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Production of essential/fragrance oil from pineapple peel extract for direct perfume formulation to enhance efficient waste management

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Abstract

Sustainable and effective waste management is an enormous task all over the globe especially in developing countries like Nigeria. And poor waste management basically is termed to be the second most troublesome issue affecting developing countries after portable water. Therefore, pineapple peel which is a solid waste was employed for the production of essential/fragrance oil using soxhlet extraction method and the oil extract were further used for perfume formulation with the application of n-Hexane as the solvent media. At the temperature of "65 °C" and "150 minutes", the maximum oil yields obtained during extractions were "1.96%" and "1.97%" respectively. The quality and strength of the perfume obtained after formulation falls in the ranges of "15 to 20%" fragrance concentration of Eau de Parfume that can last 4 to 5 hours. Some major physiochemical parameters of the pineapple peel such as pH, API and acid values recorded 3.79, 27.476 and 2.946 mg KOH/g respectively. Other parameters were density and specific gravity also have 0.8765 and 0.8875 @ 20 °C indicating lightness above water, but the viscosity was 0.757 kg/L which was higher than the viscosity of water. Also, refractive and ester index were 9.35 and 6.404 respectively.

Keywords: Pineapple peels; Waste management; Sustainable; Perfumes; Environment; Essential oil; Solvent; Extract; Perfume; Fragrance; Formulation; Yield

1. Introduction

Organic wastes from fragrant plants and fruits can be used to make essential oils and for perfumes formulation. One of such plant is the pineapple wastes. Pineapple is a tropical fruit that is readily available all around the world. It is from the Bromeliaceae family and is also known as Annas Comosus (UNCTAD 2016). Pineapple (Annas Comosus) is one of the most important tropical fruits worldwide, contributing to over 20% of the world production of tropical fruits (Wijeratnam 2016). Pineapple is generally consumed fresh which accounts for about 70% of the total world production (FAO 2005, Coveca 2002). However, sustainable waste management is an enormous task all over the globe especially in developing countries like Nigeria due to factors such as poverty, increase in population, urbanization, and lack of proper governmental funding (UNEP 2002). Generally, the pineapple fruit is termed to be a tangy cousin to all fruits, because of its numerous benefits to mankind as its interiors are delicious, pulpy and crunchy. Thirty-six compounds have been identified, accounting for 86.7% of the oil its composition. The major constituents were myrcene (28.5%), (E)-β-farnesene (23.4%), germacrene D (6.8%), geranyl isovalerate (6.4%) and (Z)-en-yn-dicycloether (8.1%). However, it is not everyone that considers or knows the usefulness of pineapple peels except those who consider it to be an agricultural waste that distorts the atheistic outlook and natural views like several other wastes which are poorly discarded or discharged into the environment. Similarly, other waste parts of the pineapple consist of its residual skin, pulps, stem, and leaves which are by-products of the pineapple processing industries and are mostly generated from poor handling of the fresh fruit, storage, or lack of good and reliable transportation system (Praveena and Estherlydia 2014). In recent years pineapple peels have been used for several purposes which are not limited to commercial

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pineapple oil or Indian verbena oil which has a reddish yellow colour with an intense odour and taste, a small amount of its oil is used in making soap, detergent and other preparations (UNCTAD 2016). At present agricultural-based waste discharges account for about 30% of total industrial waste generated including liquid, residues, and refuse (Ashworth and Azevedo 2009), and pineapple peels consequently are named among them. Pineapple peels also contribute to the negative effect on our ecosystem (Praveena and Estherlydia 2014), as poor waste management especially solid wastes which are termed to be the second most worrisome issue affecting developing countries after water quality (Senkoro 2003). In the same vein, at the present times, among developing countries, Agro-industrial wastes have now found their use in different areas such as cosmetics production, biofuels, medicines, germicides and insecticides (Agbafor and Akubugwo, 2007). Furthermore, there are better ways of utilizing and converting these wastes into several usable and valuable products such as soap making, oil, clothing, perfumes etc. though perfuming formulation from its fragrance oil is one of the innovative ways of solving the organic waste problem in the environment.

While most fragrant liquids used for the body are often referred to as perfume, true perfumes are defined as liquids that contain fifteen per cent fragrant oil distilled in alcohol. Traditionally perfumes were made from plant and animal substances and prepared in the form of water, oils, unguents, powders, and incense. A perfume is made up of complex fragrances; it comprises three notes which are the base notes, middle notes and top notes. The base note is the final scent of a perfume that is noticed only after the perfume has had time to dry. The smell that develops after the perfume has mixed with unique body chemistry is referred to as the middle note and the top note is the first smell experienced in an aroma (Sakwe and Uku, 2023). In modern times perfumes are now utilized in a wide range of areas as opposed to pre-historic times when it was solely used to send homes and skin. Most products now contain fragrances as part of their ingredients just to appeal to the sense of smell of the consumers. Some products are even perfumed with industrial odorants to mask unpleasant smells or to appear "unscented." (Mbuligwe and Kassenga 2004)

The use of pineapple peels is so cogent that it will be a valuable product that eventually will add to several other natural/organic and man-made products in applying to the natural bodies and clothes as well as scents for its unique aroma into the environment. Pineapple peel is also known to be a by-product resulting from the processing of pineapple into slices and that represents about 10% (w/w) of the weight of the original fruit (Kareem SO, Akpan I, Alebiowu OO, 2010). For sustainable utilization of pineapple peels into a value-added product as perfumes, it will automatically reduce the wastage; enhance commercialized viable product, as well as an environment-friendly alternative to enhance quality and effective waste management. Alternatively, Sakwe and Uku (2023) observed that the production of high-end perfumes can be made from underutilized plants that can serve as sources of essential oils. Essential oils are made from various parts of plants, such as stems, leaves, roots, and flowers (Hesham, Rassem *et al.,* 2016). Precisely, various techniques can be employed in the extraction of essential oils and the formulation of perfumes. Over time, different techniques are employed in the extraction to increase oil output and regulate the oil's composition (Sakwe and Uku 2023). But, effectively, there are three main procedures for essential oil extraction such as solvent extraction method (Suryawanshi *et al.,* 2016), Hydro-distillation method (Jigisha K. Parish *et al., 2011),* and effleurage extraction method (Albrigi inherb, 2014). Above these three, solvent extraction techniques could be more applicable, though for fragile plants it helps to achieve a better yield of essential oil with a smaller amount of harvesting (Chrissie *et al.,* 1996, Sakwe and Uku 2023). Perfume aromas help to kill and alter foul odours in the living environment and also, it is used for aromatherapy which is a form of relaxation exercise (Coulson *et al,* 2003). To attain sustainability in waste management requires environment-friendly alternative schemes and methods. Such techniques must be effective, efficient, and less costly for sustainability and practicability. Therefore the conversion of known agricultural waste as pineapple peels to a viable product such as perfume which is environmentally friendly as well as serves as a scent producing its aroma to the environment is quintessence.

2. Methods and materials

2.1. Experimental Materials

2.1.1. Pineapple Peel

The fresh Pineapple peels were collected from local vendors at the Yenagoa ultra-modern market before discarding into the market sub-dumps, washed and dried in a shaded moisture free environment.

2.1.2. Other Experimental Materials

All other experimental materials employed in this research include chemicals (n-Hexane, diethyl-ether, ethanol, potassium hydroxide, benzyl salicylate etc.) Glassware (Duran beakers, conical flasks, round-bottom flasks and decanters), equipment (Digital Weighing Balance - Model No.FA2104, Heating Mantle, Viscometer-Model NDJ-55 and

Electronic Sieve Shaker), other materials used were Rubber Stopper, Ice cubes maker, knives, Olive oil, Aluminum Foils and Electronics Grinder.

2.2. Determination of oil yield

The oil yield was determined by weighing the extract with the digital weighing balance at the successful experimentation.

% oil yield (w/w) = (Weight in gram of extracted oil)/ (Weight in gram of sample)

2.2.1. Physicochemical analysis of the extracted pineapple peel

Table 1 Physiochemical properties of Essential oil of Pineapple peel

Physio-chemical properties	Essential/Fragrance oil of Pineapple peel
Acid Value	2.946 mg KOH/g
API	27.476
Colour	Yellow-Green
Density	0.8765
Ester Index	6.404
Odour	Specific
Ph	3.79
Refractive index	9.35
Specific Gravity	0.8858 @ 20 °C
Viscosity	0.757 kg/L

Some major physicochemical properties of the extract from the Pineapple peel were also evaluated such specific gravity, acid index, ester index, refractive index and pH etc. (Table 1). It was determined in accordance with the Association of Official Analytical Chemist (AOAC), Specific Gravity Value by the methods of Pearson (1976) and API value (Pranabashis et al, 2009).

3. Results and discussion

Results obtained during the experimental procedures in this paper are all in summary as presented in Tables 1, 2, 3 and 4 respectively.

Table 2 Results For Solvent Extraction with varying time

Dried sample (g)	Time(minutes)	Oil Extract (g)	Yield (%)
130	30	2.13	1.64
127.89	60	2.21	1.73
125.74	90	2.28	1.81
123.45	120	2.32	1.88
121.16	150	2.39	1.97

Table 3 Results For Solvent Extraction with varying temperature

Dried sample (g)	Temp	Oil Extract (g)	Yield (%)
130	45	2.12	1.63
127.91	50	2.19	1.71
125.74	55	2.28	1.81
123.50	60	2.33	1.87
121.21	65	2.37	1.96

Table 4 Particle sample powdered sieved of pineapple peel Analysis

Sieve Number	Diameter (mm)	Initial Dry Sample (g)	Final Dry Sample (g)
8	2.36	1200	29.00
10	2.00	1171	50.30
12	1.70	1120.7	72.80
20	0.85	1047.9	262.90
30	0.60	785	277.60
40	0.425	507.4	280.70
60	0.25	226.7	96.60
Pan		130.10	0.20

Pineapple peels as waste were obtained from vendours at the Yenagoa ultra-modern market in Bayelsa State as a control mechanism not to be discarded to the market sub-dump which was part of waste management. The pineapple peels were extracted and essential/fragrance oil was obtained, and the oil was further formulated to a usable perfume product. However, a Soxhlet extraction technique which is a better solvent extraction method was employed to obtain the essential/fragrance oil from the pineapple peel. The pineapple peels were washed thoroughly with clean water, it was sundried for 3 days and later oven dried for 24 hours before crutching it to powdery form then sieved at the laboratory. The sieving analysis was performed at the Chemical Engineering Department, Federal University Otuoke (FOU). The sieve was stacked and vibrated on a sieve shaker for half hour (30 minutes) at amplitude of 60 with a test sieve. The crutched powdered sample were then sieved and stacked on various sieves with sieve numbers such as 8, 10, 12, 20, 30, 40, 50 and 60 respectively. A total weight of "1200 g" of the dried crutched powdered pineapple sample was weighed and poured into the topmost stacked sieve with sieve number 8, a timer was set on and the electronic sieve shaker was turned on for 30 minutes interval for all the seven sieves until final results were obtained. After each timed interval the shaker was turned off and the powered sample was weighed, recorded before pouring to the next sieve. This process was duly carried out on all the seven sieves and at the same time interval until final result of "130.10 g" was obtained (Table 4)

On achieving the fragrance oil extract after proper sieving of the crutched powdered pineapple sample, the "130 g" of the dry sample were poured into a 500 ml clean flat bottom flask. 500 ml of N-hexane solvent were poured into the 500 ml flask, and the mixture was allowed to stay for a period of 1hour. This process was done to extract all the oil content in the dried powdered pineapple peel sample. After the complete extraction, the extract was decanted into another 500 ml beaker. 200 ml of ethanol were poured into the extract since the fragrance oil is soluble in ethanol. The mixture was later transferred into a 500 ml separating funnel for liquid/liquid separation process. The lower was ethanol extract and the upper was N-Hexane layer were collected into two separate 250 ml beaker and were placed in a water bath at 40 ^{o}C. This was done to remove the ethanol leaving the natural essential/fragrance oil, and the yield oil extract was determined with respect to varying time and temperature shown in Table 2 and 3 as well as figures 1 and 2 respectively. The yield increases with respect to both time and temperature, though at maximum of "150 minutes" and "65 ^{o}C" to avoid yield disintegration.

On the perfume formulation, 15 ml Olive oil as the carrier oil was placed inside a beaker containing 25 ml of 43% volume of vodka. An addition of 15 drops of lavender as sensualized base note were used, then 25 drops of the pineapple peel fragrance oil serves as the middle note and 10 drops of sandalwood as the top note. To improve the perfume lasting time, a fixative reagent of 5 ml benzyl salicylate was added to the solution, covered and was domiciled at room temperature at a dark corner which allowed the distinct quality scents becomes perceivably strong after much interaction and well mixed. Later the formulated product was transferred into a plastic bottle via a funnel, then corked, covered and kept in a cool dark undisturbed area for normal aging period of three weeks before future and effective usage. Comparatively, the quality and strength falls in the ranges of 15 to 20% fragrance concentration of Eau de Parfume that can last between 4 to 5 hours and it can be graded above Eau de Cologue fragrance concentration of 2 to 4% which contains higher alcohol (Sakwe and Uku, 2023).

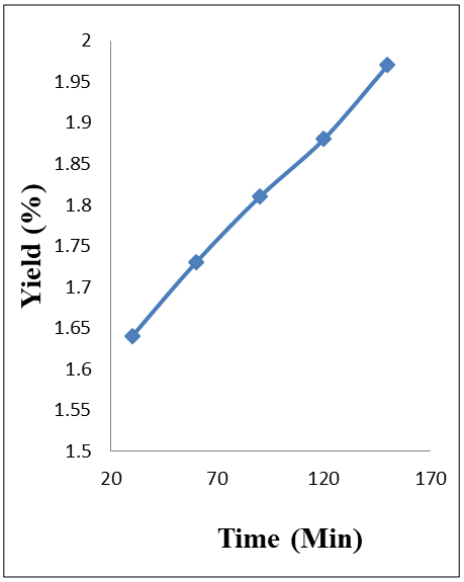

Figure 1 Graph of Yield against Time

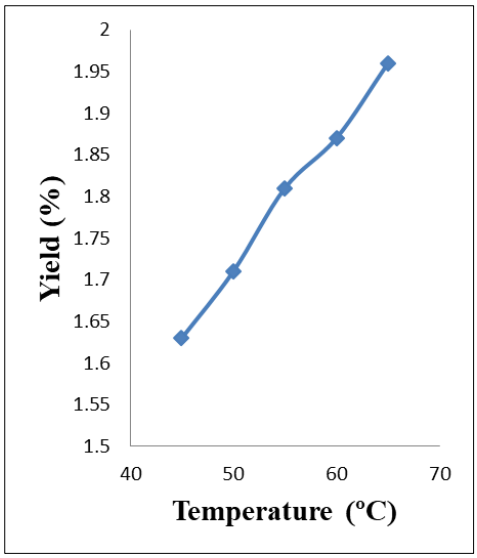

Figure 2 Graph of Yield against Temperature

Similarly, Table 1 shows some major physiochemical parameters of the pineapple peel essential/fragrance oil were also determined and the pH and acid value only were compared to Nadya et al., 2012 who recorded pH and acid values as values 3.85 and 0.32% respectively. It was determined with respect and in accordance to the Association of Official

Analytical Chemist (AOAC), Specific Gravity Value by the methods of Pearson (1976) and API value (Haldar et al, 2009). The density and specific gravity of 0.8765 and 0.8875 @ 20 °C indicates of its lightness above water but its viscosity at 0.757 kg/L was higher than that of water. Other parameters considered were API value as 27.476, refractive and ester index were 9. 35 and 6.404 respectively, though not compared to other literatures.

4. Conclusion

In proper effective and compliance practices in waste management, it is advised that before any waste is ready to be disposed, it must first be considered whether such waste can be reused, recycled, recovered or treated. And pineapple peel which is one of the four wastes produced from pineapple (Annas Comosus) plant which includes the skins, leaves, stems and peels, it is of essence that the pineapple peels should no longer just be seen as a disposable agricultural waste, but can be converted to other viable and usable products such essential/fragrance oil and perfume to possibly enhance a cleaner environment. In this regards, essential/fragrance oil was produced from pineapple peels using soxhlet extraction techniques which is a form of solvent extraction yielding a maximum oil output of "1.96%" and "1.97%" at a temperature of "65 ^{o}C" at "150 minutes" respectively. The fragrance oil was further employed in the formulation of usable perfume products that falls in the fragrance concentration of 15 to 20% known as Eau de Parfume that can last between 4 to 5 hours. Conclusively, this research has not only solve the problem of pineapple peel wasteful discharges to the environmental, but it has serve as a means of creating jobs and helps to improve body scents in humans and living environment.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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