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Full Length Research Paper

Preference analysis between the use of drugs and plants in pain management in a quilombola community of the state of Ceará, Brazil

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The objective of this study was to analyze the context of the management of people from traditional quilombola community, in relation to the use of plant species and allopathic drugs used in treatment of pain. Questionnaires were used to determine the socio-demographic profile and the interview-semi-structured method with participants adopted. The analysis of data was done by statistics for the socio-demographic variables and the discourse of the collective subject to interpret the contents of the interview. There were 52 residents interviewed, predominantly (67%) by female. Most of the participants have low education level and the main occupational activity is agriculture. In the treatment of pain, herbal teas were considered the preferred method by the participants. Some used allopathic medicines, but attribute to plants the meaning of greater effectiveness in therapy. It has also been noted that informants did not use concomitant drugs and plants because of the fear of poisoning. It is concluded that there is a shortage of studies on the representations and meanings of the preference of inhabitants of traditional localities, considering plant species and industrialized drugs specific for pain, as well as for the treatment of diseases in general. Thus, it is expected that this work will arouse the interest of researchers in studying more about popular knowledge and health management.

Key words: Popular knowledge, pain, medicinal plants.

INTRODUCTION

The definition of pain is of a sensitive and/or emotional nature experience, linked to a tissue or potential injury, and may be capable of causing some impairment in quality of life (Haeffner et al., 2012). Related to a pathological process or not, pain is among the main reasons that lead the population to seek health services (Holtz and Neto, 2008; Nascimento and Kreling, 2011). In this view, several methods have been sought in the treatment of pain with a view to relief or cure, mainly by those who coexist with chronic pain, arising from conditions such as rheumatic diseases. Among these alternatives, the use of medicinal plants is one of the most common and also the oldest therapies among civilizations (Bavaresco et al., 2016).

In this context, Brazil is one of the countries that has the largest and most important species biodiversity (around 20% of the world total), with an estimated number of 350,000 to 550,000, of which 55,000 are already cataloged. This scenario is due to the tropical characteristics of the country and the distribution of this diversity is wide, considering all regions of the territory (Ribeiro et al., 2014).

In the case of Northeast region, especially the state of Ceará, data estimate that there are approximately 46% of xerophilous species, endemic and little explored in the pharmacological area. However, these are well known among traditional populations and employed in healthcare (Cartaxo et al., 2010).

Hence, the study of popular knowledge has been of great interest by the scientific area, since traditional medicine is able to provide subsidies for sciences, especially when considering the discovery of new medicines for the treatment of various diseases (Badke et al., 2012). Conversely, it should be noted that, with the advancement of public policies and programs, the access to industrialized drugs for the treatment of pain and other diseases has been possible in many communities. It is also believed that, people know how to recognize the most efficient plant species because studies show that the plants with the best biological activity seem to be used by a greater number of people (Medeiros et al., 2013; Portela et al., 2010).

Thus, the objective of this study was to analyze the preference for the use of plants or drugs as therapy for pain – considering the concept of preference as the conscious act of the informant, in choosing a resource at the expense of others who are also available – by a traditional quilombola community with access to both resources.

MATERIALS AND METHODS

Description of the study area

The Sítio Arruda community (Figure 1) is located in the municipality of Araripe-CE, approximately 17 km from the urban area, belonging to the Cariri region. Considered as a remaining quilombola area, its territory was recognized by the Palmares Cultural Foundation (FCP) in May, 2009. However, land regularization by the state of Ceará was only possible in 2015 (FCP, 2009; INCRA, 2015).

With a total area of 334 hectares and 39 resident families, Sítio Arruda is situated approximately 528 km from the capital city of Fortaleza which has the following geographic coordinates: Latitude 7°11'51.75"S and Longitude 40°15'32.96". It has a typical soil and vegetation variations of semiarid, flat relief, smoothly undulated with pluvial plain and annual precipitation estimated between 500 and 700 mm. The main economic activity of the locality is subsistence agriculture (Sousa and Fernandes, 2016).

Procedure for data collection and data analysis

The completion of this work obeyed the ethical precepts of research with human beings, highlighted in Resolution 466/2012 of the National Health Council (Brazil Ministério da Saúde, 2012). The approval by the Ethics Committee had an opinion number 1367311. The data collection period was between August, 2016 and January, 2017. An initial visit was made to the locality and, mediated by a community leader, a prior knowledge about the chosen region was provided. The main purpose of this contact was to gain trust, which is indispensable in obtaining information known as the "rapport" technique (Albuquerque et al., 2010). At this time, the proposal of the study was presented to the leader, emphasizing the objectives and the relevance. With authorization given by the community representative, the next step was the composition of the sample. In this way, men and women residing at the site were selected, 21 years and above.

Firstly, a questionnaire for characterizing the socio-demographic profile was applied to all those involved, with an interview performed. The speeches were obtained through the use of a tape recorder. The elaborated script obeyed the semi-structured interview technique, containing 5 questions: 1. Do you prefer the use of plants or "medicine" from the pharmacy for the treatment of pain? 2. What is your opinion about the use of homemade preparations with plants for the treatment of pain? 3. What is your opinion about the use of "pharmacy drugs" (medicines) for the treatment of pain? 4. Have you taken "medicine from the pharmacy" and weed medicine together at the same time (in association) for the treatment of pain? What do you think about using the two together? 5. Have you replaced the medicine the doctor prescribed for the use of plants? If so, tell me how it was. If not, why?

The socio-demographic analysis was developed using the simple frequency statistical method. The contents of the interviews were examined through the Collective Subject Discourse (CSD) (Lefevre and Lefevre, 2005), with the help of qualiquantisoft.

RESULTS AND DISCUSSION

Did you replace doctor prescription with plants?

Of the 52 interviewees there were 35 women (67%) and 17 men (33%) who were between 21 and 90 years old, most of them between 30 and 45 years old and married (61.5%). Considering the education level, 33 reported not having completed elementary education, which is

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Figure 1. Geographical location of Sítio Arruda, Araripe – CE.
Source: Google Maps, 2017.

equivalent to 62.5%. The number of non-school children was also highlighted, secondly represented by 13 of the interviewees (26%). Farmer was the predominant profession (57.5%), followed by housewives (25%) and the time of residence in the community ranged from 10 to 40 years. Other details of the socio-demographic profile of the population can be observed in Table 1.

When questioned about the main method of choice for pain treatment, 55.77% of the informants reported a preference for plants, 11.54% stated the use of allopathic drugs, 25% reported that the option depend on the isease and 7.69% said they had no preference. These results on plant choice are similar to those found by other researchers. In a community in the State of Pará, 18 residents were interviewed. Of these informants, 16 (73%) referred and preferred what they call home remedies and 2 (9%) opt for drugs are available at health centers, as evaluated (Flor and Barbosa, 2015). When asked what they think about homemade plant preparations for pain management (Question 2 of the interview), the CSD pointed out five central ideas, which can be seen in Table 2.

It is noted that, thinking about the sense of effectiveness was the most prevalent. This point of view was also defended by quilombola residents, from a community located in Paraíba. Of the 24 interviewees, 60.9% stated that plants have better action than laboratory drugs, and access to them is easier and cheaper (Sales et al., 2009). Giraldi and Hanazaki (2010) emphasize that preference for such resources strengthens the traditional culture of health care and broadens contact with local biodiversity. Also, the use of these resources as a source of treatment is a safer method for many people, since they believe in the healing potential that plants offer besides have fewer adverse effects than industrialized drugs (Oliveira and Santos, 2016; Pedrollo et al., 2016). The data in Table 3 represent the central ideas and CSD on the opinion of population regarding drugs of, allopathic origin.

There is a varied perception of the interviewees when it comes to industrialized drugs. Although the use of drugs present, the justification that the "teas" are better has stood out. However, another point draws attention: the choice between drug and plant depends on the pain. Conversely, the literature shows a shortage of papers that portray the determinants which lead people to choose between medicines and plants and at what point this decision happens. However, some scholars point out possible explanations about the representations of populations, especially the older ones, in view of the allopathic drugs. Many of them believe that the industrialization process makes these compounds more capable of causing adverse reactions, or other damages. This bias reinforces the conception that plants are better, since they are obtained from nature without any intervention that may make it lose its naturalness to promote healing (Lima et al., 2012).

Considering this aspect, in a relevant study Nascimento

Table 1. Distribution of respondents according to age group and socio-demographic variables.

Variables	Age											
	21 to 29		30 to 45		46 to 59		60 to 75		76 to 90		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Gender												
Female	10	19	13	25	7	13.5	4	7.5	1	2	35	67
Male	3	5.7	11	21	2	4	1	2	-	-	17	33
Marital status												
Married	9	17	17	32	3	5.7	3	5.7	-	-	32	61.5
Single	4	7.5	4	7.5	2	4	1	2	-	-	11	21
Divorced	-	-	1	2	1	2	-	-	-	-	2	4
Widow	-	-	2	4	3	5.5	1	2	1	2	7	13.5
Education level												
Non- schoolchildren	-	-	5	10	5	10	3	6	-	-	13	26
incomplete Elementary school	9	17	17	32	4	7,5	2	4	1	2	33	62.5
complete Elementary school	-	-	2	4	-	-	-	-	-	-	2	4
Incomplete High School	4	7.5	-	-	-	-	-	-	-	-	4	7.5
Complete high school	-	-	-	-	-	-	-	-	-	-	-	-
Profession												
Farmer	4	7,5	19	36.5	4	7.5	3	6	-	-	30	57.5
Retired	-	-	-	-	1	2	2	4	1	2	4	8
Housewife	5	10	4	7.5	4	7.5	-	-	-	-	13	25
Student	4	7,5	-	-	-	-	-	-	-	-	4	7.5
Daycare Center Assistant	-	-	1	2	-	-	-	-	-	-	1	2
Residence time in the community												
>= 10 < 20 years	3	6	3	6	1	2	2	4	-	-	9	18
>= 20 < 30 years	10	19	3	6	-	-	1	2	-	-	14	27
>= 30 < 40 years	-	-	18	34.6	8	15.4	2	4	1	1	29	55

Source: research data, 2017.

et al. (2016) when comparing the use of plants with the use of animals and applying free lists to the rural community in the semiarid region of northeastern Brazil, the plants were preferred, especially because of the easy access in comparison with the species of the fauna. Regarding the talk about the use of the plant and drug association, according to question 4 of the interview, participants' answers allowed the identification of the central ideas and respective CSD that are presented in Table 4.

According to the above, the joint use of plants and medicines for 46 informants is something that corresponds to the danger, clearly defended by the thought of poisoning. The same logic was

Table 2. Relationship between central ideas of question 2, the proportion of responses according to the participants of the research and CSD for question 2.

Question 1: "What is your opinion about using homemade plant preparations for the treatment of pain?"			
Central ideas		**Community Informants**	
		n	**%**
A	It is good because it's effective.	32	61.54
B	It's good, but it depends on the type of pain	11	21.15
C	I do not use it because it is not effective	2	3.84
D	It's good, but I do not currently use it	7	13.46
E	I do not know because I've never used it.	1	1.92
Total of informants: 52*			

Collective Subject Discourse

CSD - Central Idea A: I like it very much, I drink the tea first, I prefer it, it's good because it passes the pain, it relieves a lot, it's gone, it's not better, it always worked, I mean, most of the time it happens. The tea solves the pain everything, some pain passes alone; some pain only the tea solves it. I lived my whole life with medicine from the plant, since I was a child, my mother always did it for me, we did not have the ease of today, me and my brothers, everything, when I got sick, was a medicine from the woods, I did not have this hospital business, it was prayer, faith, and tea, and I also treated my son with medicine from the plant! My daughter was saved by faith and mother's medicine. The boy here is all grown up with tea. Everyone uses medicine from the plant and I help a lot of people with medicine from the plant, we did not live without plants because it is better the medicine that we do at home.

CSD - Central Idea B: The plant is good, but it depends on the type of pain. I always take the tea first, if it does not calm, I take the drug. My pain is very strong, I do not like to take pills, but I take it when I cannot hold it anymore. There are also the boys who have to take them to the hospital, if they do not [tea] it is a more serious disease, then they have to go to the hospital. If it's more urgent, it's a better hospital. When I feel like going to the doctor, I'll go there. God helps me, and I know, I say: you know, this here is not for me to make medicine here! Both the treatment with the plants and the medicines are good because many things I prefer the hospital, but others I prefer the weeds, it depends on the disease.

CSD – Central Idea C: Same as water, my daughters do for me, but it does not help. The one who trusts me is my mother, but I do not take.

CSD – Central Idea D: It's very good, it works, but I do not use it anymore. Here, we took more as a child, then we grew and became harder for the pain and nowadays it is better to take the same pill and have the hospital. Here at home, we do not have, because the woman has pain in the knee and it is bad to get pregnant, and there is still this drought, you can not only carry water for a few drinks, it's hard to do it: you have to plant, and then I prefer the medicine.

CSD – Central Idea E: They say it's good, but I never took it.

* A subject's speech may have more of a central idea.

Source: Research data (2017).

found in other surveys. Residents of a city in Ceará were also approached about the concomitant use of chemical drugs and plants. Of the 151 informants, 87.1% do not use associated, because they believe that there may be some damage to the organism (Oliveira and Lucena, 2015).

A similar attitude was also found in the center-west region of Rio de Janeiro. Of 998 inhabitants interviewed, 44.1% said, they did not use drugs and plant together. However, this data was not the most relevant. For 47.5% of the participants, the associated use of drugs and plants is performed when the indication of a certain plant is known.

However, they do not explain how this knowledge is determined or if there is any kind of orientation by health professionals (Veiga-Junior, 2008). The next data correspond to the aspects found, when informants were questioned about the plant's replacement of some medicine prescribed by the doctor. Not substituting medicine for the use of plants was the main affirmation given by the participants. The justifications for such conduct were diverse. However, it can be seen that majority could not explain the reasons why they do not stop following the prescription, which becomes a gap that can be worked out in future studies.

However, another study has shown that, the substitution of prescribed drugs by plants is a common act among people especially, those residing in rural areas ranging from 50 to 69 years old. The preponderant factor is in the traditional culture of health care, learned during life (Junior, 2008). The second most prevalent idea is related to the fact that, several participants have never

Table 3. Relationship between central ideas of question 3, the proportion of responses according to the participants of the research and CSD for question 3.

Question 3: What is your opinion about the use of "pharmacy drugs" (medicines) for the treatment of pain?			
Central ideas		**Community informants**	
		n	**%**
A	I do not like it because I think it's dangerous	3	5.77
B	I have no opinion about this because I have never used it for pain treatment	6	11.54
C	It is effective, but tea is better	20	38.46
D	I usually do not use it because access is difficult	4	7.69
E	I've used it, but it depends on the type of pain	15	28.85
F	I prefer the use of the medicine	6	11.54
G	I do not consider it effective	7	13.47
Total of informants 52*			

Collective Subject Discourse

CSD - Central Idea A: It can poison, I do not use it because I'm afraid. Have you thought? Take medicine forever because of pain? That is bad!

CSD - Central Idea B: I never took it for pain, it should be good, but I never took it. There are a lot of people who take and give, I do not know because I do not take that kind of medicine for pain, I do not like going to the doctor or hospital."

CSD - Central Idea C: I've had it, it's good, but I do not change my tea, I drink tea first. I see the people going to the health centers, to the hospital, I'm not going. I think it is a waste of time because I have everything here, I do not spend with pharmacy medicine, but people get good medicine from the pharmacy as well. And it's good too because the pain passes. Only that in the fight of every day it is my plant, we go to the medicine of pharmacy only when it needs, because we prefer the plant. I only take medicine from the pharmacy because I have many diseases and when there is no way, but the plants are my favorite.

CSD - Central Idea D: I never take these medicines because it is difficult, there is a drug that is expensive, we do not always have one, and the pharmacy is in Araripe. Also, you cannot go without asking, we pay R$ 70,00 to go to the city, so we do not use it too much.

CSD - Central Idea E: Both the plant and the pharmacy is good. I also take a drug from a pharmacy, but it depends on the type of pain, because there is a disease that only the plant medicine does not work, for my pain in the knee, what happens is the medicine. Taking medicine for woman's pain [menstrual cramps] is lost, are we taking it every month? Also in children, when the plant medicine has no effect [for pain] we take it to the hospital, it solves it.

CSD - Central Idea F: I prefer it, since I'm not very sick, just leave some medicine stored for when the pain increases, I just need to take one when it hurts my head and my body. Also, the tablet is faster, you took it, it passed, I think better so it gives more effect. I can no longer live without a pharmacy.

CSD - Central Idea G: Before I took it and resolved, today I take, there is a day that passes, there is a day that does not pass. Also, I do not know, after my wife has been taking these remedies her wounds are few. And there are few that it renders, it has a remedy that is like water.

*A subject's speech may have more of a central idea.

Source: Research data, 2017.

used drugs.

Although the rise of allopathic medicines has been constant in the present times since access is not always possible, especially when considering the financial factor for acquisition. However, not using allopathic is also a decision of many people. The explanation is given by cultural interfaces, beliefs, and highly valued empirical knowledge (Sales et al., 2009).

Conclusion

The practice of using plants for the treatment of pain among the population of Sítio Arruda is seen as a important aspect in the context of their day to day lives, due to the traditional nature of the knowledge spread among them. This knowledge deserves to be respected, especially when analyzing the historical context that built the community. Even though traditional empirical knowledge is common among the participants, a variety of how this knowledge is assimilated and used in the management of the pain relief and/or treatment conducts is evident.

There was also shortage of studies on the representations and meanings of the preference of inhabitants for traditional localities, considering medicinal

Table 4. Relationship between central ideas of question 4, the proportion of responses according to the participants of the research and CSD for question 4.

Question 4: Have you taken "medicine from the pharmacy" and plant medicine together at the same time (in association), for the treatment of pain? What do you think about using the two together?			
Central ideas		**Community Informants**	
		n	**%**
A	No, because it can cause poisoning	46	88.46
B	No, but they say it can cause poisoning	4	7.69
C	No, because I take a lot of medicine from a pharmacy	1	1.92
D	No, but I do not think it poisons	1	1.92
E	No, because I never use either	1	1.92
Total of informants 52*			

Collective Subject Discourse

CSD - Central Idea A: No!" "God!" You cannot take both because you can poison. Everyone here knows that you cannot take the two together: the plant and the drug; it is to risk too much! I've never seen anyone poison, but you'd better not risk it. My mother, my mother-in-law, the elders, everyone says they poison. You cannot take it together, the medicine in the forest is strong, very green, and the pharmacy is strong, there you must go to the hospital. We keep the plant medicine when we're taking it from the pharmacy. When I was using the medicine that the doctor gave me, I did not have tea. For example, the day I take ibuprofen, I do not drink the tea. Because here it is, you have tea today, and if it does not solve, the other day you take the pharmacy. One has to take one or the other. Take the two together, do this and you get worse!

CSD - Central Idea B: No, I never took it together, they say it poisons, I do not know, the people who say, I've heard many of the old people saying that it poisons if you take both.

CSD - Central Idea C: I have the fear of drinking tea because I already take so much pharmacy medicine!

CSD - Central Idea D: I never took it, but I do not believe in this business that poisons.

CSD - Central Idea E: "I took none, who will say the two together."

*A subject's speech may have more of a central idea.

Source: Research data, 2017.

Table 5. Relationship between central ideas of question 5, the proportion of responses according to the participants of the research and CSD for question 5.

Question 5: Have you replaced the medicine that the doctor prescribed for the use of plants? If so, tell me how it was. If not, why?			
Central ideas		**Community informants**	
		n	**%**
A	No, because I never took a drug from a pharmacy.	9	17.30
B	No, because if it is not effective, I return to the doctor	1	1.92
C	No, because it's the last resource I'm looking for	6	11.54
D	No, but I cannot explain the reason well.	27	51.92
E	No, because I trust the doctor.	2	3.84
F	No, because my treatment is serious.	1	1.92
G	Yes, because it was not being effective.	5	9.62
H	Yes, because I did not find it safe.	1	1.92
I	Yes, because he did not have the prescribed medicine available	1	1.92
Total of informants 52*			

Collective subject discourse

CSD - Central Idea A: No, I never took medicine from the doctor, I never went to the doctor, so I never had to change, because I do not take medicine from the pharmacy, those that the doctor gives. I do not even know what pharmacy medicine is, how would I change it?

CSD - Central Idea B: No, if the medicine did not work, I'll find a way back to the hospital.

CSD - Central Idea C: I never did this, or I took tea or took medicine, but I never changed it, because I only use it if tea does not solve it, when the pain does not go with tea, when it is very strong, then I look for the medicine in the pharmacy. Sometimes I go to the doctor, if I go, I will not change.

Table 5. Cont'd.

CSD - Central Idea D: No, but I'm not sure, I never take medicine from the pharmacy so I cannot change.
CSD - Central Idea E: I do not live without the medicine of the pharmacy, I am sick, from when I was born.
CSD - Central Idea F: Because the medicine from the pharmacy did not work, with faith in God I became good with medicine from the plants. I already had a paracetamol once and it did not work on the day, I took the tea and solved it. I changed it from my son too, the doctor said he had the flu and passed a medicine to him, I did not give it, because the flu you only give a tea of garlic that solves and my girl when she was sick, it was the same way taking the medicine of the pharmacy, I went and did it at home, and she was good. I changed it and she got better.
CSD - Central Idea G: No, because if the doctor passed it, it is better to hear, right? I take what the doctor does very well.
CSD - Central Idea H: Yes, just a remedy for my girl, because it was very strong.
CSD - Central Idea I: I took paracetamol and it was over, I had taken the last one the other day, I made the same tea.
*A subject's speech may have more of a central idea.

Source: Research data, 2017.

plants and industrialized drugs specific for pain, as well as for the treatment of diseases in general. Finally, the understanding of singular and collective knowledge enables an important tool for directing care to these people, considering the role of health professionals. It is also shown as a way of preserving and respecting each one's thinking and acting. Thus, it is expected that this work will arouse the interest of researchers in studying more about popular knowledge and health management.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Physicochemical properties and antimicrobial activities of soap formulations containing *Senna alata* and *Eugenia uniflora* leaf preparations

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Senna alata **leaf extract demonstrates antimicrobial properties that promise utility for treatment of topical infections. Its combination with similarly bioactive** ***Eugenia uniflora*** **leaf extract in soap formulation could enhance anti-infective efficacy. The objective of this study was to develop potent antiseptic herbal soap formulations (HSFs) with the combined leaf extracts of the two plants. A soap base having suitable physicochemical properties (emolliency, foaming potential, and pH) was selected from a series of trial formulations produced from basic soap ingredients. Into this was incorporated three different preparations (namely, the methanolic fresh leaf extract (FLE), methanolic dry leaf extract (DLE), and the pulverized dry leaf sample (DLP) of** ***S. alata*** **and** ***E. uniflora*****, respectively, singly or combined in 1:1 (w/w) ratio; to produce HSFs containing 5, 9, or 11%w/w concentrations of the leaf preparations. The physicochemical properties of the HSFs were determined as well as their antimicrobial activities by hole-in-plate agar diffusion assay against** ***Staphylococcus aureus*****,** ***Bacillus subtilis*** **and** ***Candida albicans*****. The selected soap base exhibited highest-rank emolliency, satisfactory stable froth production, and pH value. The physicochemical properties of the resulting HSFs were similar. The HSFs containing combinations of the DLEs at 9 and 11% concentrations demonstrated antimicrobial activities against** ***S. aureus*** **and** ***C. albicans*** **comparable (p>0.05) to those of the comparator commercial antiseptic soap containing 0.30% triclosan.** ***B. subtilis*** **was less sensitive (p<0.05) to the HSFs. On the other hand, when used singly, the DLEs as well as the FLEs and DLPs were significantly less potent (p<0.05) than the DLEs combined in the soap formulations. In conclusion, the HSFs containing** ***S. alata*** **and** ***E. uniflora*** **DLEs combined (1:1 w/w) at 9 and 11% concentrations exhibited satisfactory physicochemical properties and potent antimicrobial activities similar to the comparator commercial antiseptic soap employed in the study.**

Key words: *Senna alata*, *Eugenia uniflora*, leaf extracts, herbal soap formulation.

INTRODUCTION

Plants have always contributed largely to medicines and healthcare preparations by providing lead compounds for drug development or as refined herbal remedies (Iwu, 1993). Different plant parts have been used in traditional medicines around the world for treatment of human diseases and infections (Vineela and Elizabeth, 2005;

Ekpo and Etim, 2009). Plants containing bioactive (antimicrobial) principles demonstrate potential for use as anti-infective agents and could be formulated as topical herbal remedies (as ointment, cream, lotion, gel, soap or crude/solvent extract) for the care and treatment of skin infections, as alternative to using synthetic antimicrobial agents.

Senna alata (L.) Roxb (Caesalpiniaceae), synonym *Cassia alata*, is a shrub widely distributed in tropical countries and popularly known as ringworm plant due to the utilization of its fresh leaves for treatment of skin diseases such as ringworm, eczema, pruritis, scabies, and ulcers (Burkill, 1995; Reezal et al., 2002). Phytochemical screening of alcoholic extract of *Senna* leaves has revealed the presence of anthraquinone glycosides, phenolic compounds and saponins, which could account for some of its biological activities, including antimicrobial and antioxidant effects (Sharma et al., 2010).

The leaf extract of *S. alata* prepared in different solvents and by various techniques has been reported to demonstrate antimicrobial activity. When the fresh leaves were extracted with different solvents, only the extracts derived from polar solvents (water, methanol) exhibited antibacterial activity against *Staphylococcus aureus*, while the extracts by non-polar solvents (n-hexane, acetone) were inactive (Faruq et al., 2010). Whereas the freeze-dried aqueous extract of the fresh leaves showed antifungal activities comparable to that of acriflavine (6 mg/ml) against *Epidermophyton floccosum* and *Candida pseudotropicalis* (Akinde et al., 2002), the air-dried powdered leaf ethanolic and aqueous extracts demonstrated much broader spectrum of antimicrobial activities (Ogunjobi and Abiala, 2013). Air-dried *S. alata* leaves formulated as soap exhibited antifungal activity against the fungus, *Saccharomyces cerevisiae*, but showed no inhibitory activity against bacterial organisms: *S. aureus*, *E. coli* and *P. aeruginosa* (Aminuddin et al., 2016). Thus, preparation and formulation factors were shown to influence the antimicrobial properties of *S. alata* crude preparations.

Antimicrobial activities of dried, powdered leaf ethanolic extract and leaf essential oil of *Eugenia uniflora* Linn (Myrtaceae) have also been reported against several bacterial and fungal species (Fiuza et al., 2008; Victoria et al., 2012), while other biological activities and potentials of its various parts and constituents are also reported, which support the ethnomedicinal uses of the plant in treating bronchitis, influenza and intestinal problems (Souza et al., 2004; Fortes et al., 2015; da Cunha et al., 2016). Furthermore, combinations of *E. uniflora* with other plant extracts (Bernardo et al., 2015) or chemical agent (metronidazole) (Santos et al., 2013) have demonstrated enhanced antimicrobial activity of the plant, while the activity of formulations of *E. uniflora* extracts as soaps and ointments has also been reported (Alalor et al., 2012; Aminuddin et al., 2016).

Studies on triclosan, an antimicrobial agent popularly used in antiseptic toiletries, have raised questions on its possible hazard to human health (Deliaert et al., 2008; Zorrilla et al., 2009) and its contribution to development of antibiotic-resistant germs in the environment (Chalew and Halden, 2009). In the United States of America, the Food and Drug Administration (FDA) has announced the prohibition of sale of “consumer antiseptic washes” containing triclosan effective September, 2017 (FDA, 2016). The need for safer antiseptic ingredients has, therefore, become more apt. This present study aimed to develop an effective anti-infective herbal soap formulation with a combined leaf extracts of *Senna alata* and *E. uniflora* using soap ingredients that would enhance emolliency on the skin.

MATERIALS AND METHODS

Good quality grade palm kernel oil, coconut oil and shea butter were procured locally at the Main Market, Ile-Ife Nigeria. The shea butter was purified by melting and filtering through a filter paper No. 100 (24 cm diameter, Rundfilter MN713 Macherey-Nagel D-5160 Duren, Germany) in a funnel into a flask placed in an oven (60°C). The filtrate was poured into a clean glass container and left for seven days at room temperature (30±2°C) to solidify. Standard grades of other formulation ingredients namely, sodium hydroxide (pellets), sodium lauryl sulphate, stearic acid, and oleic acid (Evans Medical Ltd., Liverpool) were also used.

Collection of *S. alata* and *E. uniflora* leaves

Fresh leaves of *S. alata* and *E. uniflora* were collected from Adagun Abiri Road Ile-Ife, and at New Buka, Obafemi Awolowo University (OAU) Ile-Ife, respectively, within the period from July to August, 2013. The leaves were authenticated at the herbarium of the Faculty of Pharmacy, OAU Ile-Ife, Nigeria.

Preparation of *S. alata* and *E. uniflora* leaves

Approximately, 200 g of the freshly collected leaves of each plant was macerated in neat methanol (solvent) on the same day of collection, extracted using a Soxhlet extractor (Scientific Glass Laboratories (SGL) Ltd. Staffordshire) at 40°C, and subsequently concentrated using a rotary evaporator (Rotavapor RII, Buchi Labortechnik, UK) at 40°C. The concentrate was oven-dried at 35°C for 2 h to produce the methanolic extract of the fresh leaves (that is, the fresh leaf extracted, FLE). The dried, pulverized (dry leaf powdered, DLP) forms of the *S. alata* and *E. uniflora* leaves were prepared by air-drying (for 50 to 60 days; approximately 400

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g) of the collected leaves at the ambient temperature (30±3°C), and then grinding the dry leaves with a laboratory mill (Christy and Morris Ltd., Chelmsford Essex, NJ USA) into fine powder.

A 150 g portion of the dry, powdered leaves of each plant was macerated and extracted with methanol using the Soxhlet extractor, concentrated with the rotary evaporator at 40°C, and oven-dried at 35°C for 2 h to produce the methanolic extract of the dried, pulverized leaves (that is, the dry leaf extracted, DLE).

Preparation of soap base formulations

Three formulations of soap base (A, B, and C; 130 g each) were initially prepared in duplicates by the cold and hot processes using the basic soap ingredients: palm kernel oil (PKO), sodium hydroxide (NaOH) and distilled water, in concentrations shown in Table 1.

In the cold process, the required weight of NaOH pellets was dissolved in the required quantity of water and approximately 2 min was allowed for the exothermic dissolution of the pellets. The PKO was heated on a water-bath to about the same temperature (≈ 60°C) as the NaOH solution. The NaOH solution was then slowly poured into the oil (PKO) while stirring continuously with a plastic spatula until a slurry was formed (that is, the slurry stage). The slurry was then poured into plastic moulds to produce soap tablets, approximately 25 g each, and allowed to stand undisturbed for 48 h at the ambient temperature (29±2°C), to solidify. The soap preparation was removed from the moulds, wrapped in cellophane and kept for four weeks, to allow for curing.

The hot process was similar in procedure at its initial steps to the cold process. After mixing the warm aqueous NaOH solution with the heated oil (PKO), the hot slurry was further heated on a water-bath until a suitable endpoint for the required heating process was reached, indicated by whitish coagulates appearing in the hot slurry. The slurry was then poured into moulds and allowed to set, and subsequently cured over the next four weeks.

Other soap base formulations (D, E, F, G, H, I, J, and K; 130 g each; Table 1) were also prepared by the hot process using shea butter and/or coconut oil, in varied proportions of the soap base ingredients as well as other soap base formulations (L, M, and N; 130 g each; Table 1) with inclusion of excipients, such as sodium lauryl sulphate (a surfactant), stearic acid or/and oleic acid (fatty acids) intended to enhance performance and stability of the soap.

Determination of physicochemical properties of soap base formulations

All the soap base formulations prepared were tested for their physicochemical properties.

Foaming propensity testing

To determine the foaming propensity, a 1 g portion of each soap formulation was dissolved in 10 ml of water (distilled and tap water) by minimum heat (≤60°C) and 5 ml of the resultant solution was transferred into a 10-ml test tube. The test tube was shaken for 1 min using a vortex test tube mixer (Salford Scientific Supplies Ltd, Henderson Biomedical, UK) and then left to stand undisturbed. The time taken for the soap solution to defoam, in triplicate tests, was recorded.

pH determination

The pH value of 1 g sample of each soap formulation dissolved in 10 ml of distilled water was determined in triplicates with a digital pH meter (HM Digital Inc. Culver City, USA) at preset time intervals after production of the soap, namely, 24 h (Day 1), Day 7 (Week 1), Week 4, Week 12, and Week 18.

Emolliency test

The emolliency test was designed to evaluate occlusiveness of the formulations. A 2 g portion of each soap formulation was smeared onto the surface of white sheets of paper over approximately 5 cm^2 surface area and left to stand on the laboratory shelf for 24 h (temperature 29±1°C; humidity 78±2%, determined with wet/dry bulb hygrometer); after which the degree of translucency was graded into a three-level ranking: mild, moderate, or strong translucency.

Preparation and determination of physicochemical properties of herbal soap formulations

The FLE, DLE, and DLP preparations of *S. alata* and *E. uniflora*, as well as equal quantity combinations (1:1 w/w ratio mixing) of the preparations, namely: *S. alata* FLE mixed with *E. uniflora* FLE; *S. alata* DLE mixed with *E. uniflora* DLE; and *S. alata* DLP mixed with *E. uniflora* DLP; were each incorporated into the selected soap base formulation (coded K) at the slurry stage of the preparation process before pouring into moulds. The different test preparations were incorporated at concentrations of 5, 9, or 11%w/w into the soap base formula K (Table 1). Foaming propensity test and pH determination at preset intervals over 12 weeks were carried out on the resulting herbal soap formulations. Similar tests were carried out on the comparator soap, Septol® antiseptic soap (Bush W.J. & Co. (Nig.) Ltd.), a commercial antiseptic soap product containing 0.30% Triclosan as the active (antimicrobial) principle.

Antimicrobial activity testing of herbal soap formulations

The antimicrobial activities of the herbal soap formulations, the soap base (K) (negative control), and of Septol® antiseptic soap (positive control), were determined using the hole-in-plate agar diffusion assay against *S. aureus* (NCTC 6571), *Bacillus subtilis* (NCTC 8236) and *Candida albicans* (a clinical isolate obtained at Microbiology Department, OAU Ile-Ife, Nigeria). A pure distinct colony of each bacterial strain inoculated in 10 mL Mueller Hinton broth (Oxoid, UK) aliquots and incubated at 37°C for 18 h was used. 0.2 mL of the culture of each organism was then seeded into 20 mL aliquots of molten Mueller Hinton agar (Oxoid) (MHA) in sterile Petri dishes and allowed to set. Antifungal activity against Candida was tested using a 48 h surface culture of *C. albicans* on Sabouraud dextrose agar (SDA; Oxoid) slopes, which after being washed off was diluted to an inoculum size of 10^7 cfu/mL and used to seed 20 mL aliquots of molten SDA in sterile Petri dishes and allowed to set.

Wells (9 mm diameter) were cut into the seeded agar plates with a sterile cork borer and approximately 150 mg of each herbal soap sample was introduced into the holes in quadruplicate experiments. The plates were left at room temperature (29±1°C) for 1 h to allow for diffusion and then incubated at 37°C for 24 h for bacteria and 25°C for 48 h for fungi, after which the diameters of inhibition zones were measured.

Statistical analysis

The data obtained were evaluated by two-way analysis of variance (ANOVA) followed by the F test, and Student's *t*-test for paired mean comparisons, to determine statistical significance of differences in computed mean values. In all cases, differences were

Table 1. Composition of soap base formulations.

Ingredients	Composition attributes/ Formulation codes/ Ingredient quantities (%w/w)													
	Containing soap base ingredients without excipients											Containing soap base ingredients with excipients		
	Single oil present (PKO)			Single oil present (SB/CO)			Two oils combined		Three oils combined			Three oils combined		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Palm kernel oil (PKO)	64.5	51.4	61.5	0	0	0	54.5	55.0	37.9	44.7	41.7	43.2	22.0	47.4
Shea butter (SB)	0	0	0	61.5	0	0	7.6	0	5.8	7.3	16.7	6.6	22.0	10.5
Coconut oil (CO)	0	0	0	0	61.5	46.2	0	6.3	5.5	7.3	8.3	6.2	11.0	10.5
Sodium hydroxide (NaOH) pellets	5.0	16.2	7.7	7.7	7.7	23.0	7.6	7.7	17.2	8.1	8.3	19.6	5.5	10.5
Water	30.5	32.4	30.8	30.8	30.8	30.8	30.3	31.0	33.6	32.5	25.0	22.1	33.0	10.5
Sodium lauryl sulphate (SLS)	0	0	0	0	0	0	0	0	0	0	0	0.7	1.1	2.1
Stearic acid	0	0	0	0	0	0	0	0	0	0	0	1.5	2.2	3.2
Oleic acid	0	0	0	0	0	0	0	0	0	0	0	0	3.3	5.3

PKO: Palm kernel oil; SB: shea butter; CO: coconut oil; NaOH: Sodium hydroxide; SLS: sodium lauryl sulphate.

considered significant at the p≤0.05 level. The data were presented as mean ± standard error of mean (SEM).

RESULTS

Foam stability and pH profile of soap base formulations

The time taken for foam disappearance or complete foam collapse of the aqueous solution of different soap base formulations varied. The foams persisted longer (indicating higher foaming capacity and foam stability) in distilled water than in tap water (community pipe-borne supply). Formulation J gave the most stable foam produced in distilled water, lasting 69 min (Table 2). Soap base formulations C, D and E contained the same quantities (61.5%) of PKO, SB and CO and NaOH (7.7%). However, E demonstrated the longest foam stability in distilled water while D had the shortest stability in tap water. Soap base K had the least foam stability and pH lower than the other two soap bases in the three oil-combination soap bases (I, J, K).

All the soap base formulations expectedly produced alkaline pH solutions (Tokosh and Baig, 1995), values of which decreased gradually over 18 weeks of study (Table 2). The use of relatively high concentrations of NaOH with low oil concentrations resulted in higher pH of the soap base solutions (B, F).

Emolliency of soap base formulations

The ranked emolliency results of soap base formulations (Figure 1) revealed a trend. The relative translucency produced by the formulations showed general correlation with overall concentrations of oil present in the soap formulations (rounded, in Figure 1, to nearest integers). Thus, most of the formulations that produced strong translucency (A, C, D, E, and K) contained very high (62 to 67% w/w) total oil concentrations (Figure 1). Formulations G and H (55% oil content), which also gave strong translucency on white paper, contained two oils combined in their formulae (Table 1). Of the three soap bases prepared with combinations of the three oils (I, J, K), soap base K which contained a relatively higher proportion of SB demonstrated the highest emolliency (Figure 1).

The fact that formulation F, having only one oil component at 46% concentration in its formula (Table 1), demonstrated strong emolliency (Figure 1), suggests that its coconut oil component possesses greater oleaginous (lipophilic) property than does PKO (the oil component of formulation B; Table 1); formulation B being a similar (single oil, PKO) composition soap product with higher (51%) oil concentration level (Table 1), but showing only mild occlusive character (Figure 1). Formulation B had the lowest oil concentration (51%) among the formulations containing PKO as sole oil ingredient (Table 1) but contained the highest NaOH of the three indicating more effective saponification of the oil which would have

Table 2. Foam stability duration and pH of soap base formulations.

Formulation code***	Water type/foam duration** (min)††		Time after soap production/mean pH value†† of aqueous solution of soap formulation				
	Distilled water	Tap water	Day1	Week1	Week4	Week12	Week18
A	23.2±1.3^{u}	17.0±1.0^{t}	11.5^{b}	10.3 (10.7)*^{c}	10.3^{c}	10.3^{c}	10.2^{c}
B	13.0±1.0^{s}	11.0±1.0^{r}	12.8^{a}	11.5 (11.9)*^{b}	11.5^{b}	11.4^{b}	11.0^{b}
C	44.0±2.0^{w}	43.0±2.0^{w}	11.3^{b}	10.1 (10.7)*^{c}	10.1^{c}	10.1^{c}	10.0^{c}
D	38.8±1.3^{v}	0.3±0.6^{m}	10.6^{c}	10.6^{c}	10.5^{c}	10.3^{c}	10.1^{c}
E	61.3±4.5^{x}	6.0±1.0^{p}	11.1^{b}	11.1^{b}	10.9^{c}	10.7^{c}	10.3^{c}
F	38.0±1.0^{v}	2.7±0.6^{n}	12.2^{a}	11.8^{b}	11.7^{b}	11.7^{b}	11.2^{b}
G	45.0±2.0^{w}	0.3±0.6^{m}	10.3^{c}	10.3^{c}	10.3^{c}	10.3^{c}	10.1^{c}
H	33.0±1.0^{v}	11.3±0.6^{r}	10.3^{c}	10.3^{c}	10.3^{c}	10.2^{c}	10.0^{c}
I	60.0±4.0^{x}	44.0±2.0^{w}	11.9^{b}	11.2^{b}	10.8^{c}	10.6^{c}	10.4^{c}
J	69.0±5.0^{z}	8.7±0.6^{q}	10.3^{c}	10.3^{c}	10.2^{c}	10.2^{c}	10.0^{c}
K	17.0±2.0^{t}	5.0±1.0^{p}	10.7^{c}	10.1^{c}	10.0^{c}	9.8^{c}	9.7^{c}
L	47.0±2.0^{w}	14.0±1.0^{s}	10.3^{c}	10.3^{c}	10.3^{c}	10.3^{c}	10.3^{c}
M	21.2±2.3^{u}	14.0±1.0^{s}	12.2^{a}	11.7^{b}	10.2^{c}	10.2^{c}	10.0^{c}
N	15.0±2.0^{s}	9.0±1.0^{q}	12.6^{a}	11.8^{b}	10.2^{c}	10.2^{c}	10.0^{c}
Comparator soap (Septol®)	275±8.0^{f}	129.0±5.0^{k}	9.5^{c}	9.4^{c}	9.4^{c}	9.3^{c}	9.3^{c}

***See Table 1, **Data are expressed as mean±SEM. ††Different superscript letters indicate significant difference (p<0.05); Values with same superscript letter are not significantly different (p>0.05).
*Values in parenthesis indicate the results of formulation samples prepared by cold process, monitored for 1 week.

lesser unsaponified oil to give emolliency.

The soap base formulation K was finally selected as the most suitable for incorporation of the *S. alata* and *E. uniflora* leaf preparations, since it demonstrated the highest emolliency (Figure 1) and consistently showed the lowest pH values throughout the 18 weeks of study (Table 2).

Physicochemical properties of herbal soap formulations

Foaming propensities of the herbal soap formulations in tap and distilled water (Table 3) were in similar range to those of the soap base K (Table 2), but were much lower than those of the comparator soap, Septol®, the froths of which lasted 129 ± 5 and 275 ± 8 min (approximately 2 and 4½ h), respectively, in tap and distilled water. On the other hand, pH values of the herbal soap solutions (Table 3) were also similar to those of the plain soap base K (Table 2), indicating that incorporation of *S. alata* and *E. uniflora* leaf preparations did not alter the physicochemical properties of the soap base considerably. Septol® aqueous solutions demonstrated a lower pH value (9.34 ± 0.12) than soap base K (9.7; Table 2) but the values were not significantly different (p>0.05), and remained virtually unchanged over the study period, as found also for the herbal soap counterparts (Table 3).

Antimicrobial activities of herbal soap formulations

The soap base (K) demonstrated antibacterial activities, giving inhibition zone diameters of 15.5±1.5 and 18.5±1.5 mm (mean±SEM), respectively, against *S. aureus* and *B. subtilis*; but no activity against *C. albicans*. However, incorporation of the plant preparations made the resulting herbal soap formulations active against *C. albicans* and also more active against the bacteria innocula (Table 4).

DLE forms of *S. alata* and *E. uniflora* combined (at 9 and 11% w/w concentrations) in soap preparations resulted into herbal soap formulations that demonstrated antimicrobial

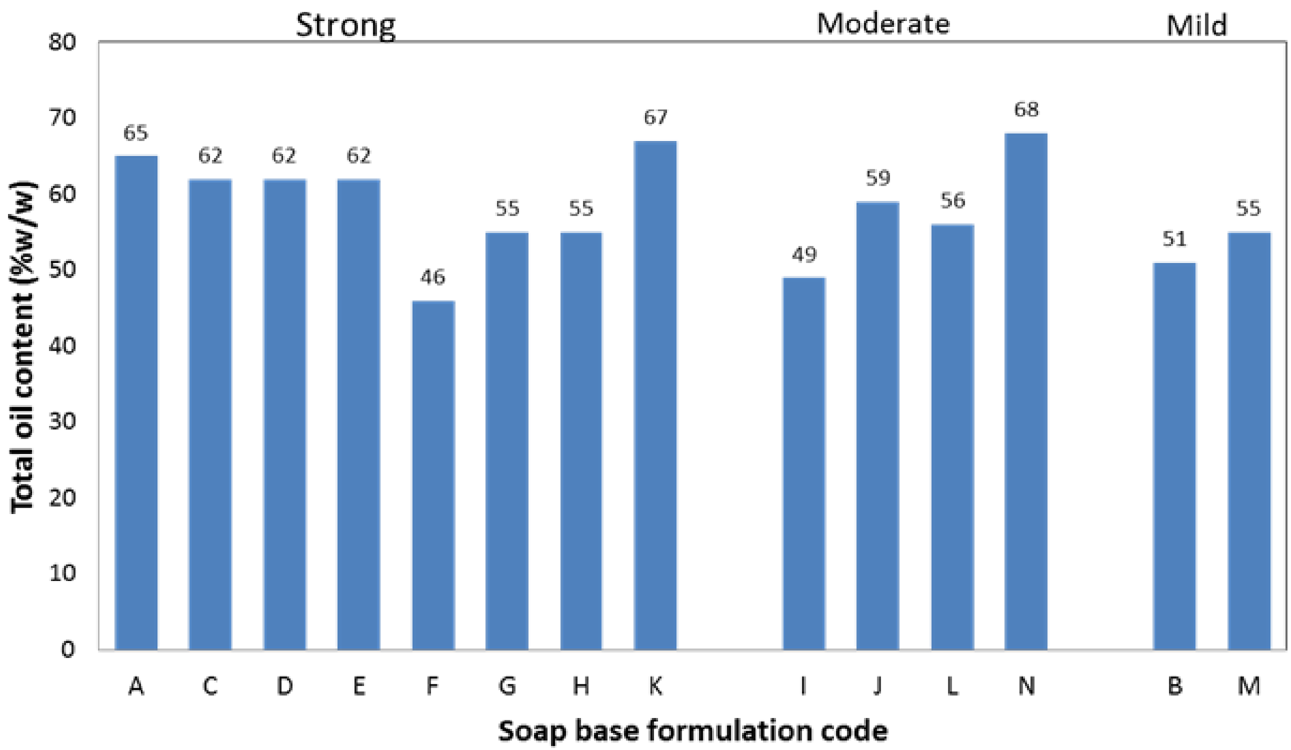

Figure 1. Emollience ranking of soap base formulation relative translucency produced on white paper.

activities similar to those of Septol® against *S. aureus* and *C. albicans* ($p>0.05$) (Table 4). They were, however, significantly lower in activity than Septol® against *B. subtilis* ($p<0.05$). *B. subtilis* was also insensitive to some of the herbal soap formulations produced with the dry leaf powdered (DLP) or FLE forms of both plants combined. On the other hand, the activities of *S. alata* and *E. uniflora* leaf preparations singly used in soap formulations were significantly lower than those of Septol® ($p<0.05$) (Table 4).

DLE forms of *S. alata* and *E. uniflora* used in the soap formulations (whether singly or combined) were active against all the test organisms (Table 4), and so proved superior in their antimicrobial activities to similar formulations produced with the other leaf preparations, against which some organisms demonstrated no apparent sensitivity (Table 4). The *E. uniflora* DLE used alone in the soap formulations generally demonstrated greater antimicrobial activities than the *S. alata* DLE used alone, particularly at the lower (5 and 9%) concentrations (Table 4). The 9 and 11% concentrations of both *S. alata* and *E. uniflora* leaf extractives in the soap formulations generally produced higher antimicrobial activities than the lower concentration (5%) (Table 4). Higher than 11% w/w concentrations of the plant preparations were, however, not used in the study because preliminary experiments had shown that foaming propensity of the soap formulations was lost at such concentrations.

DISCUSSION

The importance of an anti-infective soap formulation is to keep the user's skin both clean and healthy through its cleansing and antimicrobial actions, removing skin-surface hydrophobic dirt and microbes, which can clog and infect dermal pores. It is the combination of these functions that makes an antiseptic soap formulation superior and often preferred above the use of ordinary soap preparations for the prevention or treatment of inflammatory skin conditions, such as acne or impetigo. Soaps belong to the anionic group of surfactants. The anionic and cationic surfactants are known to generally enhance penetration of antimicrobial agents through the cell wall of microorganisms; and this constitutes a possible mechanism by which they usually enhance the activities of such agents against infection-causing organisms (Hugo and Russell, 1998; Aiello et al., 2007).

The soap bases prepared in this study demonstrated some degree of antibacterial activity. Inclusion of leaf extracts increased the antibacterial activity and extended antifungal activity. Fresh leaf juice of *S. alata* has been reported to exhibit reduced activity on storage beyond 48 h at ambient temperature, due probably to hydrolysis of the active constituents (Akinde et al., 2002). The presence of water in the fresh leaves that would reduce its relative weight used for the extraction in comparison to the weight of the dry leaves would affect the overall

Table 3. Foam stability duration and pH of herbal soap formulations.

Plant preparation type/Plant name	Concentration of extract in soap formulation (%w/w)	Foam stability: Water type/Foam duration** (min)[††]		pH: Time after soap production/ pH value* of aqueous solution of soap formulation			
		Distilled water	Tap water	Day 1	Week 4	Week 8	Week 12
Dried Leaf Extracted (DLE)							
S. alata (DLE)	5	15.0±1.5[t]	6.0±0.6[q]	10.4	10.3	10.3	10.1
	9	14.0±1.0[s]	5.0±0.3[p]	10.3	10.3	10.2	10.2
	11	15.0±1.5[t]	5.0±0.3[p]	10.5	10.2	10.2	10.1
E. uniflora (DLE)	5	15.0±1.5[t]	5.0±0.3[p]	10.2	10.1	10.1	9.8
	9	16.0±1.5[t]	5.0±0.3[p]	10.3	10.2	10.0	9.7
	11	16.0±1.5[t]	5.0±0.3[p]	10.2	10.1	10.1	9.6
S. alata + *E. uniflora* (DLE)	5	15.0±1.5[t]	6.0±0.4[q]	10.3	10.2	10.0	9.8
	9	16.0±1.5[t]	5.0±0.3[p]	10.2	10.2	10.0	9.7
	11	16.0±1.5[t]	5.0±0.3[p]	10.1	10.1	10.1	9.7
Dried Leaf Pulverized (DLP)							
S. alata (DLP)	5	18.0±1.5[t]	6.0±0.4[q]	10.2	10.0	9.8	9.7
	9	18.0±1.5[t]	5.0±0.3[p]	10.4	10.3	9.9	9.7
	11	16.0±1.5[t]	5.0±0.3[p]	10.3	10.2	9.8	9.7
E. uniflora (DLP)	5	15.0±1.5[t]	6.0±0.4[q]	10.4	10.1	10.1	9.8
	9	17.0±1.5[t]	4.0±0.3[p]	10.0	10.0	10.0	9.6
	11	16.0±1.5[t]	4.0±0.3[p]	10.3	10.1	10.0	9.7
S. alata + *E. uniflora* (DLP)	5	17.0±1.5[t]	6.0±0.4[q]	10.4	10.1	10.0	9.8
	9	17.0±1.5[t]	5.0±0.3[p]	10.5	10.2	10.0	9.7
	11	15.0±1.5[t]	5.0±0.3[p]	10.3	10.2	10.1	9.8
Fresh Leaf Extracted (FLE)							
S. alata (FLE)	5	16.0±1.5[t]	7.0±0.4[q]	10.4	10.3	9.8	9.9
	9	17.0±1.5[t]	6.0±0.4[q]	10.3	10.1	9.9	9.7
	11	17.0±1.5[t]	8.0±0.5[q]	10.5	10.2	9.7	9.7
E. uniflora (FLE)	5	16.0±1.5[t]	5.0±0.3[p]	10.5	10.4	10.1	9.8
	9	13.0±1.0[s]	5.0±0.3[p]	10.5	10.1	9.8	9.8

Table 3. Cont'd.

	11	12.0±1.0^s	4.0±0.3^p	10.5	10.1	9.9	9.7
	5	15.0±1.5^t	5.0±0.3^p	10.5	10.3	10.1	9.7
S. alata + *E. uniflora* (FLE)	9	15.0±1.5^t	6.0±0.4^q	10.2	10.2	10.0	9.7
	11	15.0±1.5^t	6.0±0.4^q	10.3	10.1	9.7	9.6

**Data are expressed as mean±SEM. ††Different superscript letters indicate significant difference ($p<0.05$); Values with same superscript letter are not significantly different ($p>0.05$). *Data indicate mean pH values; there was no significant difference ($p>0.05$) in all the values here presented.

Table 4. Microorganisms' susceptibility to herbal soap formulations containing *S. alata* and *E. uniflora* leaf preparations.

Plant constituent of formulation	Concentration (% w/w)	Plant preparation forms/Microbe type/Inhibition zone diameter* (mm)††								
		DLE *S. aureus*	DLE *B. subtilis*	DLE *C. albicans*	DLP *S. aureus*	DLP *B. subtilis*	DLP *C. albicans*	FLE *S. aureus*	FLE *B. subtilis*	FLE *C. albicans*
	5	16.0±2.0^h	10.0±1.0^k	16.0±1.0^h	16.0±2.0^h	0.0	14.5±0.5^h	0.0	0.0	16.5±0.5^h
S. alata	9	19.0±3.0^g	12.0±1.0^j	18.5±0.5^g	22.0±4.0^f	0.0	15.0±1.0^h	13.0±1.0^j	0.0	15.0±1.0^h
	11	17.5±2.5^g	22.0±4.0^f	21.5±0.5^f	22.0±4.0^f	0.0	17.5±1.5^g	11.0±1.0^j	0.0	17.5±1.5^g
	5	19.0±3.0^g	19.0±3.0^g	21.5±1.5^f	19.0±3.0^g	0.0	0.0	13.0±1.0^j	0.0	16.5±0.5^h
E. uniflora	9	19.0±3.0^g	22.0±4.0^f	20.0±1.0^f	19.0±3.0^g	16.0±2.0^h	16.5±1.5^h	16.0±2.0^h	16.0±2.0^h	17.5±0.5^g
	11	22.0±4.0^f	22.0±4.0^f	21.0±1.0^f	23.5±4.5^f	15.0±5.0^h	18.0±1.0^g	17.5±2.5^g	19.0±3.0^g	18.0±1.0^g
	5	22.0±4.0^f	16.5±1.5^h	17.5±0.5^g	13.0±±1.0^j	0.0	10.0±1.0^k	17.0±2.0^g	0.0	18.5±0.5^g
S. alata + *E. uniflora*	9	24.0±3.0^e	19.5±0.5^g	23.0±2.0^f	14.5±1.5^h	0.0	11.5±0.5^j	20.5±0.5^g	0.0	23.5±0.5^f
	11	26.0±1.0^e	20.0±1.0^g	25.0±2.0^e	16.0±2.0^h	0.0	16.0±2.0^h	23.5±4.5^f	22.0±4.0^f	25.0±1.0^f
Comparator soap (Septol®)		Microbe type/Inhibition zone diameter* (mm)††								
		S. aureus	*B. subtilis*	*C. albicans*						
		24.25±1.71^e	25.25±5.19^e	21.50±1.91^f						

*Inhibition zone diameter values indicate the mean±SEM of the data. ††Different superscript letters indicate significant difference ($p<0.05$); Values with same superscript letter are not significantly different ($p>0.05$). 0.0: no inhibition of organism growth. DLE: Dry leaf methanolic extract; DLP: dry leaf pulverized; FLE: fresh leaf methanolic extract.

quantity of active components of the FLE. These factors may account for the higher antimicrobial activity of *S. alata* DLE compared to the FLE. On the whole, the results of this study have established the potency of *S. alata* and *E. uniflora* DLE forms combined in soap formulation against susceptible organisms (*S. aureus* and *C. albicans*) as being comparable to the activities of the comparator antiseptic soap, Septol®. These organisms are known to be commonly associated with human skin (Chiller et al., 2001) or as opportunistic pathogens in man (Gow and Yadav, 2017).

Evaluation of emolliency may include the use of ranked indices (Parente et al., 2008). The emolliency test used in the present study was designed to evaluate occlusiveness of the soap formulations. Occlusive agents produce translucency on white paper due to the presence of residual oils in the formulation. The extent of translucence should therefore indicate the relative amount of residual oils present in the soap sample after the saponification process. This is demonstrated by the results in Figure 1 where the highest emolliency was observed with soaps containing high concentrations of oils, singly or combined. By mechanism of action, emollients are occlusive, humectant and/or restorative. Occlusive agents form a thin film on skin surface preventing moisture loss, mostly due to the presence of natural oils (Choi and Maibach, 2005; Bouwstra and Ponec, 2006). The use of emollients in topical products corrects problems in skin scaling disorders and emollients may also have suppressive effects on epidermal thickening, in addition to anti-inflammatory activity and transient relief from irritation (Nola et al., 2003). The glycerol (end-product of saponification reactions) in all the soap formulations of this study was not separated from the soap, for the possible benefit of contributing its moisturizing quality to the user's skin (Tucker, 2011) from the soap products when used.

Coconut oil is reputed for producing good quality suds when used in the preparation of soaps (Gervajio, 2005), hence, the quality of the foam produced with the oil compared to those of PKO and SB. Shea butter contains a higher proportion of unsaponifiable matter than the other two oils (Moharram et al., 2006). This might be responsible for its low foaming ability but caused its soap base to be more emollient and with lower pH. The presence of excessive NaOH in a soap preparation will increase the pH of such soap, as observed with soap bases B and F. Tap water is likely to contain divalent and trivalent metals which may reduce foaming and foam stability of the monovalent sodium soaps in water by forming water immiscible divalent soaps.

The skin has a pH range of 4 to 6. To reduce irritation, skin products are expected to have pH as close to this range as much as possible. The pH of the comparator soap product is similar to that of the formulated herbal soap, even though the values are not within the pH range for the skin. The comparator soap is popularly used with no reported adverse effect on the skin due to pH.

Conclusions

This study has shown that *S. alata* and *E. uniflora* dry leaf methanolic extracts combined in 1:1 w/w ratio and formulated into soap at 9 or 11% w/w concentration exhibit antimicrobial activities against *S. aureus* and *C. albicans* comparable to those of a comparator soap, Septol®, containing 0.30% triclosan. The resultant herbal soap formulations also demonstrated suitable pH and foam stability properties, and could therefore serve as a substitute for soaps containing synthetic antiseptic agents especially triclosan, which has become controversial because of its untoward effects in humans (Deliaert et al., 2008) and the environment (Chalew and Halden, 2009).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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