]. However, sterols and volatile monoterpenoids have not been described from *A. fasciculatum*. The current study examined the chemistry of the plant and the utility of a balm made from it in the treatment of skin conditions.

## Materials and Methods

### Plant Extract

*A. fasciculatum* was collected in July (fig. 1). The plant is very common and is present in most botanical collections in California. Some of the plant branches and leaves (131.5 g) were ground in a mortar and pestle and added to 500 ml of ultrapure acetonitrile to make an extract for further analysis.

### General Apparatus

Nuclear magnetic resonance (NMR) spectra ( $^1\text{H}$  and  $^{13}\text{C}$  NMR) were recorded at room temperature with a Varian Mercury Plus instrument at 400 MHz. Chemical shifts ( $\delta$ ) are reported in ppm relative to tetramethylsilane. Gas chromatography/mass spectrometry (GC/MS) employed a Thermo-Fisher Focus-DSQ II gas chromatograph with a mass-selective detector. The column temperature was 40 °C for 10 min, which increased 2 °C per min to a final temperature of 250 °C for 5 min. High-performance liquid chromatography (HPLC) combined with MS analysis involved a Thermo Finnigan LCQ Deca with a reverse-phase column. The solvent system consisted of 10% MeOH in water that increased at 2% per min to 100% MeOH. High-resolution HPLC/MS was performed with an Agilent Technologies Time-of-Flight 6210 with a reverse-phase column. The solvent system was 10% MeOH in water that increased at 2% per min to 100% MeOH. Column chromatography was performed with Silicagel 60 columns (EMD, Darmstadt, Germany) that were developed with the solvent ethyl acetate (5, 20 then 40%) in hexane. Six to eight fractions were collected and checked by analytical thin-layer chromatography (TLC) using 20% ethyl acetate in hexane. The plates were sprayed with 10% sulfuric acid and heated to visualize spots. Column-purified fractions were further purified by preparative TLC (250- $\mu\text{m}$ -thick plates, EBM) in 20 or 40% ethyl acetate/hexane. Six bands were scraped from each preparative TLC plate.

### Balm Preparation

The balm was made from an olive oil infusion of the plant and bees wax. The branches and leaves (50 g) of *A. fasciculatum* were put into 2 liters of extra virgin olive oil to infuse for 1 month. All of the olive oil was decanted and mixed with 134 g of melted bees wax in a 75 °C water bath until thoroughly mixed. This mixture was allowed to harden at room temperature to form a hard balm in 37-ml containers (fig. 2).

### Patient Selection

Patients were recruited from the community by word of mouth and posters. Patients had all been previously diagnosed with eczema, seborrhea, psoriasis or Adams disease [6] by their doctors. Each patient was instructed to rub the balm with a finger to melt it. The melted balm was then applied, with the finger or a cotton swab, to the skin where needed. The balm was applied once in the morning and once in the evening for 7 days. The patients were instructed to continue the treatments given to them by their doctors. The patients were also told that they should find less irritating soaps containing vegetable-based biodegradable anionic and nonionic cleaning agents. A questionnaire was given to each patient with 3 questions to answer before the treatment (questions were 'How much does your skin condition interfere with your daily activities? How much does your skin condition itch? How much does your skin condition hurt?'). Each question



**Fig. 1.** *A. fasciculatum*, California chamise.



**Fig. 2.** Balm made from *A. fasciculatum*.

had a numerical scale from 0 to 10, with 0 indicating none and 10 indicating too much. The patients could circle one of the numbers on the scale to indicate their answers. The same 3 questions were answered after 1 week of applying the balm. The patients were encouraged to write specific comments on the back of the questionnaire.

## Results

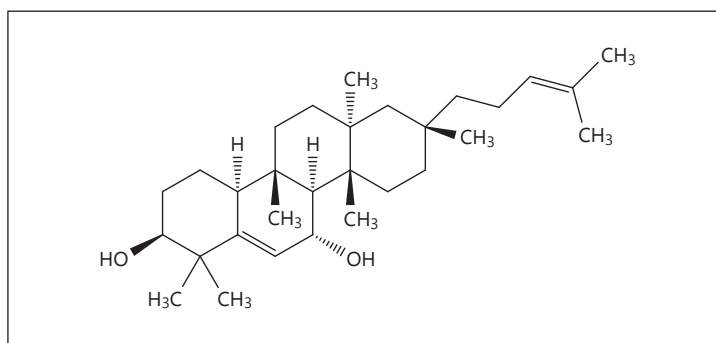
### *Phytochemistry*

Hydroquinone is known to occur in *A. fasciculatum* [5]. It was found in the present study and identified by GC/MS with the expected fragments in the positive ion mode at 110, 81 and 55 AMU. Geranial, a known compound [7], was also found by GC/MS with expected fragments in the positive ion mode at 153, 110, 95, 85 and 71 AMU.

Oleic acid was found in a column-purified fraction from the plant and was identified by HPLC/MS and NMR. Campesterol was identified in a column-purified, preparative TLC-purified fraction of the plant and was also identified by HPLC/MS. The expected positive ion mode fragments for campesterol at 401 and 383 AMU were found in a minor HPLC peak at a retention time of 37 min. These ions were expected, as published on the Chemical Entities of Biological Interest (ChEBI) website.

Another phytosterol identified was suberosol. It was found in a column and TLC-purified fraction. Positive ion mass spectrometry fragments were 455 ( $MH^+$ ) and 437 ( $M-H_2O$ )<sup>+</sup> AMU, as expected from the ChEBI website. The NMR was identical to the predicted spectrum from the ACD Labs NMR Predictor.

Diterpenoids were found, including thaliandiol. Expected fragments in the positive ion mode were found at 443 ( $MH^+$ ) and 425 ( $M-H_2O$ )<sup>+</sup> AMU, as indicated by the ChEBI website. The NMR was as predicted by the ACD Labs NMR predictor. Thalianol was also found. By



**Fig. 3.** 7 $\alpha$ -hydroxybaruol.

HPLC/MS, the expected positive ion fragments were found at 427 (MH<sup>+</sup>) and 409 (M-H<sub>2</sub>O)H<sup>+</sup> AMU. The NMR was as expected from the ACD Labs NMR predictor.

Nonsteroidal triterpenoids were found, such as glutinol. The molecular ion (MH<sup>+</sup>, 427) and dehydration product (409) were as predicted by the ChEBI. The NMR was identical to the predicted spectrum from the ACD Labs NMR Predictor.

An unknown triterpenoid was found, 7 $\alpha$ -hydroxybaruol (fig. 3). This column- and TLC-purified compound was impure and was repurified by preparative TLC with 40% ethyl acetate in hexane (R<sub>f</sub> = 0.42). The molecular ion was found at 442 (M<sup>+</sup>) AMU. The deoxygenation product (M-O)<sup>+</sup> was at 426 AMU. Two-dimensional NMR analysis (HMBC and HMQC) in acetone D<sub>6</sub> found  $\delta$  1.16, 1.22 and 1.79 (H-1, H-1'), 1.48, 1.78 and 1.83 (H-2, H-2'), 3.21–3.24 ppm (H-3, t, j = 1), 4.98 (H-6, d), 4.12–4.14 (H-7, t, j = 1), 1.24–1.30 (H-8), 1.98 (H-10), 0.77–0.84 (H-11, H-11'), 0.9–1.0 and 1.58–1.65 (H-12, H-12''), 1.48, 1.52 and 1.57 (H-15, H-15'), 0.93–1.07 and 1.52–1.61 (H-16, H-16'), 0.70 and 1.24 (H-18, H-18'), 1.16 and 1.35 (H-19, H-19''), 1.87 (H-20, H-20'), 5.14–5.18 (H-21, t, j = 1), 0.93 (H-23, H-23', H-23''), 0.88 (H-24, H-24'', H-24'''), 0.94 (H-25, H-25', H-25''), 0.89 (H-26, H-26', H-26''), 0.83 (H-27, H-27', H-27''), 0.89 (H-28, H-28', H-28''), 1.57 (H-29, H-29', H-29''), 1.67 (H-30, H-30', H-30''); the signal for the 3- and 7-hydroxyls was at 3.78 ppm. These proton signals were exactly as predicted by the ACD Labs NMR Predictor. <sup>13</sup>C NMR found  $\delta$  120.05 (C-1), 28.65 (C-2), 76.70 (C-3), 41.50 (C-4), 146.78 (C-5), 122.31 (C-6), 68.23 (C-7), 51.99 (C-8), 35.68 (C-9), 38.75 (C-10), 34.00 (C-11), 33.06 (C-12), 35.27 (C-13), 41.27 (C-14), 30.87 (C-15), 32.95 (C-16), 32.89 (C-17), 46.01 (C-18), 41.46 (C-19), 23.70 (C-20), 124.57 (C-21), 130.44 (C-22), 27.70 (C-23), 25.40 (C-24), 18.26 (C-25), 17.41 (C-26), 23.48 (C-27), 29.89 (C-28), 25.52 (C-29) and 17.60 (C-30). High-resolution HPLC/MS was performed to confirm the molecular identity from two major fragments: (M-H<sub>2</sub>)H<sup>+</sup> found 441.3704 AMU, expected 441.3733 AMU; (M-H<sub>2</sub>O)H<sup>+</sup> found 425.3775 AMU, expected 425.3783 AMU.

#### Patient Results

The first patient was a Caucasian man suffering from Adams disease [6]. The patient reported cracking and bleeding finger tips and soles of the feet as well as rashes on the legs and arms. The patient reported discomfort at the level of 10 on a scale of 10. Itching and pain were also 10. The patient used the balm and switched to a less irritating soap. After 1 week, he reported that for the first time in nearly 7 years, his skin had returned to normal. His discomfort, pain and itching were 0 (fig. 4, 5). The second patient was an infant boy, less than 1 year old, who suffered from eczema in the genital region. His mother reported that he had trouble sleeping and was uncomfortable most of the time. She used the balm on the infant and reported that he slept better, the redness had somewhat diminished and his comfort had improved. The mother was also instructed to find a less irritating soap. The third patient was a male Latino who suffered from a rash 3 inch in diameter that cracked and bled. His condition



**Fig. 4.** Adams disease of the left thumb.



**Fig. 5.** The same thumb after treatment with the balm.

interfered with his daily activities at the level of 6, and itching and pain were at the level of 8. After using the balm, he reported that his condition interfered with daily activities at the level of 1. Itching and pain diminished to the level of 1. The patient reported that nothing had worked for him before the balm. The fourth patient was a young Chinese woman who had eczema on her hands. Her condition interfered with daily activities at the level of 8, as was the level for itching. Pain was reported to be at the level of 3. After using the balm for 1 week, all questions were answered at the 0 level. Her skin had returned to normal after 1 week. The fifth patient was a young Caucasian woman with eczema in her ear canals. Her condition interfered with daily activities at the level of 6. Itching was reported as an 8 and pain was at the level of 1. After using the balm for 1 week, she found that her condition interfered with daily activities at the level of 4, itching at 7 and pain still at 1. The sixth patient was a young Chinese woman with eczema on her hand and fingers with some cracking and bleeding. She reported washing her hands up to 18 times daily. Her condition interfered with daily activities at the level of 6 and did not improve with the balm. Itching improved from 7 to 5, but pain did not change and remained at the level of 3. The patient was instructed to find a less irritating soap. The seventh patient was a young Filipino woman. Her eczema interfered with daily activities at the level of 7 and improved to 4 with the balm. Itching improved from 6 to 3. She reported no pain from her condition. The eighth patient was a black woman with psoriasis and seborrhea. Her condition did not interfere with daily activities and did not cause



pain or itching. The balm helped against dryness and discoloration of her skin. She reported that her seborrhea improved with the balm. The last patient was a Caucasian woman with eczema on her neck and hands. She reported improvement with the balm especially on her neck but less on her hands. Her condition improved from 3 to 2 in terms of daily activities and from 3 to 1 for itching. She had no pain from her condition and reported to wash her hands 6–7 times daily. She was instructed to find a less irritating soap.

## Discussion

Hydroquinone is used as a skin-bleaching agent and is regarded as safe [8]. It is absorbed through the skin and can be irritating if used in high concentrations [8, 9]. Systemic administration of hydroquinone is toxic to the kidneys [9]. However, hydroquinone has an activity against neutrophils, which can relieve inflammation [10]. Geraniol has an antifungal activity and can cause hypersensitivity [11, 12].

Campesterol is a phytosterol with little cytotoxic activity [13]. It also has several mechanisms of anti-inflammation, such as the inhibition of nitric oxide synthesis, the inhibition of cyclooxygenase 2 expression and the inhibition of inflammatory mediator production including tumor necrosis factor, interleukin-1 and thromboxane B2 [14]. The phytosterol suberosol is known to modulate lymphocyte activity and may be anti-inflammatory [15]. Thaliandiol and thalianol have not been examined for pharmacological activity in the current literature. Many phytosterols and diterpenoids are absorbed through the skin [16].

Glutinol has a powerful analgesic and a moderate anti-inflammatory activity [17, 18]. The activity of 7-hydroxybaruol is not known. Several triterpenoids are known to cross the skin. The ability of glutinol or 7-hydroxybaruol to cross the skin is not known.

The balm helped every patient to a certain extent but worked best for most patients in areas other than the hands. Lesions on the hands did not improve as consistently. This seems to be because of frequent hand washing with irritating soaps. Patients who were able to switch to less irritating soaps had better results on their hands. Eczema is well known to be exacerbated by irritating soaps that leave the skin too dry. Heat and dryness are known to exacerbate eczema. The balm is an olive oil and bees wax preparation that is expected to moisturize the skin and decrease dryness, which should be helpful in eczema.

Adams disease is exacerbated by cold and wet skin conditions [6]. Irritating soaps make the skin crack and bleed. Chafing causes rashes similar to eczema. Adams disease is managed with heat and monoterpenoids such as capsaicin, which help relieve pain.

Relief of pain and itching by the balm may be from glutinol, occurring within a few minutes. However, some patients reported no pain from their condition, neither with nor without the balm.

Psoriasis plaques did not appear to be well treated by the balm in 1 psoriasis patient. However, discomfort and dryness were reported to improve with the balm.

Irritation is a major aspect of eczema. The balm appeared to relieve irritation in most patients, except on the hands where less consistent results were found. This may be due to frequent hand washing with irritating soaps.

There are several potential anti-inflammatory compounds in the balm, such as glutinol, campesterol and suberosol.

The mainstay of eczema treatment is topical steroids, which provide an excellent therapy for most patients. However, steroid therapy fails in some patients, especially after long-term use. Chamise balm appears to be useful in such patients.

Future studies on the balm will include a clinical trial of eczema patients. More studies are needed on psoriasis patients to see if the balm provides a useful therapy.

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