



Adansonia digitata and Daniella oliveri seed oils and cosmeceutical products exhibited potent pharmacological and marginal toxicity on fibroblast cells

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ABSTRACT

There is a growing demand for the use of seed oils in food, pharmaceuticals, and cosmetics, especially in skincare and hair care products. The aim of this study was to formulate organic cosmetic products from underutilized seed oils and evaluate their pharmacological and toxicity potentials. Human foreskin fibroblast cells were used to evaluate the cytotoxicity of the sample, while using staurosporine as positive control drug. Standard agar diffusion assays were utilized to assess the in vitro antimicrobial activities against a variety of organisms, such as *Streptococcus aureus*, *Klebsiella pneumoniae*, *Bacillus subtilis*, *Escherichia coli*, *S. typhi*, *Pseudomonas aeruginosa*, *Candida albicans*, *Aspergillus niger*, *Penicillium notatum*, and *Rhizopus stolonifer* while the anti-inflammatory potential was evaluated using lipoxygenase inhibition assay. The ability of the seed oils and formulated cosmeceutical products to act as antioxidants were examined using complimentary DPPH and ABTS radical scavenging assays. In addition, the anti-parasitic effect of seed oil against *Toxoplasma gondii* was established. The green organic medicated soaps and emollients, free of all synthetic antioxidants, preservatives, colourants, stabilizers, perfumes and antibiotics were produced. The oils and their value-added cosmetic products from the seed of *A. digitata* and *D. oliveri* yielded 29 % and 16 % product and exhibited suitable physicochemical parameters comparable to edible oils used for industrial purposes. While *A. digitata* oil showed the presence of 22 fatty acids with oleic acid (46.04 %) and palmitic acid (19.98 %) as most predominant with total unsaturation of 60.55 %, *D. oliveri* showed 12-hydroxydodecanoic acid (23.25 %) and pentadecanoic acid (21.13 %) as the most predominant with total unsaturation of 20.54 %. The presence of essential fatty acids coupled with significant antioxidants, antimicrobial and low in vitro cytotoxicity underscore the cosmeceutical prospects of the plants. Although the Emollient exhibited a slightly reduced level of inhibition towards the tested clinical pathogens with a minimum inhibitory concentration value ranging from 50 to 100 mg/mL, the products hold huge promise as purely organic formulations with significant level of antimicrobial activities

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comparable to the standard drugs. While further in vivo toxicological evaluations would be required, the seed oils open up a channel of research for bountiful scientific explorations.

Introduction

Cosmetics are essential inevitable products that are widely used for the beautification of the outlook of the body. However, the hazardous and adverse effects caused by synthetic cosmetics cannot be overemphasized as they are reported to be responsible for diseases such as cancer, endocrine disruption and various skin allergens. Cosmetics made from natural sources possess the ability to improve psychological, social and clinical impulses in users with minimal or no adverse effects. With little to no negative effects, consumers' psychological, social, and clinical impulses can be improved by natural source cosmetics [1]. A lot of artificial and synthetic ingredients found in cosmetics, particularly in soaps and creams, like parabens, butylated hydroxy anisole (BHA), and butylated hydroxytoluene (BHT), which are used as preservatives, antioxidants, and/or antiseptics, are known to cause allergic reactions inflammation and itchiness, which calls into question their usefulness and applications [2]. Their production process and utilization have been reported to cause the release of toxic pollutants and contaminants into the environment and this is now a global concern. Hence, there is a need to switch from the application of synthetic raw materials to a less hazardous natural source. Therefore, the need for new techniques in the production of pharmacologically effective, less toxic and environmentally friendly natural cosmetics is paramount. There are several underutilized seeds in Nigeria, of which *Adansonia digitata*. L and *Daniella oliveri* are prominent [3].

Adansonia digitata. L of the family Malvaceae is a big tree that grows primarily in the tropics and can live up to 1000 years [4]. It is widely distributed in the semi-arid and sub-humid parts of sub-Saharan Africa, as well as in western Madagascar [5]. Baobab pulp is reported to have anti-oxidant properties, it has shown considerable 'anti-sickling' activity and can also be used internally as a palliative and diaphoretic for fever and dysentery [6,7].

Daniella oliveri (Rolfe) of the family Caesalpiniceae is known as copaiba africana and balsam (eepo iya). This native African tree is widely distributed in Benin, Cameroon, Nigeria, and other African nations [8]. *D. oliveri* parts including bark and leaves have medicinal uses for a number ailments. Its leaves are used to cure headaches and tuberculosis, and it has been shown to have antispasmodic properties in vitro against three spasmogens in isolated guinea pig ileum. The anti-inflammatory properties of the stem and leaves are applied to a range of genitourinary tract conditions as well as skin infections [8] while its stem bark is used as a remedy for gastrointestinal parasites[9]. The resin of *D. oliveri* has anti-microbial, antioxidant and antibacterial activities and also can heal sores[10].

Both the seed of *A. digitata* and *D. oliveri* have been reported for their potential antioxidant and antimicrobial activities[11–13]. This study aims at preparing organic antiseptic cosmeceutical soaps and emollients from *A. digitata* and *D. oliveri* seed oils and evaluate their pharmacological activities.

Experimental

Plant materials collection and authentication

The seeds of *Adansonia digitata*. L, and *Daniella oliveri* were harvested from the tree during the fruiting season around February 2018 within the premise of the University of Ilorin and identified at the University of Ilorin Herbarium by renowned Taxonomist at the Department of Plant Biology. The following vouchers were acquired: UIH/002/964 and UILH/002/905 for *Adansonia digitata*. L, and *Daniella oliveri* respectively. The seed were obtained after de-shelling the fruit of *A. digitata* and removing the attached shaft on *D. oliveri* seed. They were washed, dried at room temperature and pulverized for a larger surface area.

Solvents and chemical reagents

The solvents and reagents which include ethanol, methanol, n-hexane, de-ionized water, distilled water, chloroform, sodium thiosulphate, glacial acetic acid, potassium iodide (SSKI oral solution), and potassium hydroxide were analytical grades.

Oil extraction

The dried pulverized seeds of *A. digitata* and *D. oliveri* were separately subjected to soxhlet extraction, using n-hexane at 60 °C for 5 h. The extracted samples were concentrated via a rotary evaporator and weighed to determine their percentage yield [14].

Fatty acid profiling

Seed oils obtained from *A. digitata* and *D. oliveri* were converted to esters to determine the fatty acid profile following a reported method[1]. For each oil, 2 g was refluxed with methanolic hydrochloric acid and the solvent was concentrated in vacuo. The fatty acids profiling was accomplished using gas chromatography-mass spectrometry (GC–MS).

Physicochemical analysis

Following standard method [15] the acid value was determined by titrating the oil in a mixture of diethyl ether, methanol and phenolphthalein with aqueous sodium hydroxide. The Wijis method was used in the determination of the iodine value. Free fatty acid, total free caustic alkali and saponification values were determined by titration.

Lye preparation

Wood ash was soaked in hot water for 24 h and filtered to obtain the lye, a brown-coloured solution which was evaporated to dryness.

Saponification process

The oils were saponified via a heated procedure. In a beaker, 10 mL of oil was brought to a boil, and while the oil was still hot, 10 mL of preheated lye solution was added, stirring continuously. Immediately, a thick, semi-solid mass of soap with a dark brown color was noticed. Variations of additives were added, including honey, *Moringa oleifera*, and *D. oliveri* resin. The semi-solid mass was then agitated for an additional ten minutes before being allowed to cool and set for a few weeks [16].

Characterization of soaps

The soaps were characterized by pH analysis, determination of foaming ability, and solubility and compared with commercial samples using previously reported protocol [1].

Characterization of oil by gas chromatography-mass spectroscopy (GC-MS)

A (GCMS-QP 2010SE) (SHIMADZU JAPAN) equipped with 100 % grade dimethylpolysiloxane and packed into an RTX5MS column was utilized. The following are the parameters for the GC-MS operation: the temperature of the column was first maintained at 60 °C and 1.56 mL/min, and it was thereafter set to climb to 280 °C at a rate of 5 °C per minute. The temperature of the detector (mass spectrophotometer) was kept at 250 °C while the injector was set at 200 °C. With a linear velocity of 45.6 cm/s and a pressure of 97.1 Kpa, helium was employed as the carrier gas. At a voltage of 70 eV, electron impact (EI) was the ionization mechanism. Volatile components were identified by carried out using the peak enrichment technique of reference compounds and these peaks were confirmed by comparing spectra to those of NIST library mass spectra.

Characterization of lye

The prepared lye solution was characterized using an HI-2003 Edge conductivity meter, 2100 N Turbidimeter and pH 7310 meter to determine its conductivity, total dissolved solids and pH respectively. Also, the elemental analysis was carried out using XRF (X-ray fluorescence). An Eclipse III (XR-100CR) coupled with by MCA 8000AMultichannel Analyzer (AMTEK INC. MA; USA) was used to irradiate the lye sample. The samples to be irradiated were placed in the sample chamber at 45° to the source X-ray tube and the Si-PIN photodiode detector. The source X-ray tube was maintained at a voltage of 25 kV and a current of 50 µA and each of the samples was irradiated for a real Time (RT) of 1000 s.

In vitro antioxidant assays

DPPH assay

For the free radical scavenging evaluation of the oil and soap, the samples were examined using a modified method of in vitro DPPH assay [1,7]. After being prepared at a concentration of 0.1 mM in methanol, the DPPH free radical was shielded from light. The seed oils were produced as stock solutions at 1 mg/mL and thereafter diluted in methanol to final concentrations of 500, 250, 200, 100, and 50 µg/mL. After adding 1 mL of 0.1 mM DPPH methanol solution to the sample or standard solutions (α -tocopherol and gallic acid separately), the mixture were left to incubate for 30 min under dark conditions. At 518 nm, the absorbance was measured. Prior to interacting with the material, the absorbance of DPPH was also measured in a blank experiment.

ABTS assay

Applying certain modifications, the ABTS cation decolorization assay, as previously published [17] was used to measure the ABTS radical scavenging activity of *A. digitata* and *D. oliveri* oil and the soap samples. By reacting a 7 mM ABTS stock solution with 2.45 mM potassium persulfate and letting the mixture stand in the dark at room temperature for 12 h before to use, the ABTS radical cations (ABTS•+) were created. Methanol was added to the ABTS•+ solution to dilute it until the absorbance at 734 nm was 0.7 ± 0.01 . After one minute of reacting with two milliliters of the ABTS•+ solution, the soaps and oil samples (1 mL) were tested for absorbance at 734 nm. As a reference substance, ascorbic acid was employed. The findings were computed as mean value $\pm$ standard error of mean (SEM) ($n = 3$) and reported as a percentage inhibition of ABTS radicals as ascorbic acid was adopted as a reference [18].

Table 1Fatty acid composition of the *Adansonia digitata* and *Daniella oliveri*.

Fatty Acids	Degree of Saturation	%RA of <i>D. oliveri</i>	%RA of <i>A. digitata</i>
Myristic acid	14:00	–	0.53
Stearic acid	18:00	8.78	9.54
4-octadecenoic acid	18:01	–	0.03
6-octadecenoic acid	18:01	–	0.05
Pentadecanoic acid	14:00	21.13	0.11
Palmitoleic acid	16:01	–	0.77
Palmitic acid	16:00	13.38	19.98
Linoleic acid	18:02	–	0.36
10-Heptadecenoic acid	17:01	–	0.98
Heptadecenoic acid	17:00	–	0.7
Stearolic acid	18:01	–	8.34
2-octylcyclopropene-1octanoic acid	19:01	–	1.78
Oleic acid	18:01	20.54	46.04
11-Eicosenoic acid	20:01	–	1.61
Arachidic acid	20:00	–	3.4
Behemic acid	22:00	–	2.29
Tricosanoic acid	23:00	5.78	0.25
Lignoceric acid	24:00:00	7.13	1.57
Pentacosanoic acid	25:00:00	–	0.29
Cerotic acid	26:00:00	–	0.33
12-Hydroxydodecanoic acid	12:00:00	23.25	–
Octadecenoic acid	19:00	–	0.33
9-Octadecenoic acid	18:01	–	0.59
Total saturate		79.45	38.79
Total unsaturated		20.54	60.55
Monounsaturated		20.54	60.36
Polyunsaturated			0.36

%RA indicates percentage relative abundance (peak area relative to the total peak area).

Anti-inflammatory assay

Using lipoxidase as the enzyme and linoleic acid as the substrate, anti-lipoxygenase activity was investigated [19]. After dissolving the test samples in 0.25 mL of pH 9, 2 M borate buffer, 0.25 mL of 20,000 U/mL lipoxidase enzyme solution was added, and the mixture was incubated for 5 min at 25 °C. Then, 1.0 mL of a 0.6 mM linoleic acid solution was added, thoroughly mixed, and the absorbance at 234 nm was measured. The standard of reference was indomethacin. It was calculated to find the percentage of inhibition.

Antimicrobial assay

The disk agar diffusion method was adopted [20]. The primary test organisms utilized were from clinical isolates kept in the Department of Medical Microbiology at the University of Ibadan at Nigeria's College of Medicine. The plates were dried in an oven set at 60 °C for 15 min with their lids slightly lifted. The test organisms were suspended in saline solution (0.85 % NaCl) and adjusted to match a turbidity of 0.5 McFarland Standard after being cultured on nutrient agar plates and incubated at 37 °C. Mueller Hinton agar plate surfaces were inoculated using a sterilized cotton swab and the standardized suspension. After serial dilution, different concentrations of the different soap samples were generated (using sterile distilled water) in the range of 500 mg/mL to 62.5 mg/mL. After the plates were left for roughly thirty minutes, the disks were aseptically moved using sterile forceps straight into the sensitivity plates. After 30 min of application, the plates were turned over, incubated for 24 h at 35 °C, and the zone of inhibition measure [21] [22].

Cytotoxicity assay

For the purpose of maintaining human foreskin fibroblast (HFF) cells, DMEM (Nissui, Tokyo, Japan) was supplemented with 10 % (v/v) fetal calf serum (FCS; Gibco, Invitrogen, UK), penicillin and streptomycin (100 U/ml; Biowhittaker, UK), and GlutaMAX™-I (Gibco, Invitrogen, UK). At 37 °C and 5 % CO₂, cells were cultured till confluence. Unless specified otherwise, every experiment was carried out in 96-well plates (Nunc; Fisher Scientific, Pittsburgh, USA). The desired cell density was achieved by trypsinizing the cells at confluence and re-suspending them. Following a 72-hour incubation period, the cells were treated with several quantities (ranging from 125 to 1000 µg/mL) of oil extracts after being seeded onto plates at a density of 1×10^5 cells per well. One positive control medication was staurosporine. Cell viability was assessed after the treated cells were cultured for 72 h. The experiment was run separately in triplicate [23].

Statistical analysis

Data were obtained in triplicate except where otherwise stated. They were subjected to one-way analysis of variance (ANOVA) and average value reported with standard error of mean (SEM). The data were considered to be statistically significant at $P < 0.05$.

Table 2Physicochemical properties of the oils of *Adansonia digitata* and *Daniella oliveri*.

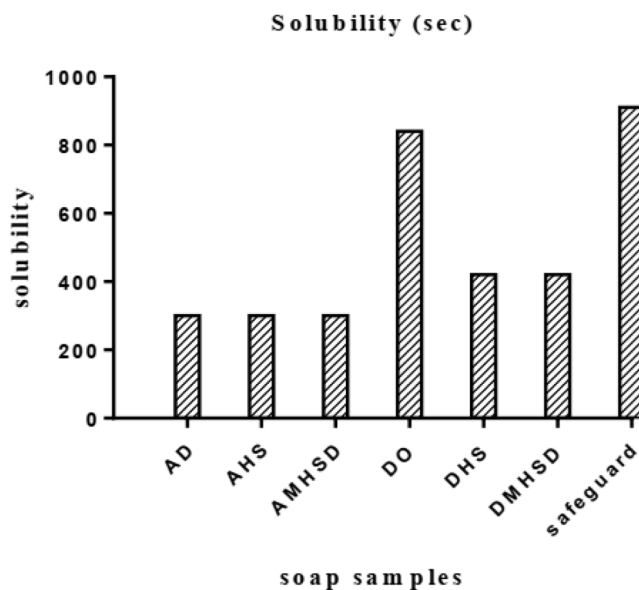
Parameters	<i>A. digitata</i>	<i>D. oliveri</i>
% Yield of oil from seed	29.00 ± 0.10	16.08 ± 0.02
Saponification value (mg KOH/g)	175.00 ± 4.95	265.00 ± 4.72
Acid Value (mg KOH/g)	2.50 ± 0.66	1.95 ± 0.10
Free fatty acid (%)	3.22 ± 0.02	0.34 ± 0.01
Iodine value (mg/g)	48.71 ± 0.09	103.00 ± 5.70
Colour	Light yellow	Light yellow
Odour	nutty	Nutty
Physical state at ambient temp (25 °C)	Liquid	Liquid

Test was carried out in triplicate and represented as average (±SEM).

Table 3Physicochemical characteristics of the organic soap samples prepared from *Adansonia digitata* and *Daniella oliveri* Seed oils and oil mix.

Parameters	AD	AHS	AMHSD	DO	DHS	DMHSD	Safeguard (standard)
Mixing ratios	4ml	5ml: 1ml:0.1g	4ml: 1ml: 1ml: 0.1g:	4ml	5ml: 1ml:0.1g	4ml:1ml:1ml: 0.1g:	–
Total fatty Matter (%)	15	30	48	26	39	40	–
Free caustic alkali (%)	0.62	0.78	0.47	0.78	0.47	0.31	–
Washing ability	Very good	Good	Good	Very good	Good	Good	Very good
Foam height (cm ³)	2.25	2.0	1.0	2.5	2.25	2.0	3.5
Solubility (sec)	300	300	300	840	420	420	910
Texture	Hard	Hard	Soft	Hard	Hard	Soft	Hard
Colour	Brown	Brown	Brown	Brown	Brown	Brown	Pink
pH before curing	10.59 ± 0.05	10.35 ± 0.04	10.34 ± 0.04	10.17 ± 0.06	10.29 ± 0.06	10.24 ± 0.01	–
pH after curing	9.85 ± 0.07	9.75 ± 0.07	8.70 ± 0.10	8.50 ± 0.05	8.60 ± 0.01	8.58 ± 0.02	9.05

Mixing ratios: AD- *A. digitata* oil; AHS- *A. digitata* oil + Honey+ scent leaf; AMHSD- *A. digitata* oil + *Moringa oleifera* oil+ Honey+ scent leaf + *D. oliveri* resin; DO- *D. oliveri* oil; DHS- *D. oliveri* oil + Honey + scent leaf; DMHSD – *D. oliveri* oil + *Moringa oleifera* oil + Honey + scent leaf + *D. oliveri* resin.

**Fig. 1.** Solubility test of the soaps.

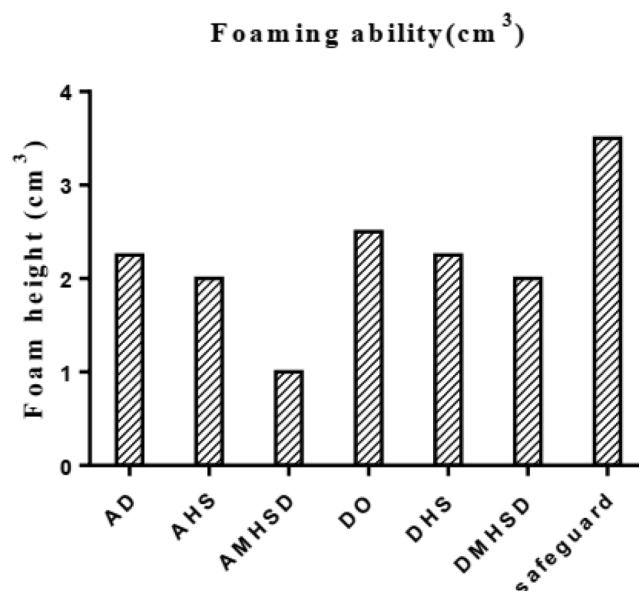
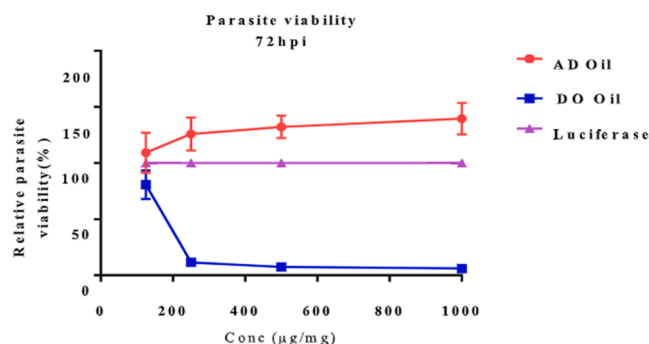


Fig. 2. Foaming Ability Test of the soaps.

Fig. 3. Parasitic viability of seed oil from *A. digitata* and *D. oliveri* against *Toxoplasma gondii*.

Results and discussion

Fatty acids composition of extracted oils

The fatty acid profiles of seed oil obtained from *A. digitata* and *D. oliveri* were determined by subjecting the trans-esterified oil to GC-MS analysis and the result obtained is as indicated (Table 1).

Physicochemical characterization

Qualities of the seed oils from *A. digitata* and *D. oliveri* were determined as a function of their physicochemical properties. The result obtained is as indicated (Table 2).

The acid values 2.50 ± 0.66 mg KOH/g and 1.95 ± 0.10 mg KOH/g for the *A. digitata* and *D. oliveri* respectively are considerably low falling within the accepted recommended range for edible oil i.e. 0.00–3.00 mg KOH/g[24]. The low acid values also suggest a long shelf-life since it is less susceptible to lipase action and other physical factors[25]. The iodine value for *A. digitata* seed oil, 48.71 ± 0.09 mg/g suggests a low concentration of unsaturated fatty acids in the seed oil and its reduced susceptibility to reactions such as oxidation, addition, hydrogenation which could result in a long shelf life and improved health benefits for consumers. *D. oliveri* with an iodine value of 103 ± 5.70 mg/g falls in the range of semi-drying oils suggesting that the oils may find application in the manufacture of fast drying oil paints, varnishes and cosmetics [26]. The saponification values of *A. digitata* and *D. oliveri* were 175 ± 4.95 and 265 ± 4.72 respectively mg KOH/g were relatively high. These values fall within the range of already commercialized oils such as palm kernel oil with a saponification value 177.61 mg KOH/g²⁷. This is an indication that they have potential application in the soap industries [28]. Also, the free fatty acid value of *A. digitata* and *D. oliveri*, 0.34 % and 3.22 % respectively were below the maximum limit of 5 %,

Table 4
Elemental analysis of the lye solution.

Elements	Concentration	Unit
Ca	1.14 ± 0.020	wt. %
K	19.38 ± 0.14	wt. %
Fe	389 ± 11	Ppm
Mn	115 ± 8	Ppm
Rb	102 ± 3	Ppm
Sr	19 ± 2	Ppm
Zn	23 ± 1	Ppm
Ni	0.86 ± 0.06	wt. %
Y	0.002 ± 0.001	wt. %
Br	0.05 ± 0.003	wt. %
Cl	2.41 ± 0.05	wt. %
P	1.36 ± 0.11	wt. %

The tests were run three times, with the results shown as an average (±SEM).

Table 5
pH, Conductivity and Turbidity of the lye solution.

Parameters	Concentration
pH	11.42 ± 0.01
Turbidity (NTU)	17.70 ± 0.00
Conductivity (µS/cm)	40.47 ± 0.21

The tests were run three times, with the results shown as an average (±SEM).

Table 6
ABTS, anti-oxidant activities of the oil and soaps.

Conc. (µg/mg)	Ascorbic acid (%)	Safeguard (standard) (%)	AD (%)	AMHSD (%)	Emollient (%)	AD Oil (%)
10	22.67±0.76	8.45±3.78	12.52±0.38	10.57 ± 2.42	7.05 ± 1.36	3.86 ± 0.55
20	30.41±0.40	11.16 ± 1.66	12.52 ± 0.98	9.47 ± 0.64	6.15 ± 0.55	5.69 ± 1.19
50	56.00±1.73	8.54 ± 0.12	8.45 ± 3.01	8.96 ± 2.00	7.60 ± 1.15	6.53 ± 0.32
100	63.03±0.58	7.29 ± 5.17	9.08 ± 3.06	12.78 ± 5.00	6.49 ± 0.47	4.82 ± 0.18
150	65.32±0.40	9.85 ± 0.08	9.98 ± 1.32	12.18 ± 4.37	5.48 ± 0.78	4.70 ± 0.06

The analysis was done in triplicate and result represented as average (±SEM).

for free fatty acids. This may be an advantage with respect to human consumption [29,30].

The physicochemical properties of soap prepared from seed oil of *A. digitata* and *D. oliveri* and other additives are as shown (Table 3; Figs 1 and 2).

In order to characterize the alkalinity of the soaps, the pH values were determined before the day of saponification and after curing, i.e. about three months as described elsewhere [7]. Since healthy human skin has a pH values which ranges between 5.4–5.9, using soap with a high alkaline content can raise the pH of the skin, which can lead to dehydration, irritation, and neutralize the body's protective acid mantle that functions as a barrier against bacteria and viruses [31], [32]. The cured soaps' pH levels all came within the National Agency for Food and Drug Administration and Control's (NAFDAC) approved range of 9 to 11, implying that fewer skin reactions are anticipated. AD and DO showed an appreciable foaming ability in comparison to safeguard (Fig 3.2). However, on addition of additives their foaming ability slightly reduced. Also DO showed the highest solubility ability in comparison with safeguard (Fig 3.1). The total fatty matter (TFM) is a measure the quality of soap. On addition of additives to soaps (AMH, AMHSD, DMH, DMHSD) showed a considerable level of total fatty matter which falls within the range acceptable for bathing according to the bureau of India standards which is a minimum of 30. Using X-Ray Fluorescence (XRF), the elemental analysis of solid lye was determined (Table 4).

The lye has high concentration of potassium 19.38±0.14 wt% compared to calcium 1.14±0.02 wt.%. This quite indicates that soap produced from the lye solution will be soft and highly water soluble and applicable in the production of soap products like shampoo, shaving creams, and emulsions [27]. Other metals such as Fe, Mn, Rb, Sr and Zn are in trace in amount and fall within the allowable range of Cosmetic Enhancement Center of England 2008. The lye solution prepared from wood ash was characterized using pH, Conductivity and Turbidity meters (Table 5).

The pH of the lye solution with a mass concentration of 20 g/250 mL, as 11.42±0.01, indicating strong alkalinity, while its conductivity and turbidity are 40.47±0.21 and 17.70±0.00 respectively which shows the presence of dissolved ions.

Table 7IC₅₀ values of ABTS antioxidant activities of the soaps.

Sample	IC ₅₀ (μg/mg)
Ascorbic acid	1.41 ± 0.47
Safeguard (standard)	0.06 ± 0.01
AD	0.12 ± 0.02
AMHSD	0.11 ± 0.02
AD Oil	0.07 ± 0.011
Emollient	0.10 ± 0.011

The analysis was done in triplicate and result represented as average (±SEM).

Table 8IC₅₀ values of soap mixtures of *Daniella oliveri*, Safeguard (control) and Ascorbic acid.

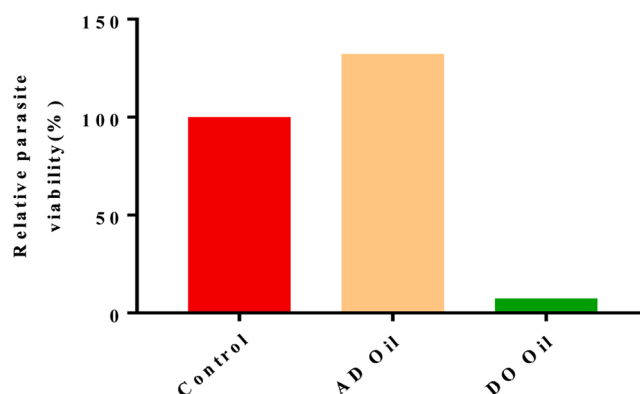
Sample	IC ₅₀ (μg/mg)
Ascorbic acid	2.06 ± 0.50
Safeguard (standard)	0.14 ± 0.023
DO	0.13 ± 0.012
DMHSD	0.11 ± 0.011
DO Oil	0.10 ± 0.0087
Emollient	0.10 ± 0.011

The analysis was done in triplicate and result represented as average (±SEM).

Table 9Absorbance and percentage ABTS inhibition of soap mixtures *Daniella oliveri*, safeguard (control), and Ascorbic acid.

Conc (μg/mg)	Ascorbic acid (%)	Safeguard (standard) (%)	DO (%)	DMHSD (%)	Emollient	DO Oil
10	34.42±1.36	8.45±3.78	8.79 ± 1.91	7.85± 0.72	7.05± 1.36	7.64 ± 0.59
20	56.45 ± 0.76	11.16 ± 1.66	9.04 ± 1.83	6.58± 0.30	6.15 ± 0.55	7.17 ± 0.47
50	62.39 ± 0.34	8.54± 0.12	8.70 ± 1.32	8.58± 0.25	7.60 ± 1.15	5.65 ± 1.57
100	62.61 ± 0.72	7.29± 5.17	7.64 ± 0.93	4.46± 0.38	6.49 ± 0.47	6.50 ± 0.35
150	62.82 ± 0.17	9.85± 0.08	6.52 ± 0.16	7.05± 1.10	5.48 ± 0.78	6.35 ± 0.28

Test was carried out in triplicate and represented as average (±SEM).

**Fig. 4.** Anti-*Toxoplasma gondii* activity of seed oil of *Adansonia digitata* and *Daniella oliveri* without α-tocopherol (trolox).

ABTS antioxidant potential of oil, emollient (oil mixture) and soaps of *A. digitata* and *D. oliveri*

The antioxidant potential of the seed and soap samples of *A. digitata* and *D. oliveri*, as well as the emollient were determined and average values of triplicate data reported (Tables 6-9).

Numerous spectrophotometric tests have been used to assess the antioxidant potential of medications and plants. 2,2-azino-bis-3-ethylbenzthiazoline-6-sulphonic acid (ABTS) is one of the most widely used. The blue/green ABTS⁺ produced by the ABTS test is the basis for its applicability to both lipophilic and hydrophilic antioxidant systems [33].

Table 10
IC₅₀ values of samples.

Sample	IC ₅₀ (µg/mg)
Ascorbic acid	1.41 ± 0.47
Safeguard (control)	0.06 ± 0.01
AD	0.12 ± 0.02
AMHSD	0.11 ± 0.02
DMHSD	0.058 ± 0.018
AD Oil	0.11 ± 0.018
DO Oil	0.07 ± 0.010
Emollient	0.11 ± 0.016

Test was carried out in triplicate and represented as average (±SEM).

Table 11
IC₅₀ values of tested samples.

Sample	IC ₅₀ (µg/mg)
Indomethacin	45.38 ± 20.71
Commercial Standard	2.89 ± 0.46
DO	2.02 ± 0.25
DMHSD	2.12 ± 0.31
AMHSD	2.48 ± 0.53
Emollient	2.66 ± 0.97
AD Oil	2.51 ± 0.50
DO Oil	1.50 ± 0.50

Test was carried out in triplicate and represented as average (±SEM).

The % ABTS inhibitory action of the samples was derived as shown. In Table 4, soap sample AMHSD showed the highest percentage ABTS inhibition of 12.18 % at 150 µg/mL followed by AD with 9.98 % compared to the control soap (safeguard) with 9.85 % at the same concentration. AD oil showed its highest ABTS inhibition of 7.60 % at 50 µg/mL while the emollient showed its highest ABTS inhibition of 6.53 % respectively at the same concentration.

In Table 9, DO exhibited the highest percentage ABTS inhibition of 8.70 %, followed by DMHSD with 8.58 % as compared to the safeguard (standard soap) 8.54 % at a concentration of 50 µg/mL, while DO oil shows its highest ABTS inhibition of 7.64 % at 10 µg/mL. However, all samples showed a weak activity in comparison to Ascorbic acid all concentrations. The ABTS antioxidant result of the soap and oil samples indicated that the radical scavenging activities were not dose-dependent. (Fig 4)

DPPH antioxidant potential of oils, emollient (oil mixture) and soaps of *A. digitata* and *D. oliveri*

The DPPH antioxidant potentials of the samples were determined using standard procedure. The IC₅₀ values obtained are as reported Table 10. The % DPPH inhibition of the samples was determined as shown in Table 3.7. AD showed the highest activity at 8.15 % followed by AMHSD with ABTS inhibition activity 7.97 % compared to the standard soap 5.24 % at a concentration of 50 µg/mL. The emollient (oil mix) showed its highest ABTS inhibition of 9.50 % at 150 µg/mL while AD oil showed its highest inhibition of 8.76 % at 100 µg/mL.

From the result, DO showed ABTS inhibition of 7.02 %, followed by D.O with 5.09 % as compared with the standard soap 4.13 % at 20 µg/mL. The emollient showed its peak ABTS inhibition of 9.50 % at 150 µg/mL, while D.O. oil exhibited its highest ABTS inhibition of 6.55 % at 20 µg/mL. But at every concentration, as demonstrated, the activity of the samples was less significant than the ascorbic acid.

Anti-inflammatory activity of tested samples

All samples were subjected to in vitro anti-inflammatory evaluation using the lipoxxygenase inhibition assay. The results are shown in Table 11.

From the data obtained, all samples exhibited significant anti-lipoxxygenase activity. The soap samples showed the highest anti-lipoxxygenase activity which was comparable to the commercial standard. While the commercial standard exhibited the significant anti-lipoxxygenase with IC₅₀ 2.89 µg/mg, the DO oil showed the most significant activity with IC₅₀ of 1.50 µg/mg. However, both the emollient, prepared soaps and the oil had activities with IC₅₀ that ranges from 1.50 – 2.89 µg/mg. The anti-inflammatory activity was comparable with standard indomethacin for all samples with a lipoxxygenase activity at a concentration of 150 µg/mL. These activities may be due to strong occurrence of many unsaturated fatty acids in the oils.

Table 12
Inhibitory effect of AD soap against clinical isolates.

	Concentrations (mg/ml)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition(mm)						
Bacteria <i>S. aureus</i>	18±0.00	16±0.00	14±0.00	10±0.00	–	Gentamicin 10 (µg/ml) 34	25
<i>E. coli</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	36	25
<i>B. subtilis</i>	15±1.40	12±0.00	10±0.00	–	–	36	50
<i>P. aeruginosa</i>	15±1.40	13±1.40	10±0.00	–	–	36	50
<i>S. typhi</i>	15±1.41	13±1.40	10±0.00	–	–	36	50
<i>K. pneumoniae</i>	15±1.41	13±1.40	10±0.00	–	–	34	50
Fungi						Triconazole (70 %)	
<i>C. albicans</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	28	25
<i>niger</i>	15±1.40	13±1.40	10±0.00	–	–	26	50
<i>P. notatam</i>	17±1.40	14±0.00	10±0.00	–	–	26	50
<i>R. stoloniter</i>	14±1.40	12±0.00	10±0.00	–	–	26	50

Test was carried out in triplicate and represented as average (±SEM).

Table 13
Inhibitory effect of ADH soap against clinical isolates.

	Concentrations (mg/mL)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition (mm)						
Bacteria <i>S. aureus</i>	18±0.00	16±0.00	14±0.00	10±0.00	–	Gentamicin 10 (µg/ml)	
<i>E. coli</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	34	25
<i>B. subtilis</i>	15±1.40	13±1.40	10±0.00	–	–	36	25
<i>P. aeruginosa</i>	17±1.40	14±0.00	10±0.00	–	–	36	50
<i>S. typhi</i>	15±1.40	13±1.40	10±0.00	–	–	36	50
<i>K. pneumoniae</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	34	25
Fungi <i>C. albicans</i>	15±1.40	13±1.40	10±0.00	–	–	Triconazole (70 %) 28	50
<i>A. niger</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	26	25
<i>P. notatam</i>	14±0.00	12±0.00	10±0.00	–	–	26	50
<i>R. stoloniter</i>	14±0.00	12±0.00	10±0.00	–	–	28	50

Test was carried out in triplicate and represented as average (±SEM).

Table 14
Inhibitory effect of AMHSD soap against clinical isolates.

	Concentrations (mg/mL)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition (mm)						
Bacteria <i>S. aureus</i>	21±1.40	18±0.00	16±0.00	14±0.00	10±0.00	Gentamicin 10 (µg/ml) 34	12.5
<i>E. coli</i>	18±0.00	16±0.00	14±0.00	12±0.00	10±0.00	36	12.5
<i>B. subtilis</i>	17±0.00	14±0.00	12±0.00	10±0.00	–	36	25
<i>P. aeruginosa</i>	15±1.40	13±1.4	11±1.40	10±0.00	–	36	25
<i>S. typhi</i>	17±1.40	14±0.00	10±0.00	–	–	36	50
<i>K. pneumoniae</i>	17±1.40	16±0.00	14±0.00	12±0.00	10±0.00	34	12.5
Fungi <i>C. albicans</i>	19±1.40	16±0.00	14±0.00	12±0.00	10±0.00	Triconazole (70 %) 28	12.5
<i>A. niger</i>	16±0.00	14±0.00	12±0.00	12±0.00	10±0.00	26	12.5
<i>P. notatam</i>	12±0.00	12±0.00	10±0.00	10±0.00	10±0.00	26	12.5
<i>R. stoloniter</i>	10±0.00	10±0.00	–	–	–	28	100

Test was carried out in triplicate and represented as average (±SEM).

Antimicrobial activity of the seed oil and soaps from *A. digitata* and *D. oliveri*, emollients against pathogens

The antimicrobial activities (Tables 12–20) of organic medicinal soaps from *A. digitata* and *D. oliveri*, emollients were tested against the same pathogens, the oils were initially tested against the pathogens in order to observe if the soaps retain the antimicrobial activity of the oil they were made from.

One of the first lines of defense against bacteria and other infective organisms that might cause skin diseases is the application of antiseptic or medicated soaps [34]. Since synthetic antimicrobial agents, such triclosan in soaps, have been connected to the occurrence of clinical antimicrobial resistance, the use of natural benign antimicrobial agents in cosmetics has become more appealing than

Table 15

Inhibitory effect of DO soap against clinical isolates.

	Concentrations (mg/mL)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition (mm)						
Bacteria							
<i>S. aureus</i>	19±1.40	17±1.40	14±0.00	12±0.00	10±0.00	Gentamicin 10 (µg/ml) 34	12.5
<i>E. coli</i>	17±1.40	15±1.40	13±1.40	11±1.40	10±0.00	36	12.5
<i>B. subtilis</i>	19±1.40	16±0.00	14±0.00	12±0.00	10±0.00	36	12.5
<i>P. aeruginose</i>	19±1.40	17±1.40	15±1.40	13±1.40	10±0.00	36	12.5
<i>S. typhi</i>	19±1.40	16±0.00	15±1.40	13±1.40	10±0.00	36	12.5
Fungi							
<i>K. pnemonae</i>	19±1.40	17±1.40	14±0.00	12±0.00	10±0.00	34 Triconazole (70 %)	12.5
<i>C. albicans</i>	17±1.40	15±1.40	13±1.40	11±1.40	10±0.00	28	12.5
<i>A.niger</i>	18±0.00	16±0.00	14±0.00	12±0.00	10±0.00	26	12.5
<i>P.notatam</i>	17±1.40	15±1.40	13±1.40	11±1.40	10±0.00	26	12.5
<i>R.stoloniter</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	28	25.0

Test was carried out in triplicate and represented as average (±SEM).

Table 16

Inhibitory effect of DHS soap against clinical isolates.

	Concentrations (mg/mL)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition(mm)						
Bacteria							
<i>S. aureus</i>	19±1.40	17±1.40	14±0.00	12±0.00	10±0.00	Gentamicin 10 (µg/ml) 34	12.5
<i>E. coli</i>	19±1.40	17±1.40	15±1.40	13±1.40	10±0.00	36	12.5
<i>B. subtilis</i>	18±0.00	16±0.00	14±0.00	12±0.00	10±0.00	36	12.5
<i>P. aeruginose</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	36	25
<i>S. typhi</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	36	25
Fungi							
<i>K. pnemonae</i>	15±1.40	13±1.40	10±0.00	–	–	34 Triconazole (70 %)	50
<i>C. albicans</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	28	25
<i>niger</i>	15±1.40	13±1.40	10±0.00	–	–	26	50
<i>P. notatam</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	26	25
<i>R. stoloniter</i>	15±1.40	13±1.40	10±0.00	–	–	28	50

Test was carried out in triplicate and represented as average (±SEM).

Table 17

Inhibitory effect of DMHSD soap against clinical isolates.

	Concentrations (mg/ml)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition (mm)						
Bacteria							
<i>S. aureus</i>	23±1.40	19±1.40	17±1.40	13±1.40	11±1.40	Gentamicin 10 (µg/ml) 34	12.5
<i>E. coli</i>	21±1.40	17±1.40	15±1.40	13±1.40	10±0.00	36	12.5
<i>B. subtilis</i>	18±0.00	16±0.00	14±0.00	12±0.00	10±0.00	36	12.5
<i>P. aeruginose</i>	20±0.00	18±0.00	16±0.00	14±0.00	10±0.00	36	12.5
<i>S. typhi</i>	18±0.00	16±0.00	14±0.00	12±0.00	10±0.00	36	12.5
Fungi							
<i>K. pnemonae</i>	17±1.40	15±1.40	13±1.40	10±0.00	–	34 Triconazole (70 %)	25
<i>C. albicans</i>	18±0.00	16±0.00	14±0.00	12±0.00	–	28	25
<i>niger</i>	17±1.40	14±0.00	12±0.00	10±0.00	10±0.00	26	12.5
<i>P. notatam</i>	15±1.40	13±1.40	10±0.00	–	–	26	50
<i>R. stoloniter</i>	15±1.40	13±1.40	10±0.00	–	–	28	50

Test was carried out in triplicate and represented as average (±SEM).

their synthetic counterparts [35].

It has been observed that seed oils exhibit broad spectrum antibacterial action [36]. Minimum inhibitory concentrations (MICs) are considered the standard for determining the susceptibility of organisms to antimicrobials. With MIC values ranging from 12.5 mg/mL to 50 mg/mL and 12.5 mg/mL to 25 mg/mL, respectively, the seed oils of *A. digitata* and *D. oliveri* demonstrated the highest antimicrobial activity against 6 bacteria: *Salmonella typhi*, *Bacillus subtilis*, *Bacillus aureus*, *Bacillus coli*, *Aspergillus niger*, *Penicillium notatam*, and *Rhizopus stoloniler*, and 4 fungi: *Candida albicans*, *Aspergillus niger*, *Penicillium notatam*, and *Rhizopus stoloniler*. However, the oil mixtures (emollient) showed a lower level of inhibition towards the pathogens with an MIC value ranging from 50 mg/mL to 100 mg/mL. All prepared organic soaps showed appreciable level of antimicrobial activity in comparison to the standard drugs. However, soap samples with additives i.e., AMH and DMH, showed the highest level of inhibition with MIC values ranging from 12.5 to 50 mg/mL, which suggest that the additives (*M. oleifera* extract and honey) significant synergistic antimicrobial activities.

Table 18

Inhibitory effect of emollient against clinical isolates.

	Concentrations (mg/mL)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition (mm)						
Bacteria							
<i>S. aureus</i>	15±1.40	13±1.40	10±0.00	–	–	Gentamicin 10 (µg/ml) 34	50
<i>E. coli</i>	16±0.00	14±0.00	10±0.00	–	–	36	50
<i>B. subtilis</i>	15±1.40	13±1.40	10±0.00	–	–	36	50
<i>P. aeruginose</i>	17±1.40	14±0.00	11±1.40	10±0.00	–	36	25
<i>S. typhi</i>	15±1.40	13±1.40	10±0.00	–	–	36	50
<i>K. pneumoniae</i>	14±0.00	12±0.00	10±0.00	–	–	34 Triconazole (70 %)	50
Fungi							
<i>C. albicans</i>	15±1.40	13±1.40	10±0.00	–	–	28	50
<i>A. niger</i>	13±1.40	10±0.00	–	–	–	26	100
<i>P. notatam</i>	13±1.40	10±0.00	–	–	–	26	100
<i>R. stoloniter</i>	13±1.40	10±0.00	–	–	–	28	100

Test was carried out in triplicate and represented as average (±SEM).

Table 19

Inhibitory effect of AD Oil against clinical isolates.

	Concentrations (mg/mL)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition (mm)						
Bacteria							
<i>S. aureus</i>	19±1.40	15±1.40	13±1.40	10±0.00	–	Gentamicin 10 (µg/ml) 334	25.0
<i>E. coli</i>	19±1.40	17±1.40	14±0.00	12±0.00	10±0.00	36	12.5
<i>B. subtilis</i>	18±0.00	16±0.00	14±0.00	12±0.00	10±0.00	36	12.5
<i>P. aeruginose</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	36	25.0
<i>S. typhi</i>	20±0.00	18±0.00	16±0.00	14±0.00	10±0.00	36	12.5
<i>K. pneumoniae</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	34	25.0
Fungi							
<i>C. albicans</i>	16±0.00	14±0.00	12±0.00	10±0.00	–	Triconazole (70 %) 28	25.0
<i>A. niger</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	26	25.0
<i>P. notatam</i>	14±0.00	12±0.00	10±0.00	–	–	26	50.0
<i>R. stoloniter</i>	14±0.00	12±0.00	10±0.00	–	–	28	50.0

Table 20

Inhibitory effect of DO Oil against clinical isolates.

	Concentrations (mg/mL)					Positive control	MIC (mg/mL)
	200	100	50	25	12.5		
Pathogens	Diameter Zone of Inhibition (mm)						
Bacteria							
<i>S. aureus</i>	20±0.00	18±0.00	15±1.40	13±1.40	10±0.00	Gentamicin 10(µg/ml) 34	12.5
<i>E. coli</i>	21±1.40	18±0.00	15±1.40	13±1.40	10±0.00	36	12.5
<i>B. subtilis</i>	22±0.00	18±0.00	15±1.40	10±0.00	10±0.00	36	12.5
<i>P. aeruginose</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	36	25.0
<i>S. typhi</i>	18±0.00	15±1.40	13±1.40	10±0.00	–	36	25.0
<i>K. pneumoniae</i>	17±1.40	14±0.00	12±0.00	10±0.00	–	34 Triconazole (70 %)	25.0
Fungi							
<i>C. albicans</i>	18±0.00	14±0.00	12±0.00	10±0.00	–	28	25.0
<i>niger</i>	17±1.40	15±1.40	12±0.00	10±0.00	–	26	25.0
<i>P. notatam</i>	17±1.40	14±0.00	11±1.40	10±0.00	–	26	25.0
<i>R. stoloniter</i>	17±1.40	14±0.00	11±1.40	10±0.00	–	28	25.0

Test was carried out in triplicate and represented as average (±SEM).

The antimicrobial result generally suggests that the organic skin soap made from natural underused items has an advantage over known synthetic goods in terms of its ability to suppress associated microbial illnesses. Minimum inhibitory concentrations (MICs) are considered the standard for determining the susceptibility of organisms to antimicrobials [37]. The organic soap samples showed a considerable MIC against all pathogens.

Cytotoxicity of the seed oil of *A. digitata* and *D. oliveri*

The untreated negative control with total viability and background values were used to compute the cell viability. To validate the experiment, 1 µM of streptospirine was used as a positive control. Results obtained are presented (Tables 21–23).

Table 21Cytotoxicity of seed oil from *Adansonia digitata* and *Daniella oliveri*.

Conc. (µg/ml)	% Cell Viability		
	Staurosporine	A.D	D.O
1000	100 ± 0.00	114.92 ± 2.70	0.007 ± 0.001
500	100 ± 0.00	105.59 ± 3.57	0.009 ± 0.002
250	100 ± 0.00	105.65 ± 2.83	0.008 ± 0.003
125	100 ± 0.00	95.35 ± 2.77	0.045 ± 0.009

Test was carried out in triplicate and represented in (±SEM).

Table 22Anti-parasite activity of seed oil of *Adansonia digitata* and *Daniella oliveri*.

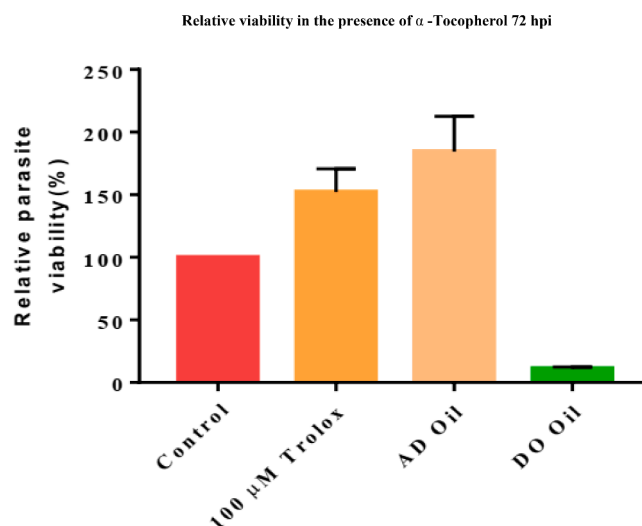
Conc. (µg/ml)	(%) Parasite Growth Viability		
	Luciferase	AD Oil	DO Oil
1000	100 ± 0.00	139.53 ± 14.0	6.64 ± 0.57
500	100 ± 0.00	132.30 ± 10.09	7.58 ± 0.58
250	100 ± 0.00	125.94 ± 14.69	11.69 ± 0.56
125	100 ± 0.00	109.18 ± 17.97	86.08 ± 8.30

Test was carried out in triplicate and represented as average (±SEM).

Table 23*Adansonia digitata* and *Daniella oliveri* seed oils' anti-parasite properties in the presence of trolox.

Samples	Relative parasite Viability (%)
Control	100 ± 0.00
100 µM Trolox	152.28 ± 7.54
A.D.	184.42 ± 11.46
D.O.	11.18 ± 0.5

Test was carried out in triplicate and represented as average (±SEM).

**Fig. 5.** Anti-*Toxoplasma gondii* activity of seed oil of *Adansonia digitata* and *Daniella oliveri* in the presence of α -tocopherol (trolox).

At 1000 µg/mL, the lowest degree of cytotoxicity was observed, and the cell viability was 139.53 ± 14.0 % while the highest was at 250 µg/mL (109.18 ± 17.97 % cell viability) for AD Oil. Also for DO Oil, the lowest cytotoxicity was obtained at 125 µg/mL and highest at 1000 µg/mL (6.64 ± 0.57 % cell viability).

Table 24Cytotoxicity IC₅₀ and Anti-parasite EC₅₀ of seed oil *A. digitata*, *D. oliveri* and Control (sulfadoxine).

Test Materials	Host cell cytotoxicity	Anti-parasite activity	Selectivity Index
	IC ₅₀ (μg/mL)	EC ₅₀ (μg/mL)	(SI): IC ₅₀ /EC ₅₀
<i>A. digitata</i>	ND	ND	ND
<i>D. oliveri</i>	≤40	≤10	<1
Sulfadoxine	≤150	≤500	<4

The values ($n = 9$) are presented as Mean $\pm$ SEM. ND stands for Not determined.

Anti-parasite properties of *A. digitata* and *D. oliveri* oils

Using 1000 μg/mL sulfadiazine as a positive control and untreated as a negative control for parasite viability, the luciferase activities was assessed.

The results (Fig. 3) revealed that the AD Oil exhibited anti-parasitic activity 139.53 ± 14.0 at 1000 μg/mL and 109.18 ± 17.97 % at 125 μg/mL while the DO Oil exhibited 86.08 ± 8.30 % inhibition of parasite growths at 125 μg/mL and only 6.64 ± 0.57 % at 1000 μg/mL. At concentrations greater than 250 μg/mL, the oil showed extreme toxicity.

Anti-parasite activity in the presence of trolox

Following the determination of the anti-parasitic activity of the oil, the mechanism of activity was determined by incorporating 100 μM of α-tocopherol into the anti-parasite screening test to ascertain whether reactive oxygen species (ROS) are responsible for the oil's anti-parasite activity (Table 19; Figs. 4 and 5).

It may be inferred from Figs. 4 and 5 that the α-tocopherol decreases the anti-parasite action of *A. digitata* and *D. oliveri* when added. This could suggest that oxidative stress has a role in the anti-parasite activities of *A. digitata* and *D. oliveri*, which in turn influences how they combat *T. gondii*.

Index of selectivity

The ratio of the cytotoxicity (IC₅₀) of (EC₅₀) was used to calculate their selectivity index (Table 24).

As can be shown in Table 20, despite having strong action against *T. gondii*, the *D. oliveri* has a relatively low selectivity (<1) as it did not exhibit significant selectivity toward the parasite relative to the host cell. Thus, widespread cellular toxicity is proposed as the cause of the anti-parasite activity.

Conclusion

Seed oils from *A. digitata* and *D. oliveri* had percentage yield of 29 % and 16 % respectively and showed suitable physicochemical parameters that support their prospects as source of edible oil as well as industrial purposes. Also, their fatty acid profiling showed a number of fatty acids such as oleic acid, stearic acid, and palmitic acid, which are important fatty acids in cosmetic productions. Antiseptic soaps produced from seeds oil of *A. digitata* and *D. oliveri* and lye solution produced from wood ash, yielded a soft brownish soap due to high content of potassium in the lye solution. These seed oils and products exhibited significant degree of biological activity comparable to commercial products. The oil holds promise for various industrial and pharmacology utilizations.

Credit author statement

Each author contributed to various aspects of the research and manuscript preparation. All authors have read and approved the final version of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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