

Original Research Article

Extraction and Evaluation of a Saponin-base Surfactant from *Cissus populnea* Plant as an Emulsifying Agent.

Abstract

The surfactant properties of *Cissus populnea* plant which has been traditionally identified as a natural surfactant, was evaluated in this work. The defatted surfactant extract from the leave, root and stem-bark of *cissus populnea* was characterized using FTIR spectroscopy. IR absorption bands indicate quantitative presence of saponin in the extract. Evaluation of the surfactant properties of *Cissus populnea* leave, root and stem-bark extract was carried out by measuring the emulsion formation/ capacity. This was carried out at different concentration (1 g/dm³, 2 g/dm³, 4 g/dm³) with comparative study using same concentrations of OMO (a commercial/synthetic surfactant manufactured by lever Brother Nigeria). Emulsion formation/capacity for of the *cissus populnea* leave, root and stem-bark extract show better creaming behaviour than OMO. Creaming stability decrease in all the surfactant, but more rapidly in commercial detergent. Within 1 and 48 hours, the emulsion formation/ capacity for 1 g/dm³ gave 97.3% - 67.1%, 92.0% - 72%, 77.0% - 58.3%, 88.3%, 2 g/dm³ 94.2% - 70.0%, 90.5% - 80.3%, 80.2% - 53.3%, 88.3% - 60.0%, while for 4 g/dm³ gave 90.63% - 68.3%, 98.0% - 50.3%, 91.3% - 66.7%, 87.5% - 64.1% for *C. populnea* leave, root and stem-bark and OMO respectively. These present *C. populnea* leave, root and stem-bark extract which is a natural surfactant, with higher formation/emulsifying power compared to OMO at different concentration evaluated. This favourable property is associated with saponin content of *C. populnea* leave, root and stem-bark extract. This work therefore contributively publishes the potentials of *C. populnea* extract as a foaming, emulsifying, wetting and cleansing agent.

Keywords: *Cissus populnea*, natural surfactant, saponin, emulsion formation/capacity

Introduction

Surfactants are usually organic compounds that are amphiphilic, meaning they contain both hydrophobic groups and hydrophilic groups. Surfactants carry polar and non-polar groups [1]; [2]. The conventional surfactant just like many other product is source from petroleum

and coal. This made this raw material source limited, suggesting the sourcing of surfactant or its raw materials from other sources. Saponin is a kind of these natural surfactants. Many plants produce significant quantities of saponins which have surfactant properties.

Saponins are groups of secondary plant metabolites that are found in abundance in various plant. *Cissus populnea* is an example of such saponin-containing plants [2]; [3].

Saponins are any of various plant glycosides with a higher molecular weight that form soapy lathers when mixed and agitated with water. It is used in detergent making, as foaming agents, and emulsifiers [3].

The word 'emulsion' comes from the latin 'to malk', as milk is an emulsion of milk fat and water among other components. Emulsion can also be described as homogenous mixture of polar and non –polar liquids. Oil and water can form different types of emulsion based on the amount of the substances in mixture. These include; oil-in-water emulsion wherein water is the dispersed phase and water is the dispersion medium, water-in-oil emulsion wherein water is the dispersed phase and oil is the external phase, and multiple emulsions including water-in-oil-in-water emulsion and oil-in-water-in-oil emulsion [4].

Cissus populnea belongs to the family of *amplidacea (vitacea)* as confirmed by [3], which are woody climbers, sometimes vines, rarely small succulents' trees, and hermaphrodite or polygamoneacious to polygamodroecions. *Cissus populnea* grows in divers' ecozones of Nigeria, Uganda, Niger Republic, Cameroon and Coted'voire [5]. The plant is climbing stem, widely distributed in many parts of Nigeria, especially within the guinea savannah region of Anambara, Kogi and Benue States [6]. The Igala and Idoma ethnic group refers to this plant as Okoho, Yorubas as Ogholo, and Hausas as dafaaraa. It is used extensively in medicinal preparation in West Africa.

All part of *Cissus populnea* exudes, a mucilaginous material is traditionally utilized as a raw materials [7]. Gum exudates are mainly obtained from the stem and root of the plant. The gum obtained from *Cissus populnea* has been evaluated for it Potential use as a dispersants in pharmaceuticals liquid system [8]. The root extract from the plant have been use for treatment of skin diseases, boils, infected wounds and for treating urinary tract infections, thus suggesting antibacterial potency of the of the plant [9]. In Ghana, the plant is used as diuretic and as a post-harvest ethnobotanical protectant [10].

Cissus populnea even though has been of various traditional uses, but has not been well worked on scientifically to ascertain its potentials in both domestic and industrial applications. This study therefore seeks to extract, characterize and evaluate the surfactant properties of *Cissus populnea* leave, roots and stem-bark extracts, and hence its potentials in the production of surfactants and cleansers.

Materials and Methods

Collection of plant Materials

Cissus populnea plant in Michika, Michika Local Government Area of Adamawa state, Nigeria was used in this study. Fresh leave, root and stem- bark of *Cissus populnea* grown in Michika were collected on 4th December, 2016. These were air dried at a room temperature, ground in to powder using pestle and mortar (stainless steel) and store in screw-capped containers. All the chemicals used were of analytical grade and were not subjected to further purification. The general available cleansing agents, synthetic/ commercial detergents were purchased from the market in Jimeta, Adamawa state.

Method of extraction

The standard method described by Agu and Barminas [11] and Kime *et al.*, [2] was used for the extraction. With this, 5 g of each of the dried ground sample were weighed into a thimble and transfer into a Soxhlet extractor chamber fitted with a condenser and a round bottom flask containing 200 cm³ of acetone. This was heated on heating mantle at 60 °C for 3 hours, to exhaustively extract lipid and interfering pigments, after, which the solvent was distilled off. The extract was further defatted by transferred into another Soxhlet extractor fitted to both a condenser and a dried weighed round bottom flask containing 200 cm³ of methanol with applied heat using a heating mantle and exhaustively extract for another 3 hours. The methanol was recovered by distillation at the end of the extraction and transfers the flask with its extracts to the oven to evaporate to dryness before cooling in desiccator. The percentage of saponin-based surfactants was calculated as shown below:

$$\% \text{ of Saponin} = \frac{\text{Weight of Saponin}}{\text{Weight of Sample}} \times \frac{100}{1}$$

Emulsions formation/capacity

Emulsion formation/capacity was carried out by according procedures described by Kime *et al.*, [2]. That is 50 cm³ sample solutions were mixed in a beaker. The mixture was homogenized using an improved method with a 100 cm³ glass syringe. This improved homogenization process involved repeated cycles of sucking and rapid expulsion of emulsion from the syringe. This was done to ensure proper droplet break-up until a creamy homogenous emulsion was obtained. Emulsion capacity is express as amount of oil emulsified and held per gram of sample.

$$\text{Emulsion Capacity} = X/Y \times 100/1$$

Where X = Height of emulsion layer

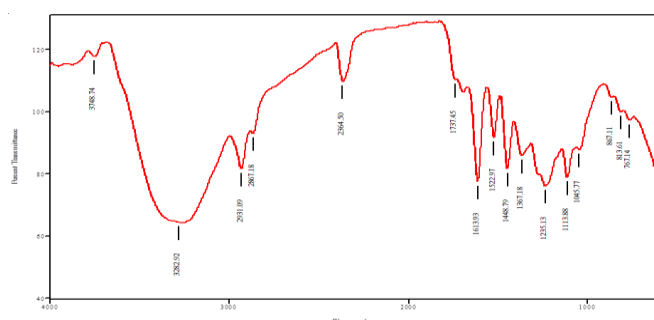
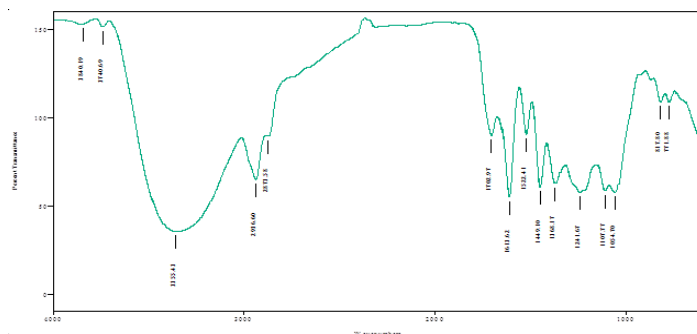
Y = Height of whole solution in the syringe

Result and Discussion

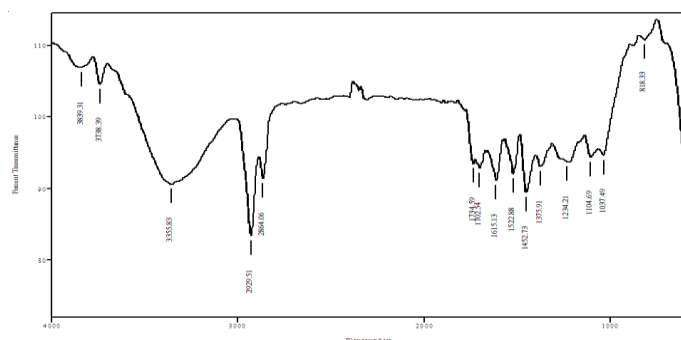
Figure 1 shows the FT-IR spectra of crude surfactant and extracted saponin from the leave, roots and stem-bark of *Cissus populnea*. The broad band between 4000 and 3000 cm^{-1} in all the spectra suggested OH stretching with broad peak intensity. The position of absorption band at 2364.04 cm^{-1} and 2922.49 cm^{-1} , 2364.50 cm^{-1} and 2316.86 cm^{-1} and the small peaks at 1008.89 cm^{-1} and 1045.77 cm^{-1} on the leave, root and stem-bark extracts respectively, were suggested to C-H stretching, C=C stretching bands and C-O stretching peak and the carboxyl group at 1734.59 cm^{-1} , 1615.13 cm^{-1} for crude and extracted saponin respectively. The functional groups identified in these spectra indicate the presence of saponins in the extracts. This can be responsible for the foaming properties of the extracts as similarly reported by Rechard [1]; Rashidi *et al.*, [12] and Kime *et al.*, [2].

Sample Filename	Leaf extract.spc
File Title	11/17/2016 11:46:33 title
Date	Thu Nov 17 11:52:18 2016

Leave extract



Root extract.



Stem-bark extract.

Figure 1: FT-IR Spectra of Extracted Saponin- base Surfactant.

Figure 2 present and compare the emulsion capacity of 1 g of *C.populnea* leave, root and steam-back extract OMO as function of time. With this quantity, the emulsion formation/capacity of the extract was good (97.3% to 67.1%), (92.0% to 72.3%) and also higher or better compare to OMO (88.3% to 60.8%) and stem-bark (77.0% to 58.3%) within the hours of evaluation (1 to 48 hours respectively). This can be attributed to a quantitative presence of saponins in *C.populnea* leave, roots and stem-bark extracts, as saponins has been reported by Agu and Barminas [11] and Kime *et al.*, [2], to be a good emulsifying agent.

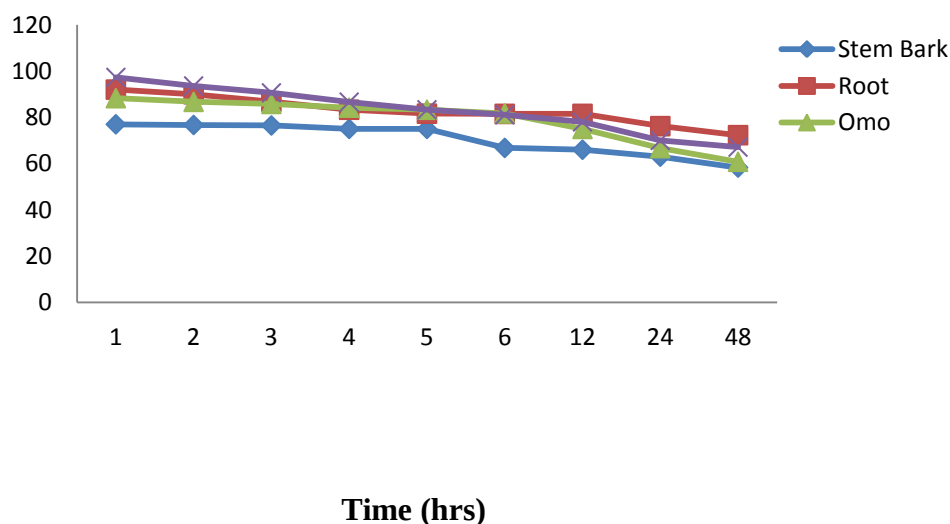


Figure 2: Emulsion capacity (%) Versus Time (hr) for 1 g of Extracted Saponin-based Surfactant and OMO solution.

Figure 3 presents and compare the emulsion capacity of 2 g of *C.populnea* leaves, roots, stem-bark extract and OMO as function of time. The emulsion capacity of *C.populnea* leave, roots and stem-bark extract (94.2% to 70.0%), (90.5% to 80.3%) is still good and correspondingly higher than that of OMO (88.3% to 60%) and stem-bark (80.2% to 53.3%) within the hours of evaluation (1 to 48 hours respectively). However, the emulsion capacity at this higher concentration (2 g) is lower compare to 1 g. This concurs with the report by Kime *et al.*, [2] that at low soap and detergent concentration, rapid coalescence among the inner and outer droplets to inner phase occurred, resulting in separation within a short period of time.

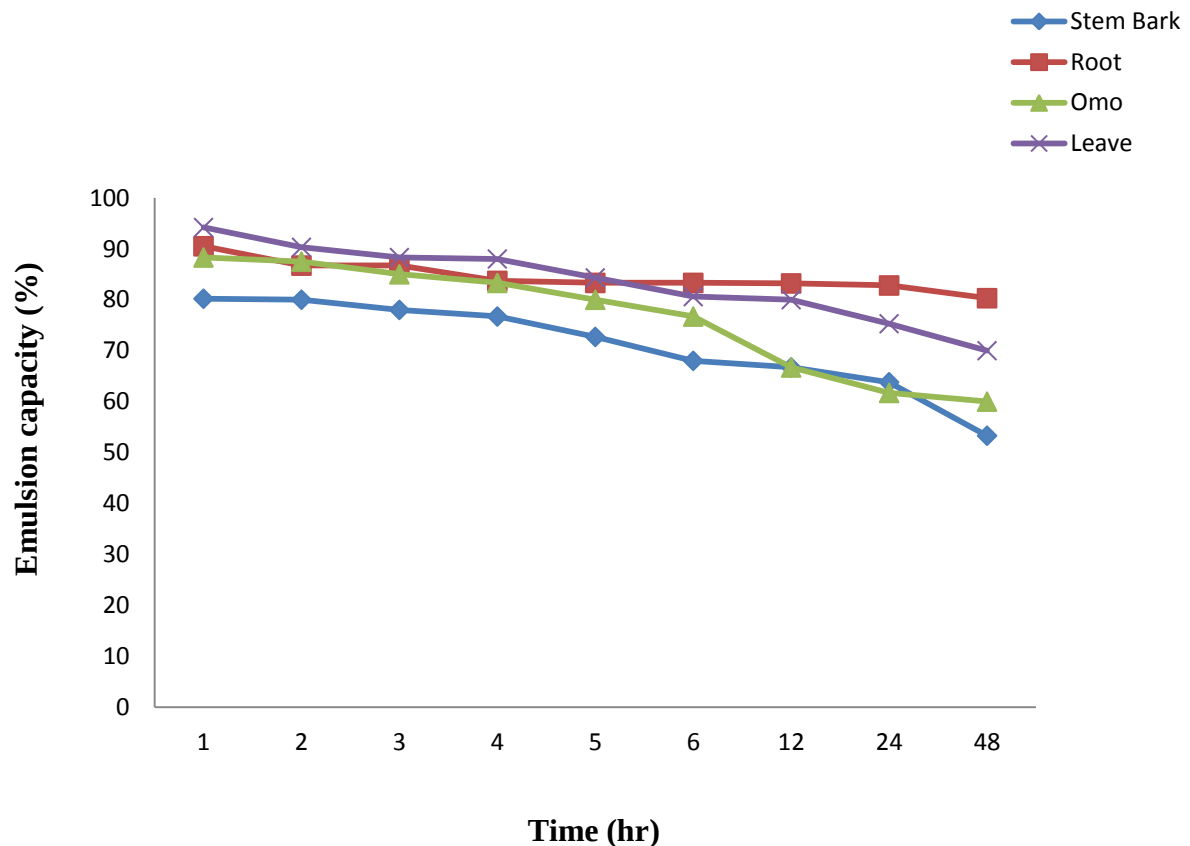


Figure 3 Emulsion capacity (%) Versus time (hr) for 2 g of Extracted Saponin-based Surfactant and OMO Solution

Figure 4 presents and compare the emulsion capacity of 4 g of *C.populnea* leaves, roots, stem-bark extract and OMO as function of time. At this concentration, the emulsion capacity of *C.populnea* leave, roots and stem-bark extract (90.6% to 68.3%), (98.0% to

50.3%) and stem-bark (91.3% to 66.7%) remains lower compare to 1 g. The leaves were also equated with roots within the 3th and 5th hours while OMO decreases. This further indicates the diminishing emulsion capacity and stability with increase in the concentration of *C.populnea* leaves, root and stem-bark extract as reported by Kime *et al.*, [2].

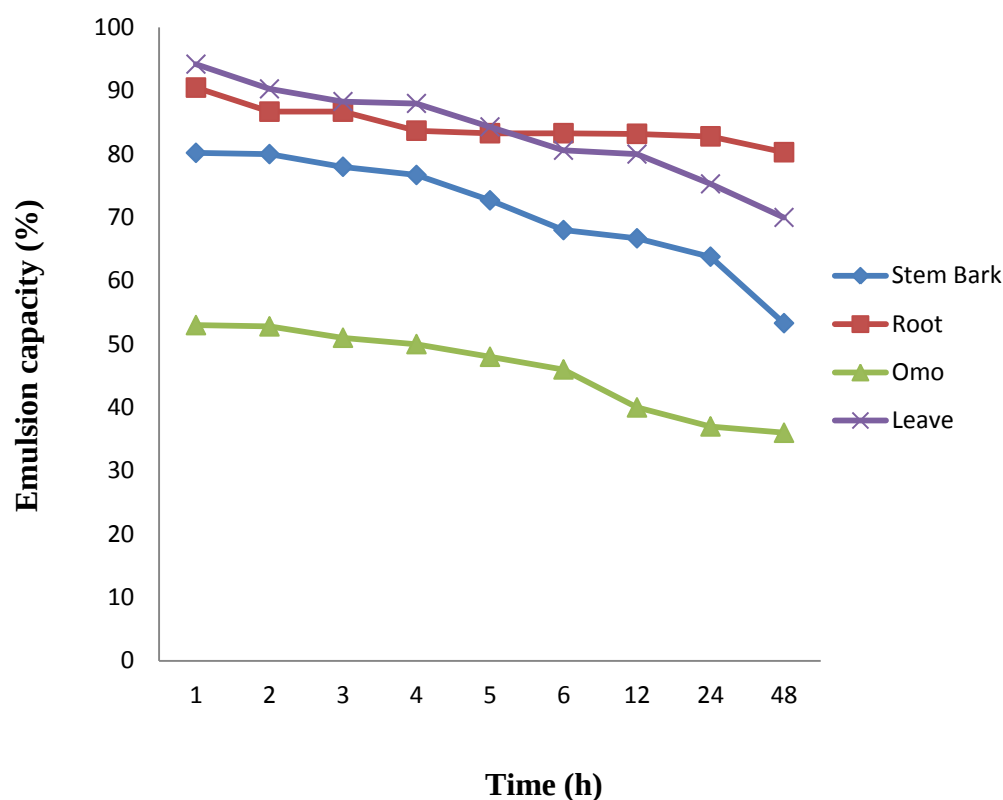


Figure 4: Emulsion capacity (%) Versus Time (hr) for 4 g of extracted saponin-based surfactant and OMO solutions.

Conclusion

This study has identified *C.populnea* plant as a source of a saponins based surfactant. The emulsion capacity and stability exhibited by the *C.populnea* extracts goes further to recommend its superiority compared to a commercial/synthetic surfactant. The adoption of *C.populnea* extracts as basic raw material therefore will further promote greenness as it will be eco-friendly. The use of *C.populnea* extract as recommended in this work will also be

economical and conservative, and may also initiate and enlarge profitable agricultural interest in the plant.

REFERENCE

1. Richard, I. F. [Ed.] (2006). Chemistry and Technology of Surfactants. Blackwell Publishing LTD. Oxford United Kingdom, 18-108.
2. Kime B., Barminas J.T., Nkafamiya I.I., Akinterinwa A. (2015). Extraction and Evaluation of Saponin- based Surfactant from *Balanites aegyptiaca* Plant as Emulsifying Agent. *International Journal of Innovative Science, Engineering and Technology* **Vol.2**: 733- 737
3. Foerster and Hartmut, L.E (2009). Project summary: functional Genomics of Triterpene Saponin Biosynthesis in *Medicago*. Retrieved from <http://en.m.wikipedia.org/saponins.5> (4): 185-193.
4. Ahmed F.J. Khan Ay, Talegonkar S. Iqbal Z. Khar RK. (2006). Curr Drug Deliv. Multiple Emulsions: An overview.
5. Geldam M. A. (2004). Effect of Aqueous Stem bark of *Cissampelos palmata* Serum, Enzymes in Normal Burkitt. The Useful Plant of West Tropical Africa, **Vol. 5**: 15-35.
6. Alfa J., Chukwu A., Audeala C. (2003). *Cissus* Stem Gum as Potential Dispersant in Pharmaceutical Liquid System rheological Characterization. *Bol Chim Farm* **(140)**: 20-240.
7. Ojekele A.B., Lawai O.A., Lasisi A.K., Adeleke T.S. (2004). Phytochemistry and Spermatogenic Potential of Aqueous extract of *Cissus populenea*. Guick and Persten Bark sd. *World J.* **6**; 2140.
8. Garcia G., Cartas L., Lorenzanajimenz M. Gijon E. (1997). Vasoconstrictor Effect of *Cissampelos joide* on Guinea-pig Aortic Rings. *Gen. Pharm.* **(29)**; 457-462.

- 206 9. Kone W.M., Alindehou K.K., Traore D., Dasso M. (2004). Tradirional Medicinal
207 Plants in North Code-d'Ivoir. Heron Press Ltd.; 35
208
- 209 10. Belmain S.R., Golo H., Adnan H.F., Atariga H., Chara F.A., Curr P. (2000).
210 Plytoparasitica. Tita. *J Int.*(5); 1-6.
211
- 212 11. Agu, M. O. and Baminas, J. T. (2013). Evaluation of violet plant
213 (securidacalongedunculata) Root as an Emulsifying Agent. *Journal of Applied*
214 *chemistry*, **4(4)**; 05-09.
215
- 216 12. Rashidi, M., Sorhrabi, B., Golafshan, S., Bahramian, A. (2013). Extraction of Natural
217 Surfactant (saponin) From Ginseng Medical Plant. Institute of Petroleum
218 Engineering, School of Chemical Engineering, College of Engineering,
219 University of Tehran, KaregarStreet, Tehran, Iran: 1-7.
220