INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 6.078
(Volume 6, Issue 5)
Available online at: https://www.ijariit.com

Extraction, characterization and utilization of cashew nut shell liquid

Ajise Bolanle E.
ajisebolanle@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Adeyemo Oluwasegun A.
Ayoshegs@gmail.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Sadiq shola K.
skam942002@gmail.com
Federal Institute of Industrial Research Oshodi,

Ojo Bayonle I
baytoss@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Chukwudebelu Jane I
adadebelu@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

Taiwo Oluwatoyin E.
toytaiwous@yahoo.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

ABSTRACT

The volume of cashew nut shell produced annually poses a challenge for disposal of cashew nut shell generated during the production of the cashew nut. Therefore, the extraction of cashew nut shell liquid from cashew nut shell will reduce the waste, provide usefulness for the cashew nut shell liquid and in turn generate revenue. The cashew nut shell liquid (CNSL) was extracted using the heating method at temperatures of 40^0C- 80^0C and solvent extraction was carried out between the temperatures of 50^0C - 90^0C. The ash content was determined to be (1.00 and 1.20), the acid values of the CNSL found to be (15.4 and 13.0mgKOH/g). The toxicity test was conducted to know its efficacy on termites and the result shown that cashew nut shell liquid is a very active anti-termite.

Keywords: *CNSL, Extraction, Characterisation, comparism*

1. INTRODUCTION

The cashew industry ranks about third in the world production of edible nuts with the world production in 2000 put at about 2 million tons of nuts in shell and an estimated value of US$2billion (FAO, 2000). World cashew nuts production comes from both wild and cultivated trees. The four major producing regions are India, Brazil, Nigeria and Tanzania. During the last decades, the production of cashew nuts in Nigeria has increased from 30,000 tons in 1990 to 176,000 tons in 2000 (FAO, 2000). The most important product of the tree is the nut, which is used as confectionery. Cashew Nut Shell liquid (CNSL) is of great industrial importance which is obtained from the seed pericarp by distillation or extraction with solvents (Abitogun and Borokini, 2009). CNSL is a component of the Cashew nut shell, it is a reddish brown viscous liquid, because of its quality it is considered a cheap material for unsaturated phenols CNSL takes a significant proportion of about 15-20% by weight of the unshelled nut in Africa, 25% by weight in India (Bhaskaran *et al.*, 2013). The economic importance of the tree is due to its valuable products which are utilized in food, medicine, chemical and allied industries. The cashew nut shell has an alveolar mesocarp which is filled with a dark and caustic oily substance called cashew nut shell liquid (CNSL), obtained as a by-product during industrial processing of cashew nuts (Lomonaco *et al.*, 2017). Its composition varies depending on how it is processed. Solvent extracted CNSL is mostly composed of anacardic acids (70%), cardol (18%), cardanol (5%), these substances are dermatogen like the oil of the poison ivy and present danger during manual cashew processing (Jason, 2012). Cashew nut shell liquid consists of naturally produced phenolic compounds such as anacardic acid (about 90%) and cardol (10%) (Venmalar and Nagaveni, 2005). Anacardic acid is a derivative of salicycyclic acid, which readily decarboxylates on heating to obtain anacardol or cardol. The cardol is a resorcinol derivative having a long unsaturated hydrocarbon chain (Cornelius 1996). It is a cheap and renewable material and replaces phenol with some advantages (Lubi *et al.*, 2000). It can replace phenol in many applications with equivalent better results. CNSL is useful for insecticidal, fungicidal, anti-termite and medicinal applications and as an additive in many plastic formulations (Lubi and Thacil, 2000). This liquid has many biological and industrial applications due to the fact that it can easily react forming various derivatives, including polymers and resins (Patel *et al.*, 2006).

This study is aimed at comparing two methods of extraction of cashew nut shell liquid using ethanol as the solvent and thermal(heat) method. Although, there are little published data on ethanol extraction but not much studies had been done on comparism between these two different methods.

2. MATERIALS AND METHODS

The cashew nut shells were obtained from the cashew nut processing plant at Abod Success Investment Limited, Ogijo, Ogun state, Nigeria

2.1 Pre-treatment

The cashew nut shell was pre-treated to remove the dirt and dried to reduce moisture. The shells were pulverized into smaller sizes using a manual grinding machine for easy extraction of the liquid.

2.2 Extraction of the liquid

Cashew nut shell liquid was extracted using solvent and heating methods. 100g of cashew nut shell was soaked in 400 ml of ethanol. The mixture was then heated in a water bath continuously at different temperature ranging from 40^0C, 50^0C, 60^0C, 70^0C, 80^0C for 8hrs. The solution was decanted and ethanol was recovered. The residue in the flask is the substance called cashew nut shell liquid (CNSL). Roasting method is a traditional method of removing the cashew nut shell liquid and it involves roasting the nut in a drum or bath. The roasting method was done using 100g of the Cashew Nut Shell in an aluminium cup using heating mantle at 50^0C, 60^0C, 70^0C,80^0C, 90^0C, the liquid which flowed out of the shell is known as cashew nut shell liquid, this is similar to the work reported by (Subbarao *et al*., 2011).

2.3 Physicochemical properties

The ash content was determined using muffle furnace at the temperature of 550^0C for 5hrs following the method of (AOAC, 2000). The pH was determined using digital pH meter, 10ml of the cashew nut shell liquid was put in the beaker and the reading was taken. The moisture content was done using (AOAC, 2000). 10ml were weighed in triplicate and placed in an oven at 105^0C for 3 hours and the samples were placed in the desiccator to cool. The dried samples were weighed and calculated. The specific gravity and iodine value was determined following the method of (Ranganna, 2009).

2.4 Efficacy test

The termite bioassay was done in the laboratory at room temperature of 28^0C using the extracted cashew nut shell liquid to know the effectiveness of the liquid against termites.

The termites were collected at their termitarium at Federal Institute of Industrial Research Oshodi, Lagos, Nigeria. They were placed in transparent containers and were made to acclimatise for 5 hours. Thirty termites were collected and placed in three different plastic containers and methanol used as control. The mortality rate was taken at 20mins intervals for several hours and recorded.

3. RESULTS AND DISCUSSION

3.1 Yield

Table 1: Percentage yield of CNSL

Method	Temperature ^{0}c	Yield (%)
Roasting	40-80	11
Solvent	50-90	43.8

This table shows the results of the percentage yield of the CNSL using different methods of extraction. The solvent method gave 43.8% yield compared to the work done by (Smith *et al*.., 2003), who worked on the extractions of the liquid with one or more intermediate depressurisation steps, the yield increased to 94%. The roasting method gave a lower yield of 11%, this was compared to the work reported by (Subarrao *et al*.,2011) which was 6-12%, the low yield obtained in this study might be due to the species of cashew nut shell and the temperature ranges used for the extraction processes. The percentage yield was calculated using:

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{Theoretical yield}} \times 100 = \frac{438}{1000} \times 100$$

$$= 43.8\% \text{ (solvent extraction)}$$

$$= \frac{110}{1000} \times 100$$

$$= 11\% \text{ (roasting extraction)}$$

3.2 Physicochemical Properties Of The Cashew Nut Shell Liquid

Table 2: Physicochemical properties of the CNSL liquid

Parameters	Roasting extract	solvent extract
Appearance	Dark brown liquid	Dark brown liquid
Nature	Viscous liquid	Viscous liquid
Moisture content(%by weight)	1.00	1.50
pH	6.4	6.2

Specific gravity (30^0C)	0.9186	0.9336
Yield(%)	11	43.8
Viscosity(Mpas-1)	500	450
Acid value (mgKOH/g)	15.40	13.00
Refractive index	1.628	1.634
Saponification value (mgKOH/g)	140	137
Iodine value (mgiodine/100g)	241.22	212
Ash content (% by weight)	1.00	1.20

The appearance of the cashew nut shell liquid is brown viscous liquid, the moisture content obtained falls within the standard permissible values (1.0 and 1.5). The pH values obtained (6.4 and 6.2) was compared to the work done on pH (5.79) of CNSL by (Matthew *et al.*,2006), which is closer to the result obtained in the present study, recent evidences suggest that the variation in the pH might be due to environmental factor and the specie of the cashew nut shell. The liquid viscosities were (500 and 450(Mpas-1) respectively, which has been established that the viscosities differ due to different method used for the extraction in this study. The specific gravities obtained were (0.9186 and 0.9336), the values obtained are in agreement with findings of previous work done by (Akinhanmi *et al.*, 2008). The acid values obtained in this study were (15.4 and 13.0mgKOH/g) this takes into account the contribution of all the fatty acids in the oil, this is in Comparison with the findings of other studies confirmed by (Ekpa and Ekpe, 1995). This is the quality control parameter employed by paint manufacturers to monitor the concentration of acid in resins. The high iodine values (241.22 and 212) which is within the range specified as drying oil (220-270mgiodine/100g) is an indication that the liquid contained high degree of unsaturated organic components, therefore it can be classified as drying oil and could find applications in paints, varnishes and surface coatings. The saponification values were (140 and 137 mgKOH/g) respectively, is an indication that the liquid cannot be used for soap production. The acid values were 15 and 13 respectively which fall within the international standard and it is a recommendation that it can be used in paint production which is higher than the work reported by (Idowu and Abdulhamid, 2003). The ash contents were (1.00 and 1.2) these results are related to the fact that CNSL cannot be used in animal feeds.

3.3 Toxicity Test

Table 3: Laboratory Toxicity of CNSL to Termites Exposure period

Ratio	1-5	6-10	11-15	16-20	21-24	Total
00:100	0	0	0	0	0	10
20:80	0	2	0	4	4	10
40:60	0	4	1	2	3	10
60:40	1	4	3	2	-	10
80:20	2	5	1	2	-	10
100:00	4	6	-	-	-	10

CNSL: Methanol

The termite bioassay results shown that the cashew nut shell liquid is very active against termite. On observations, at the highest concentration 100%, some of the termites had started dying within the time interval of 30mins. In 20% concentration, death occurs within the interval of 4hrs while in 20%, 40%, 60%, 80% concentrations, they were getting weaker, none of the termites survived after 24hrs, Similar reports indicate that Anchonames difformis root extract have some potent effect as a wood preservative against termites (Oluyege *et al*., 2007). Laboratory work was also done to see if the methanol applied with the CNSL is not responsible in killing the termites as methanol is known to be toxic. The experiment was done using loamy soil and termites with methanol in petri dishes and observed. On observations, the termites did not die on the first day and even the second day and thereafter. From the experiment, we deduced that the methanol was not responsible in killing the termite.

4. CONCLUSION

From the study, it is deduced that the solvent extraction method using ethanol is the best because it gives off most of the cashew nut shell liquid, the solvent used for the extraction was recovered and reused. The high mortality rates achieved in the laboratory toxicity test indicates that the active components in CNSL are compound for termiticidal purposes.

5. REFERENCES

[1] Abitogun A.S., and Borokini F.B. (2009). Physicochemical parameters and fatty acid composition of Cashew Nut Anacardium Occidentale) Oil. Journal of Research National Development, 7(2).

[2] American Standard for Testing and Materials (ASTM) E1755-01. (2003). Standard method for the determination of ash in biomass.

[3] Azam-Ali, S. H. and Judge E. C. (2001). Small-scale cashew nut processing. Available Source: http://www.fao.org/AG/ags/agsi/Cashew/Cashew.html, December 3, 2006.

[4] Das, P. and Ganesh, A. (2003). Bio-oil from pyrolysis of cashew nut shell: A near fuel Biomass and Bioenergy 25: 113-117

[5] Elijah A. Taiwo (2015). Cashew Nut Shell Oil; A Renewable and Reliable Petrochemical Feedstock, Advances in Petrochemicals, Vivek Patel, IntechOpen, DOI: 10.5772/61096.

[6] FAO (2000). Cashew production in Africa, 1961-2000. Food and Agriculture Organisation of the United Nations. Production Database.
[7] Hartley, L. (1998). Secondary compounds within the Anacardiaceae. Available Source: http://www.colostate.edu/Depts/ Entomology/ courses/en570/ papers1998/ hartley.html, August 15, 2006.
[8] Jason, W.C., (2012). Exposure and use Data for cashew Nut Shell Liquid. United States Environment Protection Agency.
[9] Jason, W.C., (2012). *World Agriculture and the Environment.* Pg.268.
[10] Kubo, I.; Ochi, M.; Viera P. C. & Komatsu, S. - *J. Agric. Food Chem.,* 41, p.1012 (1993).
[11] Mattew O. E., F. Labake and E. Rita Ngozi 2006. Extraction of polyphenols from Cashew nut shell. Leonardo electronic, *Journal of practices and technologies* July-September. 107-112.
[12] Oluyege, A.O., J.S. Fabiyi and K.S Aina, 2007. Evaluation of Anchonames difformis root extracts foe wood preservation against termites. Proc. Akure –Humboldt Kellog/3rd SAAT Ann..Conf.. FUT-Akure, pp: 224:226
[13] Lomonaco D., Mele G., Mazzetto S.E. (2017) Cashew Nutshell Liquid (CNSL): From an Agro-industrial Waste to a Sustainable Alternative to Petrochemical Resources. In: Anilkumar P. (eds) Cashew Nut Shell Liquid. Springer,Cham
[14] Lubi, M. C. and E. T. Thachil (2000). Cashew Nut Shell Liquid (CNSL)- a versatile monomer for polymer synthesis. Brill Acad. Publ., 1385-772X., pp:123-153.
[15] Morais, T. C.; Pinto, N. B.; Carvalho, K. M. M. B.; Rios, J. B.; Ricardo, N. M. P. S.; Trevisan, M. T. S.; Rao, V. S. & Santos F. A. - Chem-Bio. Interact., 183, p.264 (2010).
[16] Palmer International, Inc. 2001. Developing Nature's Resources. Available Source: http://www.palmerint.com/global.html, September 1, 2006.
[17] Patel, R. N.; Bandyopadhyay, S. & Ganesh, A. - Bioresour. Technol., 97, p.847 (2006).
[18] Kumar, P. S.; Kumar, N. A.; Sivakumar, R. & Kaushik, C. - J. Mater. Sci., 44, p.5894 (2009).
[19] Kumar, P. S.; Paramashivappa, R.; Vithayathil, P. J.; Rao, P. V. S. & Rao, A. S. - *J. Agric. Food Chem.,* 50, p.4705 (2002).
[20] Setianto, W. B.; Yoshikawa, S.; Smith Jr., R. L.; Inomata, H.; Florusse, L. J. & Peters, C. J. - J. Supercrit. Fluids, 48, p.203 (2009).
[21] Subbarao S. and R. Viswanathan (2003). Thermal Properties of Minor Millet Grains and flours. Biosystems Engineering 84(3): 289-296.
[22] Venmalar, D.and H.C. Nagaveni, 2005. Evaluation of copperised cashew nut shell liquid and neem oil as wood preservatives. Paper prepared for 36th Annual Meeting of the International Research Group on wood protection. Bangladesh, India.

