

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 locally recognized as a natural surfactant, was assessed 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. Determination of the surfactant properties of *Cissus populnea* leave, root and stem-bark extract was done by measuring the emulsion formation/ capacity. This was done at different concentration (1 g/dm³, 2 g/dm³, 4 g/dm³). The result obtained was compared 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 characteristics 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 efficiency compared to OMO at different concentration evaluated. This favourable characteristic is associated with saponin content of *C. populnea* leave, root and stem-bark extract. This work therefore contributively explored 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 mostly organic compounds that are amphiphilic, implying they contain both hydrophobic groups and hydrophilic groups. Surfactants possess polar and non-polar groups [1]; [2]. Richard., (2006) and Kime et al., (2015) reported that Conventional surfactants just

33 like many other product is gotten from petroleum and coal. This made the raw material
34 source limited, suggesting the sourcing of surfactant or its raw materials from other sources.
35 Saponin is a kind of these natural surfactants. Many plants produce significant quantities of
36 saponins which have surfactant properties.

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

39 Saponin is an example glycosides found in plant with a higher molecular weight that form
40 soapy lathers when mixed and shaken with water. It is used in detergent making, as
41 foaming agents, and emulsifiers [3].

42 Ahmed et al., (2006) reported that the word 'emulsion' comes from the latin 'to
43 malk', as milk is an emulsion of milk fat and water among other components. Emulsion can
44 also be described as homogenous mixture of polar and non –polar liquids. Oil and water can
45 form different types of emulsion based on the amount of the substances in mixture. These
46 include; oil-in-water emulsion wherein water is the dispersed phase and water is the
47 dispersion medium, water-in-oil emulsion wherein water is the dispersed phase and oil is
48 the external phase, and multiple emulsions including water-in-oil-in-water emulsion and oil-
49 in-water-in-oil emulsion [4].

50 *Cissus populnea* belongs to the family of *Amplidacea (vitacea)* as confirmed by [3],
51 which are woody climbers, sometimes vines, rarely small succulents' trees, and
52 hermaphrodite or polygamoneacious to polygamodroecions. *Cissus populnea* grows in
53 divers' ecozones of Nigeria, Uganda, Niger Republic, Cameroon and Coted'voire [5]. The
54 plant is climbing stem, widely distributed in many parts of Nigeria, especially within the
55 guinea savannah region of Anambara, Kogi and Benue States [6]. The Igala and Idoma ethnic

56 group refers to this plant as Okoho, Yorubas as Ogholo, and Hausas as dafaaraa. It is used
57 extensively in medicinal preparation in West Africa.

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

65 *Cissus populnea* has been used for various traditional uses, but has not been well
66 researched on scientifically to assess its potentials in both domestic and industrial
67 applications. This study was conducted to extract, characterize and evaluate the surfactant
68 properties of *Cissus populnea* leave, roots and stem-bark extracts, and hence its potentials in
69 the manufacture of surfactants and cleansers.

70

71 **Materials and Methods**

72 **Collection of samples (plant Materials)**

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

80

81

82 **Method of extraction**

83 The standard procedure described by Agu and Barminas, 2013 [11] and Kime *et al.*,
84 2015 [2] was employed for the extraction. 5 g of each of the dried grinded sample were
85 weighed into a thimble and transfer into a Soxhlet extractor chamber fitted with a condenser
86 and a round bottom flask containing 200 cm³ of acetone. This was heated on heating mantle
87 at 60 °C for 3 hours, to completely extract lipid and interfering pigments, then the solvent was
88 distilled off. The extract was further defatted by transferred into another Soxhlet extractor
89 fitted to both a condenser and a dried weighed round bottom flask containing 200 cm³ of
90 methanol applied under 60 °C using a heating mantle and completely extracted for another 3
91 hours. The methanol was recovered by distillation at the end of the extraction and transfers
92 the flask with its extracts to the oven to evaporate to dryness before cooling in desiccator.
93 The percentage of saponin-based surfactants was calculated as shown below:

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

95

96 **Emulsions formation/capacity**

97

98 Emulsion formation/capacity was carried out by according to the procedures
99 described by Kime *et al.*, 2015 [2]. That is, 50 cm³ sample solutions were mixed in a beaker.
100 The mixture was homogenized using an improved method with a 100 cm³ glass syringe. This
101 improved homogenization process involved continuous cycles of sucking and rapid
102 expulsion of emulsion from the syringe. This was carried out to ensure proper droplet break-
103 up until a creamy homogenous emulsion to form. Emulsion capacity is express as amount of
104 oil emulsified and held per gram of sample.

105 Emulsion Capacity = $X/Y \times 100/1$

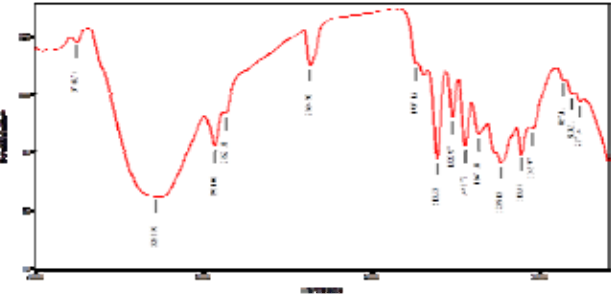
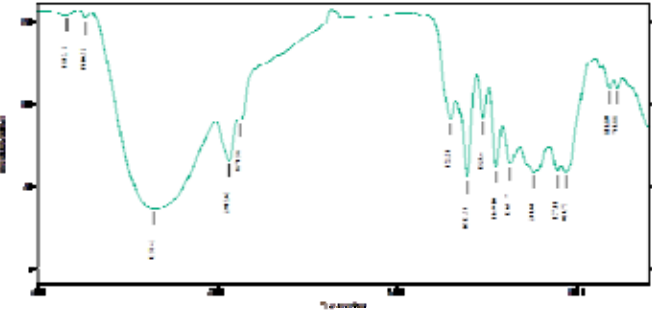
106 Where X = Height of emulsion layer
107 Y = Height of whole solution in the syringe
108

Result and Discussion

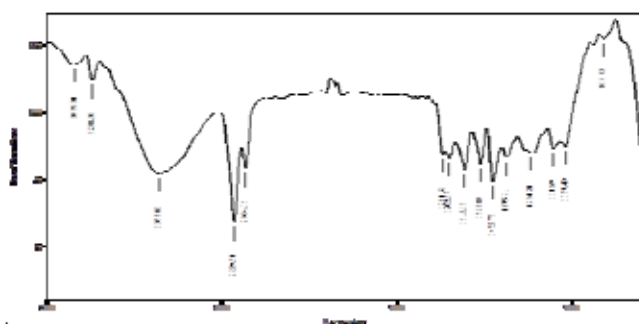
Figure 1 shows the FT-IR spectra of crude surfactant and extracted saponin from the leave, roots and stem-bark of *Cissus populnea*. The broad band between 4000 and 3000 cm^{-1} in all the spectra suggested OH stretching with broad peak intensity. The position of absorption band at 2364.04 cm^{-1} and 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 detected and identified in these spectra indicate the presence of saponins in the extracts. This accounts 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.

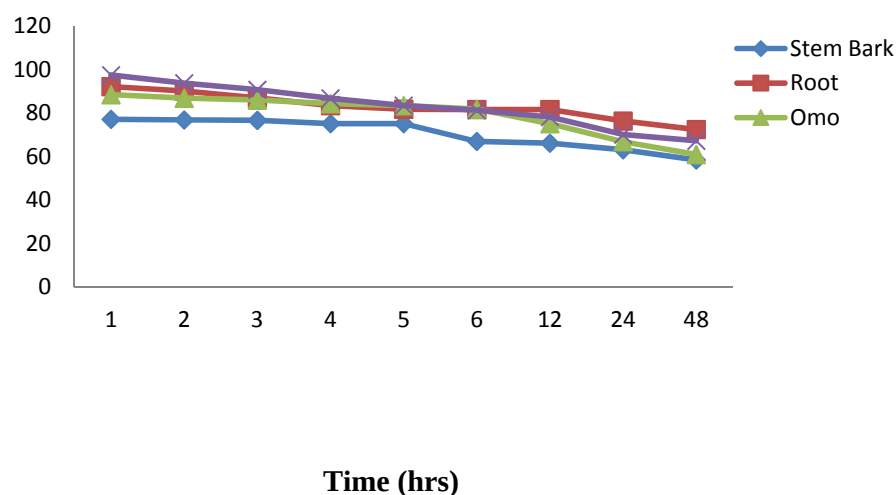


Figure 2: Emulsion capacity (%) Versus Time (hr) for 1 g of Extracted Saponin-based Surfactant and OMO solution.

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.

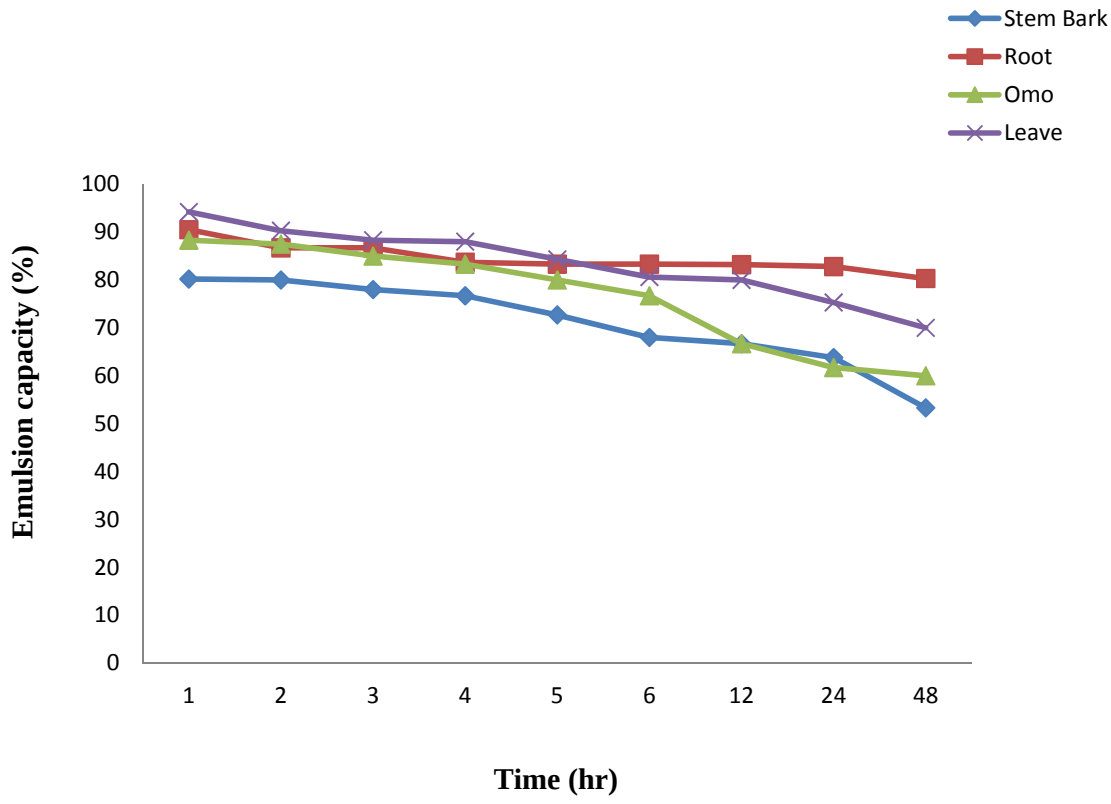


Figure 3 Emulsion capacity (%) Versus time (hr) for 2 g of Extracted Saponin-based Surfactant and OMO Solution

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].

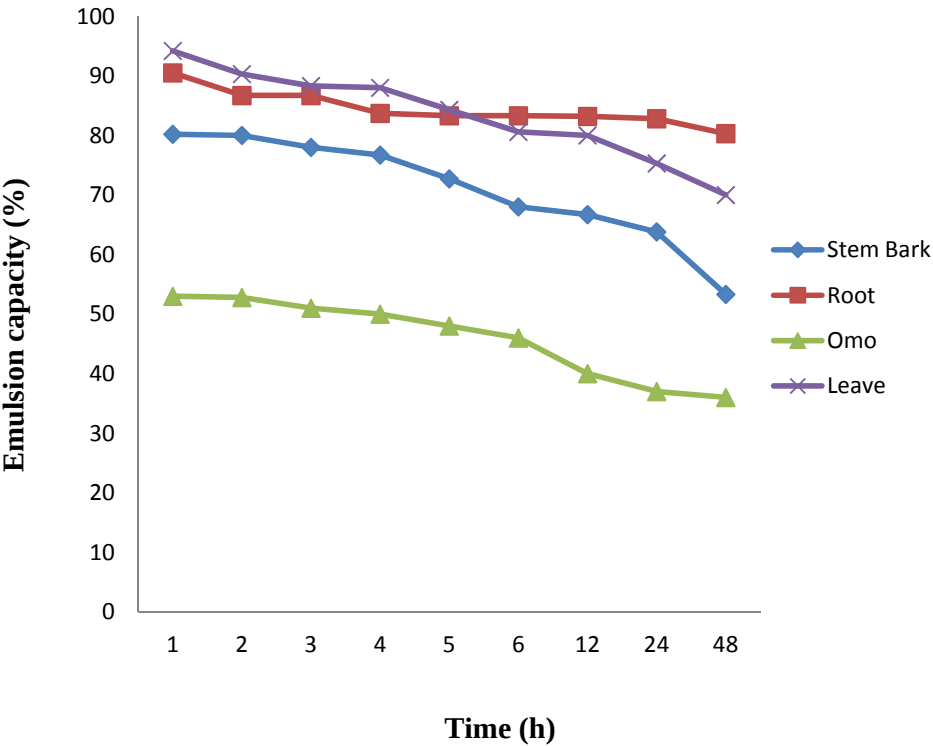


Figure 4: Emulsion capacity (%) Versus Time (hr) for 4 g of extracted saponin-based surfactant and OMO solutions.

Conclusion

This study has identified *C.populnea* plant as a source of a saponins based surfactant. The emulsion capacity and stability possessed by *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, 1. 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 form *Balanites aegyptiaca* Plantas 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 TriterpaneSaponin Biosynthesis in Medicago. Retrive from <http://en.m.wikipedia.orgisaponins.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 *Cissusso pulneain* Serum, Enzymes in Normal Burkill. 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 Pharmcenticed Liquid System rheological Characterization. *Boll Chim Farm* **(140)**: 20-240.
7. Ojekele A.B., Lawai O.A., Lasisi A.K., Adeleke T.S. (2004). Phytochemistry and Spermatogenic Potential ofEqueousextrat of *Cissus popuLNEA*. Guick and Persten Bark sd. *World J.* **6**; 2140.
8. Garcia G., Cartas L., Lorenzanajimenz M. Gijon E. (1997). Vasoconstrictor Effect of *Cissussa joide* on Guinea-pig Aortic Rings. *Gen. Psharm.* **(29)**; 457-462.

- 208 9. Kone W.M., Alindehou K.K., Traore D., Dasso M. (2004). Tradirional Medicinal
209 Plants in North Code-d'Ivoir. Heron Press Ltd.; 35
210
- 211 10. Belmain S.R., Golo H., Adnan H.F., Atariga H., Chara F.A., Curr P. (2000).
212 Plytoparasitica. Tita. *J Int.*(5); 1-6.
213
- 214 11. Agu, M. O. and Baminas, J. T. (2013). Evaluation of violet plant
215 (securidacalongedunculata) Root as an Emulsifying Agent. *Journal of Applied*
216 *chemistry*, **4(4)**; 05-09.
217
- 218 12. Rashidi, M., Sorhrabi, B., Golafshan, S., Bahramian, A. (2013). Extraction of Natural
219 Surfactant (saponin) From Ginseng Medical Plant. Institute of Petroleum
220 Engineering, School of Chemical Engineering, College of Engineering,
221 University of Tehran, KaregarStreet, Tehran, Iran: 1-7.
222