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ORIGINAL RESEARCH ARTICLE

Assessment of the Physico-Chemical Characteristics, Phytochemicals, Biological Activities, and Soap-Making Process Using the Pulp and Seed Oils of Avocados (*Persea americana*)

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ABSTRACT
Using green chemistry concepts to promote sustainability and local economic development, this study investigates the potential of avocado (*Persea Americana*) pulp and seed oils for the creation of environmentally friendly herbal antimicrobial soaps. Oils were extracted via Soxhlet apparatus, yielding 23.4% (seed) and 16.2% (pulp), and characterized for physicochemical properties. The soaps demonstrated pH values between 10.31 and 10.8, foam heights of 2.3–3.2 cm, and total fatty matter ranging from 68.4% to 89.1%, exceeding commercial standards (65.0%). Phytochemical screening revealed that tannins, saponins, and alkaloids contribute to antimicrobial efficacy. The AVSP soap (a blend of pulp and seed oils) exhibited significant antimicrobial activity, including a 21 mm inhibition zone against *Escherichia coli* and inhibition of multiple microorganisms such as *Bacillus subtilis* and *Phijoptius stoloniter* across all tested concentrations. These findings distinguish AVSP soap as a superior sustainable alternative, addressing environmental challenges posed by synthetic cosmetics and promoting agro-waste conversion into valuable commercial products. This research provides a practical approach for integrating natural resources into sustainable cosmetic formulations with potential global hygiene and environmental conservation applications.

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INTRODUCTION

The aspiration for aesthetically pleasing hair and skin is a universal phenomenon. Consequently, as the upkeep of attractive skin and hair constitutes a daily routine for numerous individuals globally, the utilization of suitable and safe cosmetic products becomes indispensable. Cosmetics derived from natural sources, which are rich in bioactive phytochemical compounds, provide substantial benefits in terms of beauty enhancement and medicinal effectiveness while reducing harm to the environment and users. Herbal soaps made from plant-based renewable resources would support the United Nations' 17 Sustainable Development Goals, which include promoting health, protecting the environment, building sustainable communities, providing clean energy, and improving safety for aquatic and terrestrial life (UNDP-SDG, 2000 and Atolani *et al*., 2016). This is in line with the principles of green chemistry. Cosmetics made from natural ingredients have been shown to improve consumers' psychological, social, and clinical reactions. Many artificial and synthetic ingredients frequently present in skin and hair cosmetic products can cause negative side effects, including dryness, brittleness, discolouration, irritation, and skin damage (Joshi and Pawal, 2015). Among other things, it has been reported that parabens, butylated hydroxyanisole (BHA), and butylated hydroxytoluene (BHT), which are used as preservatives and antioxidants in cosmetic formulations, can cause allergic reactions (Fathima *et al*., 2011; Kapoor, 2005; Joshi and pawal . 2015 and Atolani *et al.* 2016).

The use of natural antioxidants in the prevention of illnesses linked to oxidative damage in the human body and lipid peroxidation in food products has drawn increased attention from academics (Teow *et al*., 2007). Because of their ability to revitalize, hydrate, and strengthen the integrity of skin and hair, traditional medical practices in Nigeria use a range of seed oils and extracts from medicinal plants, which are economically sourced for the development of skin and hair care products. The seeds from plants usually contain lipids, fatty acids, amines, proteins, and esters, all essential for

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maintaining healthy skin function. Due to their classification as non-conventional oil seeds, a considerable proportion of precious oil-rich seeds in Nigeria are allowed to decompose every year (Atolani *et al.* 2016).

A native of Mexico, the avocado (*Persea Americana*) is a subtropical fruit that has recently attracted a lot of attention as a fruit grown in northern Thailand. Rich in nutrients and phytochemicals, avocados are an excellent source of energy since they contain 17.34 g of crude fat, 6.94 g of carbs, 5.55 g of dietary fiber, and 2.08 g of proteins per 100 g of fresh pulp [Dreher & Davenport, 2013; Marlett & Cheung, 1997; Jutamas *et al.*, 2023; Yahia & Woolf, 2011). According to Dreher & Davenport's [2013] research, avocado oil is classified as having high monounsaturated fatty acid content because it contains 71% monounsaturated fatty acids, 13% polyunsaturated fatty acids, and 16% saturated fatty acids. Avocado pulp has the potential to support a wide range of health benefits because it contains potassium, sodium, magnesium, ascorbic acid, vitamin K, folate, vitamin B6, niacin, pantothenic acid, riboflavin, choline, carotenoids, tocopherols, and phytosterols [Dreher & Davenport, 2013; Krumreich *et al.*, 2018; Ramos-Aguilar *et al.*, 2021 and Jutamas *et al.*, 2023]. Because of its healthy fat content, eating avocado has been demonstrated to lower triglycerides, total cholesterol, and low-density lipoprotein cholesterol while raising HDL cholesterol levels, which helps with keeping the blood lipid profile in a healthy range [Mahmassani *et al.*, 2018]. Additionally, avocado contains phenolic components, including phenolic acids, flavonoids, lignans, and stilbenes, the content of which is positively associated with its antioxidant properties [Lyu *et al.*, 2023]. Additionally, avocado-derived phenolics have anti-inflammatory, anti-cancer, and antibacterial qualities that provide major health benefits [Ford *et al.*, 2023]. [Jutamas *et al.*, 2023]. Avocado's fatty acid and carbohydrate (particularly dietary fiber) components may have potential benefits for cardiovascular health. The compositional profile of avocado has demonstrated its heart-healthy potential to be comparable to that of almonds, pistachios, and walnuts, with less than half the calorie content, according to the United States Department of Agriculture (USDA) [2011].

Given the potential health benefits of avocado pulp and seed oil that have been previously discussed, while several studies address individual aspects of avocado components, the current study focuses on a holistic study combining physicochemical characteristics, detailed phytochemical analysis, biological activities, and formulation of herbal soaps with antiseptic qualities. Many studies focus on either the pulp or the seed, but not a comparative analysis within the same study. Given the increasing interest in sustainable practices, research focusing on utilizing avocado waste (peel and seed) for soap-making aligns with current trends. Exploring the economic feasibility and environmental impact of such processes is valuable. These products are expected to improve the natural beauty, allure, and aesthetic quality of African skin and hair by using underutilized sub-tropical fruit, such as avocado pulp and seed oils, and applying green chemistry principles to create an environmentally sustainable environment.

MATERIALS AND METHODOLOGY

Collection of sample and Identification

The avocado sample was purchased at the Ilorin West Local Government Area's mandate market, Kwara State, Nigeria. The sample underwent sufficient authentication, and voucher specimens were added to the University of Ilorin's Department of Plant and Biological Science herbarium in Kwara State, Nigeria.

Sample Preparation

The acquired avocado sample was thoroughly cleansed with water to remove dirt and any adhering materials so as to prevent potential deterioration. The sample was cut open, and the seed was separated from the pulp. The pulp was cut into smaller sizes, air dried until the moisture was drastically reduced, and ground. The avocado seed was grated immediately after opening the avocado and then air dried. Afterward, the fine powdered material was kept in an airtight container until further use.

Extraction of Oil

Using n-hexane and a Soxhlet system, the oils were extracted for eight hours at 60 °C. Using a rotating vacuum evaporator, the solvent was extracted from the oil at 65 oC and low pressure, and the yield was computed (Oluwaniyi *et al.*, 2023).

$$\text{Percentage Oil Yield (\%)} = \frac{\text{Weight of oil extracted}}{\text{Weight of seed used}} \times 100 \quad (1)$$

Qualitative Phytochemical Screening

The phytochemical analysis (Flavanoids, Tannins, Saponins, Alkaloids, Steroids, Tarpenoids, and Glycosides) was all done using standard methods as reported by (Mbatchou and Kosoono 2012, Ibrahim *et al.* 2013, Sofowara, 1993 and Hamad., *et al.* 2016).

Soap Preparation

Preparation of Lye

The wood ash was gathered from Tanke Ilorin's Ayox bakery and steeped for a full day. The Whatman filter paper was used to filter the resultant ash solution. Evaporation was then used to concentrate the filtrate.

Saponification of the oils

The cold process does not give instant saponification; hence, the oil samples were saponified using a hot process. In a beaker, 2ml of each oil sample was brought to a boil. 10ml of lye solution that had been preheated was then added to the boiling oil while being continuously stirred (Atolani *et al.*, 2016).

Soap characterization

The pH, foaming ability, solubility, and hardness of all the soaps were measured and compared to commercial soap samples (Ameh *et al*., 2013; Atolani *et al*., 2016). Lux, a commercial brand of bath soap, served as the benchmark for comparison.

Antimicrobial method of analysis

The antimicrobial testing procedures for examining extracts and pure medications as possible antibacterial agents in vitro. In 1940, agar disk-diffusion testing was created (Heatley, 1944). *Salmonella typhi, Bacillus subtilis, Pseudomonas aeruginosa, Streptococcus aureus, Escherichia coli, and Klebsiella pneumoniae*, as well as a fungus called *Candida albicans, Pehicillium notatum, Phijoptius stoloniter, and Aspergillus niger*. To get concentrations of 500 mg/ml, 500 mg of the oils were weighed and dissolved in 1 milliliter of tween-20. By gradually diluting the oils, serial concentrations of 250, 125, 62.5, 31.25, and 15.625 mg/ml were created. A complete organism was extracted from stock and inoculated into 5 ml of sterile nutrient broth for 18 to 24 hours at 37 ^{0}C to create an overnight culture of each organism. 9 ml of sterile distilled water was mixed with 0.1 ml of each organism to create a 1:100 (10-2) diluted solution of the organism. Using a sterile cork borer measuring 8 mm, wells were created based on the number of graded concentrations of the sample. The pour plate method was used to test for bacteria. 0.2 ml of the diluted solution was put to sterile nutrient agar and left to settle for approximately 45 to 60 minutes. Duplicates of this were done. To allow for pre-diffusion, the plates were left on the bench for two hours. For 18 to 24 hours, the plates were incubated upright at 37°C. For the fungi, surface plate techniques were employed. The sterile plates were aseptically filled with duplicates of a sterile Sabouraud Dextrose Agar (62g/l), which was then allowed to properly set. Applying 0.2 ml of the organism's 10-2 to the agar surface using a sterile spreader. A sterile 8mm diameter cork borer was used to create the wells. Gradient concentrations of the extract and the controls were added to each well. To give the extracts time to adequately diffuse into the agar, the plates were placed on the bench for 120 minutes. The plates were incubated upright in the incubator for 48 hours at 26–28 0C. Using a ruler, the zone of inhibition was measured.

RESULTS AND DISCUSSION

Phytochemical Screening of oil Samples from *Persea Americana* Pulp and Seed.

The findings of the qualitative phytochemical screening of oil samples from *Persea Americana* pulp and seed are shown in Table 1. The samples were examined for seven phytochemicals. According to the tables below, the (+) symbol denotes the presence of the phytochemical in the various oil samples, while the (-) sign denotes its absence.

Phytochemicals predominantly represent secondary metabolites produced by plants, frequently playing a pivotal role in the defense mechanisms against both biotic and abiotic stressors. Humans extensively utilize secondary metabolites for their considerable economic value, serving as key components in various chemical applications such as pharmaceuticals, flavorings, fragrances, insect repellents, and dyes (Pagare *et al*., 2015). The category of phytochemicals encompasses flavonoids, tannins, saponins, alkaloids, steroids, terpenoids, and glycosides; this study elucidates that both avocado seed and pulp oil are rich in these constituents.

Table 1: Qualitative evaluation of phytochemicals in oil samples from *Persea Americana* pulp and seed

Phytochemicals	Pulp	Seed
Tannins	+	+
Saponins	+	+
Terpenoids	_	_
Glycosides	+	_
Alkaloids	+	+
Flavonoids	_	_
Steroids	_	_

Avocado pulp and seed oil extracts have been found to contain saponins. These oils' saponin content may offer therapeutic advantages in the treatment of inflammation. Interestingly, saponins can precipitate and coagulate erythrocytes. According to Rita *et al.* (2015), saponins can bind cholesterol, show hemolytic activity, create stable foams in aqueous solutions, and impart a bitter taste. Additionally, saponins are thought to act as antibiotics in the natural environment, shielding plants against microbial dangers (Opara *et al*., 2019).

Neither the pulp oil nor the avocado seed contained terpenoids. The main reason for their antifungal and antibacterial qualities is the ability of oils containing terpenoids to break cellular membranes and prevent the growth of bacteria and fungi (Tawheed and Monika, 2014). Likewise, neither the pulp nor the seed extracts of avocados contained steroids. According to research, steroids are essential for the central nervous system's operation and have analgesic qualities (Ahmed and Mohammad, 2014). The avocado fruit's pulp oil and seed both contain tannins, which are known for their potent antioxidant properties.

Both extracts contain alkaloids. Because of their natural ability to relax muscles, avocado oils can be used for their antibacterial, analgesic, and antispasmodic actions (Stray, 1998; Okwu & Okwu, 2004). In addition to their antihypertensive, antifungal, anti-inflammatory, and antifibrogenic activities, alkaloids have been shown to have microbiocidal effects. Their main anti-diarrheal qualities are probably due to their influence on the small intestine (Ghosal *et al*., 1996). According to McDevitt *et al.* (1996), certain alkaloids have demonstrated effectiveness against intestinal infections linked to AIDS as well as HIV infections. The discovery of alkaloids in the oil extracts makes them a good choice for patients because these substances have important pharmacological characteristics. The results show that the extracts included flavonoids. As a result, avocado seed and pulp oil may be used to control how the body reacts to allergies, infections, and cancers. Their antimicrobial, antifungal, antibacterial, and anti-inflammatory properties have been reported in the literature (Cushnie and Lamb, 2005).

Oil Mixing Ratio for Soap Production

The formulations employed to produce soaps from the extracted oils are shown below. The proportions of the mixtures, the coloration of the soap, and the effectiveness of the washing process are detailed in Table 2. The soap synthesized from avocado seed oil exhibited a dark brown hue, whereas the soap derived from avocado pulp oil displayed a brown coloration. The soaps demonstrating the greatest washing efficacy, as determined through observation, were those formulated by mixing both avocado seed and pulp oil.

Table 2: Ratio of the fats and oils used in the saponification process

Samples	Oils/fat and Additives Mixing Ratio	Mixing Ratios	Washing efficiency	Cooler
AVS	AVS	1	Good	Dark brown
APS	APS	1	Fair	Brown
AVSP	AVS + APS	1:1	Very good	Brown

Where AVS= Avocado seed oil soap, APS= Avocado pulp oil soap, AVSP=Avocado seed oil + Avocado pulp oil soap.

Table 3: Physico-chemical properties of prepared soaps

SOAPS	AVS	APS	AVSP	LUX
pH (Day1)	10.75	10.4	10.8	_
pH (Day2)	10.66	10.31	10.6	9.01
Foam Height (CM³	2.5	2.3	3.2	4.1
Solubility (Sec)	223	125	184	540
Texture	Soft	Soft	Soft	Hard
Total Fatty Matter %	73.1	68.4	89.1	65.0
Total alkali	0.42	0.41	0.8	0.14
Free Caustic Alkali	0.25	0.44	0.31	0.12

Where AVS= Avocado seed oil soap, APS= Avocado pulp oil soap, AVSP=Avocado seed oil + Avocado pulp oil soap.

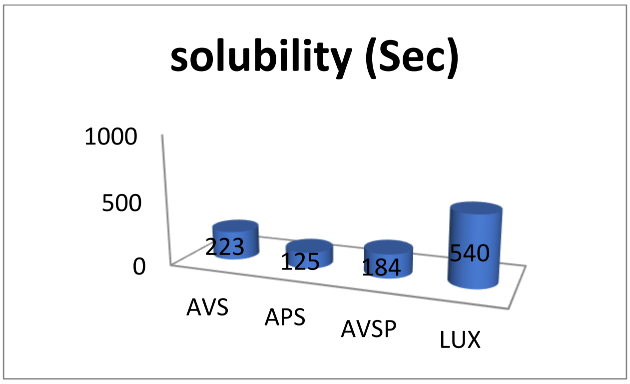

Figure 1: Solubility of soaps
Where AVS= Avocado seed oil soap, APS= Avocado pulp oil soap, AVSP=Avocado seed oil + Avocado pulp oil soap

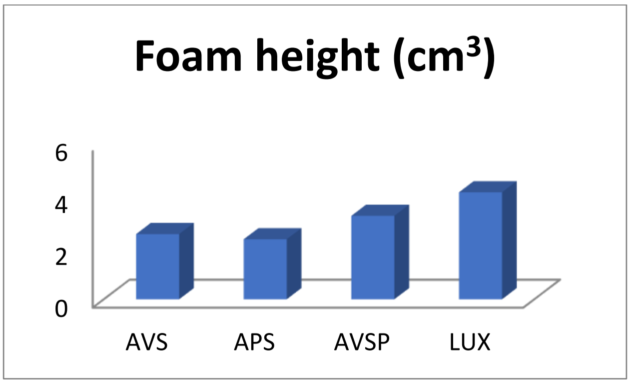

Figure 2: Foaming Ability of Soaps.
Where AVS= Avocado seed oil soap, APS= Avocado pulp oil soap, AVSP=Avocado seed oil + Avocado pulp oil soap

Soaps with high pH values (above 10) can indeed pose several risks to skin health. The skin's surface has a naturally acidic pH, typically between 4.5 and 5.5, known as the acid mantle. This acidity is crucial for maintaining the skin's barrier function, protecting it from harmful bacteria and environmental factors. High pH can cause dryness by affecting the skin's ability to retain moisture and dissolving fats from the skin surface (Gfatter et al., 1997). Skin pH changes can promote certain bacteria's growth, potentially leading to acne or other skin issues (Arefin, 2020). To mitigate the risk of skin irritation, several methods can be employed to adjust the pH of avocado oil soaps: **Superfatting:** This involves adding extra oils (avocado oil, shea butter, etc.) to the soap formulation beyond what is needed for saponification. The unsaponified oils help lower the overall pH and provide emollient properties, leaving the skin moisturized. **Acidulation with Citric Acid:** Citric acid, a natural fruit acid, can be added to the soap after saponification to lower the pH. It's important to add it carefully and in small increments, constantly monitoring the pH until it reaches the desired level. **Careful Selection of Alkali:** The type of alkali used can influence the final pH. Using a blend of alkalis or adjusting the concentration can help achieve a milder pH. **pH Testing:** It is important to test the pH of handmade soap to know whether it is ready for skin use (Soap pH Indications, Esther 2020). A safe range is between 8 and 10 (Soap pH Indications, Esther 2020). By implementing these strategies, it's possible to create avocado oil soaps with a pH that is gentler on the skin, reducing the risk of irritation and dryness. By implementing these strategies, it's possible to create avocado oil soaps with a pH that is gentler on the skin, reducing the risk of irritation and dryness.

It was found that the foam height of the seed oil soaps was lower than Lux's, with APS showing the lowest foam height. It is clear that AVS exhibits the least solubility, whereas APS is the most soluble soap. Every soap that was made had less foam than those reported by Ameh *et* *al.* (2013), although this is consistent with the results for Daniellia oliveri (Rolfe), Ocimum basilicum, and Vi tellaria paradoxa (Shea butter nut) that were reported by Atolani *et al.* (2016). Some soaps with high foaming properties can be used in shampoo and detergent production formulas. All of the soap samples' pH levels were discovered to be within the range that is advised for bathing soaps, specifically between 9 and 11 (Mak-Mensah and Firempong, 2011).

When compared to commercial soaps and the solubility values published for Vi tellaria paradoxa (Shea butter nut), Ocimum basilicum, and Daniellia oliveri (Rolfe), the soap's solubility was somewhat low (Atolani *et al.*, 2016). Due to their ability to dissolve gradually in water, the soaps' solubility and hardness are markers of how long they will last when used (Atolani *et al.*, 2016).

The soaps' pH values (Table 3) were recorded on the first and second day after formulation. Every soap's reported pH value was just a little bit higher than the 9–10 range that regulatory bodies, especially in Nigeria, have set as acceptable (Oyedele, 2002; Atolani *et al.*, 2016). The obtained pH values were marginally higher than those found in previous research (Ogunsuyi and Akinnawo, 2012; Vivian *et al.*, 2014; Atolani *et al.*, 2016). According to the measured pH values, the soaps can have corrosive qualities and cause skin responses when applied. Incomplete hydrolysis related to saponification usually results in elevated pH levels (especially when industrial-grade sodium or potassium hydroxides are used). Adding extra fats, oils, or any other superfatting agents can lessen the strong alkalinity and reduce the soap's harshness (Warra *et al.*, 2011; Atolani *et al.*, 2016).

A crucial factor in determining the quality of soap is the total fatty matter (TFM), which is always stated in commercial settings. TFM is the total amount of fatty matter, primarily fatty acids, that can be separated from a sample after it has been hydrolyzed with a mineral acid, usually HCl. TFM mostly determines the grade of soaps. Furthermore, TFM plays a crucial role in determining how long the soap will last. AVSP (avocado pulp and seed oils) was identified as the superior quality soap in this investigation because, as the above table shows, the total fatty matter of all synthesized soaps was found to be higher than that of the control (Lux), with AVSP showing the highest level and APS the lowest. A harder texture and lower quality are associated with a low TFM. Soaps with a minimum TFM of 75% were historically defined as Grade 1 in Europe and some places today, while those with a minimum TFM of 65% were categorized as Grade 2. Higher TFM soaps produce more lather, last longer, and—most importantly—cleanse the skin more effectively and gently. At least 60% TFM must be present in the lowest-quality soap (Grade 3) (Betsy *et al.*, 2013).

The abrasiveness of soaps is indicated by the presence of free caustic alkali, which can lead to partial saponification. The amounts of free caustic alkali in this investigation varied from 0.2 to 0.44, which is less than the values collected by Taiwo *et al.* (2008) and Beetseh and Anza (2013). All alkaline elements are included in total alkalinity.

Antimicrobial activities of the soaps

Results of the antimicrobial evaluation show that the soap samples possess useful antibacterial and antifungal inhibitory activities obtained at concentrations of 0.313mg/ml and above.

Table 4 shows that the seed oil soap inhibited most tested organisms at concentrations 10mg/l, 5 mg/l, and 2.5 mg/l, with the lowest inhibition on *Salmonella typhi* at a concentration 2.5mg/l. also at a concentration 1.25mg/l minimal inhibition was recorded, majorly on *Bacillus subtilis* and *Phijoptius stoloniter*. Only *Aspergillium niger* was inhibited at a concentration 0.625mg/l. This result indicates that the soap has the potential to inhibit microbial infections.

Table 4: Antimicrobial activities of AVS (*Persea Americana* seed oil soap) concentrations (mg/ml)

	Concentration (mg/ml)							
TM	**10**	**5**	**2.5**	**1.25**	**0.625**	**0.313**	**NC**	**PC**
	Diameter Zone of Inhibition (mm)							
Bacteria								
Staphylococcus aureus	19	17	15	12	_	_	_	21±1
Bacillus subtilis	19+1	18	16	14.1	_	_	_	18
Escherichia coli	18+1	17+1	15	12	_	_	_	23±1
Pseudomonas aeruginosa	18+1	17+1	13±1	10	_	_	_	21±1
Salmonella typhi	19	16±1	12±1	10	_	_	_	25±1
Klebsiella pnemonae	20+1	17	15	12	_	_	_	24
Fungi								
Phijoptius stoloniter	21+1	17+1	15	13	_	_	_	_17±1
Penicillium notatam	18+1	17	15	10	_	_	_	17±1
Candida albicans	18	16±1	15±1	10	_	_	_	19±1
Aspergillium niger	18	16	15	12	10	_	_	19±1

TM: Tested Microorganisms; NC: Negative control; PC: Positive control

From Table 5, at concentrations 10mg/l and 5mg/l significant inhibition was recorded on all tested organisms. The lowest inhibition was on *Salmonella typhi* at a concentration 2.5mh/l. Low Inhibition was recorded on all tested organisms at a concentration 1.25mg/l except on *Bacillus subtilis*. At 0.625mg/l, inhibition (low) was recorded on *Phijoptius stoloniter* and *Aspergillium niger*.

Table 6 above shows the antimicrobial activities of AVSP; the soap showed a strong inhibition against the tested organisms. At a concentration of 10mg/l, the soap showed significant inhibition against all tested organisms, with the maximum inhibition on *Escherichia coli* and *phijoptius stoloniter*. Inhibition was recorded on *Phijoptius stoloniter* at all concentrations. At a concentration 1.25mg/l the soap shows the highest inhibition on *Bacillus subtilis*.

Generally, it is evident that all soap formulations exhibited a significant inhibitory effect on the tested microorganisms at various concentrations. It has been noted that the AVSP soap demonstrated inhibition of *Phijoptius stoloniter* across all tested concentrations, a phenomenon not observed with any other soap formulation; this may be attributed to the synergistic effects conferred by the amalgamation of the two oil samples, as AVSP also inhibited a greater number of microorganisms at different concentrations. The investigation revealed that AVSP soap, derived from *Persea Americana* pulp and seed oils, exhibited the most pronounced antimicrobial activity when assessed against Lux as a standard, whereas AVP (avocado seed oil) demonstrated the least antimicrobial efficacy. Consequently, the combination of *Persea Americana* pulp and seed oils enhances the susceptibility to specific microbial agents. It can be inferred that soaps produced from *Persea Americana* pulp and seed oils possess superior antimicrobial properties compared to those derived from each oil in isolation. According to Ameh *et al.* (2013), soaps made from different combinations of shea butter and neem oils showed varying antibacterial activity. However, a more comprehensive set of antimicrobial tests is needed to test the soaps' ability to block a wider range of microbes. By reducing skin infections and the spread of infectious diseases, these soaps may help prevent illness. The main defense against bacteria and other pathogenic agents that can cause colds, influenza, skin infections, and even deadly communicable diseases is the use of antiseptic or medicated soaps for body washing (Larson, 1988; Mwambete and Lyombe, 2011; Atolani *et al.*, 2016).

Table 5: Antimicrobial activities of APS (*Persea Americana* pulp oil soap)

	Concentration (mg/ml)							
TM	**10**	**5**	**2.5**	**1.25**	**0.625**	**0.313**	**NC**	**PC**
	Diameter Zone of Inhibition (mm)							
Bacteria								
Staphylococcus aureus	20	17	15	12	_	_	_	21±1
Bacillus subtilis	20+1	18+1	16+1	_	_	_	_	18
Escherichia coli	21+1	17+1	15	12	_	_	_	23±1
Pseudomonas aeruginosa	18+1	17+1	13+1	10	_	_	_	21±1
Salmonella typhi	19	16±1	12±1	10	_	_	_	25±1
Klebsiella pnemonae	20	17+1	15	12	_	_	_	24
Fungi								
Phijoptius stoloniter	18+1	17±1	15	13	12	_	_	17±1
Penicillium notatam	20+1	17	15	12	_	_	_	17±1
Candida albicans	20	18±1	15±1	12	_	_	_	19±1
Aspergillium niger	21	18	15	12	10	_	_	19±1

TM: Tested Microorganisms; NC: Negative control; PC: Positive control

Table 6: Antimicrobial activities of AVSP (*Persea Americana* pulp and seed oils soap)

	Concentration (mg/ml)							
TM	**10**	**5**	**2.5**	**1.25**	**0.625**	**0.313**	**NC**	**PC**
	Diameter Zone of Inhibition (mm)							
Bacteria								
Staphylococcus aureus	20	17	15	12	10	_	_	21±1
Bacillus subtilis	19	18	16	14.1	12	_	_	18
Escherichia coli	21+1	17+1	15	12	_	_	_	23±1
Pseudomonas aeruginosa	18	17+1	13±1	10	_	_	_	21±1
Salmonella typhi	19	16±1	12±1	10	_	_	_	25±1
Klebsiella pnemonae	20	17±1	15	12	_	_	_	24
Fungi								
Phijoptius stoloniter	21+1	17±1	15	13	12	10	_	17±1
Penicillium notatam	20	17	15	12	_	_	_	17±1
Candida albicans	20	18±1	15±1	12	_	_	_	19±1
Aspergillium niger	21	18	15	12	10	_	_	19±1

TM: Tested Microorganisms; NC: Negative control; PC: Positive control

However, using medicated soaps could reduce the inoculum sizes of both pathogenic and non-pathogenic bacteria (Nester *et al.*, 2002). However, it has been highlighted that overuse of antiseptic soaps can have negative consequences, making users vulnerable to opportunistic skin infections and, as a result, aiding rather than avoiding the spread of diseases. Clinical antibiotic resistance has been linked to soaps containing synthetic antimicrobial agents like triclosan (Russell, 1998; Chuanchen *et al.*, 2001; Levy, 2001; White and

McDermott, 2001; Poole, 2002; Atolani *et al.*, 2016). Therefore, it might be possible to reverse this alarming trend by incorporating safe natural antimicrobial agents into soaps and cosmetics.

CONCLUSION

Analyses of the oils derived from avocado pulp and seed oils have revealed that they contain certain phytochemicals and have antibacterial qualities. Phytochemicals present in this plant include tannins, saponins, alkaloids, and flavonoids, researches has established that the presence of these phytochemicals holds medicinal and physiological properties which used for defense for and treatment of diseases and health conditions.

Underutilized oil seeds have been used to create eco-friendly herbal antibacterial soaps that adhere to the principles of green chemistry. By using these methods and natural materials to make herbal soaps, the environment would avoid being exposed to the numerous dangerous chemical compounds that come from using commercial synthetic soaps on a daily basis. The best qualities in terms of hardness, forming ability, texture, color, and antibacterial activity were found in soap prepared from a blend of avocado pulp and seed oils, which are typically an underappreciated resource in the environment. By converting agricultural waste products in the surrounding area into commercial utility items, the selected strategy improves the community's economic standing.

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