Journal of Environmental Science and Technology

ISSN 1994-7887

science alert

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OPEN ACCESS Journal of Environmental Science and Technology

ISSN 1994-7887
DOI: 10.3923/jest.2018.233.237

Mini Review
Conversion of Kola Nut Waste into Beneficial Products for Environmental Protection

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Abstract

This paper reviewed beneficial products accrued from kolanut wastes (a typical agricultural waste) generated from kolanut farming in West Africa particularly Nigeria, as a remediation strategy to several environmental pollutions associated with agricultural wastes. Some of these products discussed include; soaps, poultry feeds, biogas, substrates for microbial enzyme production and medicines. Conversion of kolanut husk into beneficial products will reduce dependence on importation of some goods thereby improving the economy through industrialization and job creation. The paper recommends conversion of kolanut wastes and other wastes due to its numerous benefits as a means to attaining the sustainable developmental goal and securing mother earth from damage caused and still been caused by man's activities.

Key words: Agricultural waste, kolanut waste, enzyme production, kolanut farming, environmental pollution, earth, sustainable

Citation: Fabunmi Temitope Bukol, 2018. Conversion of kola nut waste into beneficial products for environmental protection. J. Environ. Sci. Technol., 11: 233-237.

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

About 36 million ha of land utilized for agricultural purposes have been reported to generate annual estimated agricultural wastes of about nine million, nine hundred and eight thousand tons[1]. Intervention program under the Nigeria agricultural transformation agenda for example, was anticipated to increase rice production from about 2.7×10^6 to 6.0×10^6 Mt to cater for the increasing Nigerian population, leading to a corresponding increase in both straw and chaff waste with no intentions for the generated waste[2]. These wastes have been mismanaged with attendant environmental consequences such as eutrophication, flooding, disease outbreak etcetera, which requires an urgent and effective management strategy to curb these menaces[3]. Generally, famers are only interested in the farm produce and thus indiscriminately disposing the agricultural by-products into the environment. Kolanut fruit, an economic cash crop used for several purposes with world production of 300,000 t and Nigeria accounting for about 70% of the total world production[4].

The residues in recent times are inconsiderately left at the farm site, dehusking sites, dump sites or burnt without considerable envisaged usages. A long-standing economic and environmental concern has thus been raised, resulting in tremendous increase of research towards the conversion of generated wastes to wealth. The aim of this review is to communicate the usage of kolanut wastes, which span several purposes such as soap, animal feed, feedstock in biogas production, substrate for microbial enzyme production and some other products of interest and importance. Agricultural by-products are very nutritious, making them a good substrate for the growth of different forms of micro- organisms which could be detrimental or beneficial. Instead of allowing these agricultural waste to be a source of menace to humanity, under adequate conversion techniques it can be become useful.

DERIVABLE PRODUCTS FROM KOLANUT WASTES CONVERSION

Soap: Soap, a substance used with water for washing and cleaning is made of natural oils or fats with sodium hydroxide or another strong alkali and some other chemicals of importance in soap making. Some of these chemicals are usually imported into Nigeria and resulting to relatively expensive end products. As at 1984, an annual estimate of about fifteen thousand tonnes of sodium hydroxide were derived from kolanut husk in Nigeria, a quantity sufficient to meet up the demand for 26,000 t of sodium and potassium hydroxide imported into the country[5]. Ash derived alkalis produced by burning agricultural waste definitely serves as a good alternative to caustic soda for the manufacture of soap due to the considerable amount of potassium and sodium present, that can produce hydroxides when dissolved in water[6]. This instigated several researchers[7-12] to employ agricultural wastes such as kolanut husk/pod, cassava peels, rubber seed oil and almond leaves in the place of commercially sold sodium hydroxide for soap making. The results of their findings revealed agricultural derived alkali to be a good influence to the establishment of alkali manufacturing industries in areas dominated with agricultural practices. This is hoped to reduce importation of synthetic alkali, boost the production/usage of locally made soaps with attendant job creation.

Apart from the strain of importing synthetic alkali to the economy of developing countries like Nigeria, the effect of synthetic chemicals used in soap making to human and the environment at large should prompt researchers to develop adequate techniques for transforming natural resources such as agricultural waste to replace use of synthetic chemicals, in order to protect the environment from the harshness caused by these synthetic chemicals. Soaps contain chemical additives to make it lather properly and it also contains fragrances known to cause irritation in some people, skin disease, liver damage and contains cancer-causing chemicals. However, these fragrances can be obtained from natural aromatic pretty flowers. Also, the use of natural alkali as oppose synthetic alkali. In addition to using natural resources for production of cleaning agents, manufacturers of cleaning products such as soap can be made to contribute to the enhancement of environment and health sustainability by adopting responsible formulations and production of environmental friendly products.

Poultry feed: Feed is composed primarily of a mixture of different feed ingredients such as cereal grains, animal by-product meals, soybean, fats, vitamin and mineral premixes. Combination of the feed ingredients with water provides energy and nutrients required[13]. Feed formulation requires a technique which enhances the usage of local feed stuffs in balanced ratio, putting into consideration; the specific nutrient required at each stage of growth and ingredients of the feed as a whole (that is availability of raw materials, price of raw materials and presence of anti-nutritive factors). Nutrients are substances classified as chemicals found in food

(feeds) required for the growth, production, maintenance and health of the animals[14]. Emiola *et al.*[15], Hamzat and Adeola[16] and Fabunmi and Arotupin[17] have reported the nutritive values of kolanut husk. Their findings have been adopted by different researchers to replace maize in feed formulation at different proportion. Sobamiwa[18] and Olubamiwa *et al.*[19] utilized kolanut meal at 60% inclusion as substitute for maize in layers diet and testified improved egg shell thickness. Oluokun[20] fed kolanut husk diets to rabbits with observed result of an improved weight gain. Babatunde and Hamza[21] and Hamzat *et al.*[22] have fed kolanut husk meals to cockerels and broilers at different graded levels to replace maize with considerably good growth performance. Kolanut husk meal have been resorted to be the way out of the economic burden placed by the increasing cost of feeds but high percentage of kolanut husk have been reported to have detrimental effect on the growth performance of basically poultry animals. Emiola *et al.*[15] and Akinbomi *et al.*[23] recommended kolanut husk to replace maize in poultry diet for broilers, thereby reducing dependence of feed millers on maize with a corresponding decrease in price of poultry feed.

Kolanut as feedstock for biogas production: Wastes from agricultural crops are potential sources of energy in Nigeria where farming is practiced. Theses wastes may consist of rotten and infected crops due to poor storage and diseases and residues produced from crop processing during and after harvesting[24]. Toxic organic compounds are released directly or indirectly into the environment over a period of time by agricultural activities due to improper disposal of the wastes. Biological decomposition has been suggested as one of the ways by which waste disposal problems can be reduce at least if not totally eradicated[25,26]. Different agricultural wastes have been tried for biogas production by researchers with varying biogas yield recorded. These included the conversion of sugar cane into solid fuels by Akpabio and Illalu[27] and Ezekoye *et al.*[28] used poultry waste and cassava peels as feedstock, Neo *et al.*[29] used wheat straw/and activated sludge, Chukwuma and Orakwe[30] used cattle waste, Tokan *et al.*[31] utilized sawdust and corncobs as source of energy generation, Umeghalu *et al.*[32] used jack fruit waste by co-digesting it with cow paunch and poultry wastes, Fabunmi[23] used kolanut husk and cattle paunch waste singly/co-digested at different ratios. These researchers have reported good biogas yield from these sources and if biogas technology can be adopted in Nigeria, it will provide benefits such as energy for cooking, lighting, heating, job creation, air pollution reduction and an alternative solution to waste management. Nigeria has to consider creating biogas generation plants towards proper management of wastes, thereby creating employment opportunities and also protecting the environment. Researchers are also encouraged to apply their research findings in sensitizing farmers on how to utilize these wastes for biogas production and teaching them how to construct digesters with the available local resources. In the 20th century, feed stuffs such as corn, wheat, meat scrap and milk products were readily available for poultry but nowadays, feed industry is faced with selection of feedstuff from a wide range of options, due to an upsurge in population resulting in competition between man and his animal for same food, hike in price of feed ingredients and low yield of farm produce after harvest.

Kolanut husk as substrate for production of microbial enzymes: Enzymes are proteins, functioning as biological catalysts without which, no biochemical and cellular reactions would occur over periods of time[33]. There are different classes of enzymes, with the hydrolases having application in the industries. This class of enzyme is the most frequently used enzyme in biotechnology basically because they are active on many natural substrates. Hydrolytic enzymes produced by micro-organisms are currently used by industries and have been the principal source of different enzymes identified after extensive research[34]. Micro-organisms are fast growers with ability to grow on different substrates and they can be manipulated or engineered to produce enzymes of interest at high quantity provided the required condition for production is adequate. Xylanase, for example has found usefulness in bleaching processes, bioconversion of lignocellulosic material, clarification of juices, improve the consistency of beer and in the digestibility of animal feed stock. It can be used in the saccharification of xylan in agricultural wastes and other agrofoods[35]. However, commercially available substrates for the production of enzyme from microbial source are relatively expensive, especially in developing countries where these products are been imported. Since agricultural by-product are nutritive and can serve as food to micro-organisms, researchers has found it as a suitable alternative to synthetically produced substrates. Heck *et al.*[36] reported the use of several agricultural wastes such as banana fruit, soybean and rice wastes as good substrate for cellulase production. Palaniyappan *et al.*[37] also screened natural substrates for production of pectinase using wheat flour, corn flour and pectin (a commercial substrate). However, summary of their findings revealed better performance of wheat flour compared with the synthetic substrate (pectin). Fabunmi[23] utilized kolanut husk as substrate for the production of xylanase, pectinase, protease,

cellulase and amylase. Kolanut husk was reported to be a good substrate for the production of the screened microbial enzymes. The micro-organisms were documented to respond differently to the kolanut husk, which was attributed to difference in growth rate of the micro-organisms. Over time, agricultural residue has been proven to be a suitable substrate for enzymes production by micro-organisms. This will reduce dependence on costly synthetic substrates and a reduction in the price of products been produced with the enzymes.

Other products: Chemically treated kola nut pod[38] as low-cost natural adsorbent for the removal of 2,4-dinitrophenol from synthetic wastewater and reported it to be a good alternative. The fruit pulp (testa) of kolanut can be used for the treatment of jaundice, production of candles and for snail feed formulation[39]. Fabunmi[40] reiterated the use of fresh testa as traditional medicines for stomach pains and in the reduction of labour pains when mixed with some additives. Kolanut has found use in culture and industries for the development of new pharmaceutical and food products. The leaves, twigs, flowers, fruits follicles and the bark of both *C. nitida* and *C. acuminata* has been used traditionally to prepare tonic as a remedy for dysentery, coughs, diarrhoea, vomiting and chest complaints[41]. Extracts from *C. nitida* bark has been tested on some pathogenic bacteria and has been found to be active against the organisms. Also, extract from this specie of kolanut has also been reported to prevent the release of luteinizing hormone from rat pituitary cells and could regulate gonadotropin release thus, making it a potential natural fertility regulator[42].

CONCLUSION

Agricultural waste can easily be degraded by microbial action, making this type of waste more promising in producing important products useful to man. This paper has reviewed several beneficial products which can be accrued from the conversion of kolanut waste, an abundant waste in south-western part of Nigeria. Routine waste conversion when imbibed will be an alternative solution to the ineffective agricultural waste management in regions where agriculture is practiced. This process will also safeguard mother earth from the looming climate change and serve as an economic source in achieving some of the set sustainable developmental goals. It is recommended that agricultural waste collection center be establish to allow for easy access to the wastes for conversion to useful products, by so doing reduce; environmental pollution caused by indiscriminate disposal of this category of waste into the environment, dependence on synthetic chemicals and importation of raw materials.

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