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Extraction and Characterization of Selected Carrier Oils

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Extraction and characterization of carrier oil has been conducted experimentally on coconut, avocado and carrot oil. FTIR scan analysis was carried out on the extracted oil. Also physical and chemical properties of the carrier oils were assessed to evaluate oil quality including Specific gravity, peroxide value, saponification value, acid value and free fatty acid. The result showed all the extracted oils were liquid at room temperature an indication of the presence of oleic acid and linoleic acid and other unsaturated fatty acids. The specific gravities of 0.92, 0.91 and 0.93 for coconut, avocado and carrot oils indicate that each of the oils could be used on commercial scale. The Peroxide value recorded 0.11-0.12 meq/kg which is far below the maximum limits of 1-5 meq/kg and can last for a long time without going rancid. The low saponification values of coconut, avocado and carrot oils of 127.62 meq/kg oil, 120.12 meq/kg oil and 130.47 meq/kg oil respectively indicates that the oils could be used industrially (soap making). An iodine value of 54.63g I_2/100g coconut oil, 49.21g I_2/100g avocado oil and 55.01g I_2/100g carrot oil obtained indicates high level of unsaturated fatty acids and can explain its liquid state on storage at room temperature. Acid values of 6.10 mg KOH/g coconut oil, 9.40 mg KOH/g avocado oil and 6.50 mg KOH/g carrot oil indicated that the oils are acceptable for industrial purposes. The % FFA values obtained as 3.10%, 4.70% and 3.30% for coconut, avocado and carrot oils respectively indicates the suitability of the oils for consumption. The FTIR scan analysis showed the various compounds present in the oils and by indication presented that coconut oil have dominant properties over that of carrot oil and should not be used

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as base oil for its extraction. Carboxylic acid (effective in providing antioxidant and anti-aging protection as well as improving moisture retention) and aromatic groups were found present as well as esters (excellent hydrating and softening agents). These compounds are found in all vegetable oils thereby validating their quality and explain the excellent properties of carrier oils and why they are used in conjunction with essential oils for aromatherapy purposes as well as for human consumption.

Keywords: Carrier oils; extraction; characterization; oil quality.

1. INTRODUCTION

Due to an increase in the demand for plant and animal based oil products and the medical awareness of the therapeutic properties of essential oils, there is the growing need to evaluate the quality of carrier oils in terms of their composition and properties [1]. Carrier oils are of plant origin which are usually applied in diluting essential oils, usually obtained from fatty parts of a plant (the kernels of nuts or seeds). Although there are several other carriers that can be used in diluting essential oils such as base lotions, carrier oils are commonly used due to their versatility. Further to their growing usage and application, the quantity of compounds present in carrier oils is attraction several investigation. These has shown that there are several under-exploited carrier oils in the world.

Carrier oils, otherwise be referred to as fixed, base or vegetable oils are used to dilute essential oils which are usually concentrated before they are used in aromatherapy. They are referred to fixed oils because they do not evaporate unlike essential oils which contain volatile compounds and are easily given off [2,1]. Since these oils do not evaporate, they carry on the essential oils into the human body; hence the name 'Carrier oils'. They are usually light and non-sticky for this penetration to be effective, and preferably have little or no odor [3].

Carrier oils play a very essential role in aromatherapy than is realized. When compared to essential oils, they are seen as of little importance. To believe this would be a mistake though, because they offer a wealth of health-giving benefits [3]. Researches show that carrier oils contain vitamins, minerals, and essential fatty acids that are helpful in softening and improving the skin [2]. They make up 98% of a typical aromatherapy treatment and are very useful in treating irritated sensitive skin conditions such as eczema and psoriasis. They aid in reducing wrinkles and scar tissue.

Coconut oils are vegetable oil extracted from the coconut palm known as Cocos nucifera L. Coconut palm is the most extensively grown and used palm in the world with approximately 12 million hectare in cultivation [4] serving as a major source of income and food for about 10 million families from over 80 countries. Coconut oil plays a very distinctive role in diet due to its health and nutritional benefits. It is mainly comprises of lauric acid (47.5%) which is a low molecular weight saturated fatty acid. Coconut oil has a very long shelf life and can stay for a long period of time without going rancid; as such it is very stable and does not require refrigeration as it contains saturated fatty acid with all its carbon-atom linkages filled or saturated with hydrogen.

Avocado oil is edible oil pressed from the fruit of avocado known as Persea americana. It is used as cooking oil, for lubrication and in cosmetics due its moisturizing property. Food-grade avocado oil is increasingly making its mark on international shelves. Mexico is the largest producer of avocado in the world due to their fertile soil and wonderful climate with 45% of the world production. The Avocado pulp contains 5 to 30% of oils. The oil is extracted from ripe but not over-ripe avocado fruit. Avocado oil functions well as carrier oil for other flavors. It is high in monounsaturated fats and vitamin E, enhances the absorption of carotenoids and other nutrients.

Carrot oil is known for its excellent antibacterial and healing properties. Carrot oil possesses a softening property and therefore lubricates the cells in the outermost layer of the human skin. It aids in bringing back moisture which is lost from the human skin, making it an excellent recipe in moisturizers; and are hence used in repairing dry hair and skin. The healing properties of carrot oil also allow it to soften up the skin tissues. Hence they are considered as an important ingredient in products used for the treatment of eczema and other skin related issues.

This experimental study will evaluate the physicochemical characteristics of the extracted coconut, avocado and carrot oil by assessing the oil quality including Specific gravity, peroxide value, saponification value, acid value and free fatty acid oils to determining its stability and utilization. However, its Fourier Transform Infrared Spectroscopy analysis was carried out in determining these compounds present in the oils. The present study aimed to elucidate quality characteristics of selected carrier oils after extraction and characterization from coconut, avocado and carrot oil. FTIR scan analysis, physical and chemical properties of the carrier oils were assessed to evaluate oil quality including Specific gravity, peroxide value, saponification value, acid value and free fatty acid.

2. MATERIALS AND METHODS

2.1 Plant Materials

2.1.1 Cocos nucifera

The fruits (17 pieces) of cocos nucifera were collected from the tree at Ozuoba, Obio-akpor local government area of Rivers state Nigeria. The harvested fruits were dehusked to reveal the shell. Deshelling was carried out and the coconut flesh washed and dried under the sun. It was further ground to a particulate size of 2 mm to increase the surface area for more efficient and effective extraction. Water was then added to the ground coconut to produce its milk and the milk was filtered into a large bowl using a muslin sieve which is left unattended to for at least 24hours in order to allow for the separation of the coconut milk from the water present in the milk.

2.1.2 Persea americana

30 medium sized avocados were obtained and washed. The flesh was then scooped out into a bowl for further processing after which it was put into a blender for mashing into a puree. The properly ground puree was then spread out in a flat pan and placed directly under the sun to dry for 2 days.

2.1.3 Carrot root

10 small sized carrots were obtained, cleaned and washed. The washed carrots are dried and then grated into smaller pieces to increase surface area in order to aid extraction.

2.2 Extraction of Oil

2.2.1 Coconut oil

After separation has occurred the milk at the top is scooped and heated on fire at 100-120℃ for 60 minutes until all the water content evaporates and the oil forms. The oil is sieved using a muslin cloth/sieve to separate oil from copra meal used as a biodiesel. The water is discarded and the oil is allowed to cool.

Bottle the pure coconut oil is bottled and stored in a cool dry place; it is preferable to refrigerate. At the end of the extraction, the muslin sieve containing the copra meal was removed and used as feed for poultry.

2.2.2 Avocado oil

The dried flesh is scrapped out of the pan and placed into a muslin cloth for extraction of the oil. The cloth is then squeezed to obtain oil which is sieved and put in a bottle for proper storage.

2.2.3 Carrot oil

Carrier oil (coconut oil) is heated on fire for a few minutes under low heat. The grated carrot is then poured into the oil on fire and allowed to cook under very low heat for 30 minutes. The oil is then allowed to cool and strained. Bottling of the carrot oil takes place for storage and the carrot is discarded.

2.3 Physicochemical Analysis

Analytical methods were employed using various laboratory equipment such as beakers, pipette etc. for the determination of physical (specific gravity, smoke point) and chemical (saponification value, acid value, peroxide value, % FFA, iodine value, FTIR analysis) properties of the oils.

3. RESULTS AND DISCUSSION

The results obtained from the characterization of coconut, avocado and carrot carrier oils are presented as follows.

The selected extracted oils are liquid at room temperature and pale yellow, greenish yellow and orange in color for coconut, avocado and carrot oils respectively with an agreeable odor. The liquid state of the oils at room temperature however is an indication of the presence of oleic acid and linoleic acid and other unsaturated fatty acids. The specific gravities of 0.92, 0.91 and 0.93 for coconut, avocado and carrot oils indicate

that each of the oils could be used on a commercial scale. Unrefined coconut and carrot oil smokes at 170°C (350°F) while refined coconut oil has a higher smoke point of 232°C (450°F). Avocado oil has an unusually high smoke point, both unrefined and especially when refined. The smoke point of the sample unrefined avocado oil is 480°F (249°C) and can have a smoke point up to 520°F (271°C) when in its refined form. The exact smoke point depends heavily on the quality of refinement and the way the oil has been handled up until reaching store shelves and subsequent kitchens. Heating oil past its smoke point creates toxins and free radicals.

Peroxide value is used as an indicator of deterioration of oils. A product with peroxide value between 1-5 meq/kg is classified at low oxidation state; that between 5 and 10 meq/kg is classified at high oxidation state. However, CODEX gives a peroxide value limit of 15 meq/kg for virgin oils in general [5]. The peroxide value obtained in this study showed that 0.11-0.12 meq/kg was far below the maximum limits. This indicates that these oils can be stored for a long period of time without going rancid.

Saponification value is used in checking adulteration of oil. Oils with low saponification value can be used for the production of soap, candle and raw materials for lubricants (Agatemor, 2006). The saponification values of coconut, avocado and carrot oils were obtained as 127.62 meq/kg oil, 120.12 meq/kg oil and 130.47 meq/kg oil respectively. The relatively low saponification values of the oil indicate that the oils could be used for vast industrial applications such as soap making [6].

The Iodine value is the measure of the proportion of unsaturated acid or fat and oil present. The test measures the amount of iodine absorbed per gram of sample. An iodine value of 54.63g I_2/100g coconut oil, 49.21g I_2/100g avocado oil and 55.01g I_2/100g carrot oil obtained from each carrier oil is an indicative of high level of unsaturated fatty acids and can explain its liquid state on storage at room temperature. This makes the oils good cooking oils and suitable for margarine production.

Acid value is used to quantify the acidity of a substance. The lower the acid value, the higher the storage quality and vice versa. It is used as an indicator for edibility of oil and suitability for use in the paint industry [7]. Acid values of 6.10 mg KOH/g oil, 9.40 mg KOH/g oil and 6.50 mg KOH/g oil obtained for coconut, avocado and carrot oils respectively indicated that these oils can be used industrially.

The % Free fatty acids (oleic acid) help to determine the suitability of the oil for edible or industrial uses. The free fatty acid value obtained indicates that the oil is suitable for consumption. The percentage free fatty acid values were obtained as 3.10%, 4.70% and 3.30% for coconut, avocado and carrot oils respectively.

3.1 FTIR Scan Analysis and Interpretation

Fig. 1 shows the FTIR scan analysis of the extracted coconut carrier oil. From the fig. it is shown in the functional group region that the deep and narrow peak with wave number of 2922.2^{-1} represents the presence of O-H of carboxylic acid; there was another peak at 2855.1 cm^{-1} which shows the presence of O-H of carboxylic acid and 1744.4 cm^{-1} showing the presence of an aromatic overtone of ring bends. In the finger print region, there is also a variable intensity of wave number of 1461.1 cm^{-1} in between 1470-1460 cm^{-1} which shows the presence of a C-H deformation combined with aromatic ring vibrations according to [8]. The peaks at 1151.7 cm^{-1} and 1110.7 cm^{-1} show C-O stretch in Esters. A peak at 723.1 cm^{-1} shows the presence of an aromatic out-of-plane ring bends.

Fig. 2 shows the FTIR scan analysis of the extracted avocado carrier oil. From the figure, we observe a deep peak in the region of 3600 cm^{-1} - 2500 cm^{-1} which shows the presence of O-H of carboxylic acid, in this sample the peak was at 2922.2 cm^{-1}, there was another peak at 2855.1 cm^{-1} which shows the presence of O-H of carboxylic acid and 1744.4 cm^{-1} showing the presence of an aromatic overtone of ring bends. There is also a variable intensity in the finger print region of wave number in between 1470-1460 cm^{-1} which shows the presence of C-H deformation combined with aromatic ring vibrations according to [8]. Another peak was obtained at 1162.9 cm^{-1} which shows the presence of C-O stretch in Esters. Finally, there was a peak at 723.1 cm^{-1} which shows the presence of an aromatic out-of-plane ring bends.

Fig. 3 shows the FTIR scan analysis of the extracted carrot carrier oil. It is shown from the figure that the deep peak with wave number of 2922.2^{-1} in the functional group region represents

Table 1. Physicochemical properties of selected carrier oils

Property	Coconut oil	Avocado oil	Carrot oil
Color	Pale Yellow	Greenish Yellow	Orange
Odor	Acceptable	Acceptable	Acceptable
State at 25℃	Liquid	Liquid	Liquid
Specific Gravity	0.92	0.91	0.93
Smoke point	170℃ (350℉)	249℃ (480℉)	170℃ (350℉)
Saponification value (mg KOH/g oil)	127.62	120.12	130.47
Iodine value (g I_2/100g oil)	54.63	49.21	55.01
Peroxide value (meq/kg oil)	0.12	0.11	0.12
FFA (%)	3.10	4.70	3.30
Acid value (mg KOH/g oil)	6.10	9.40	6.50

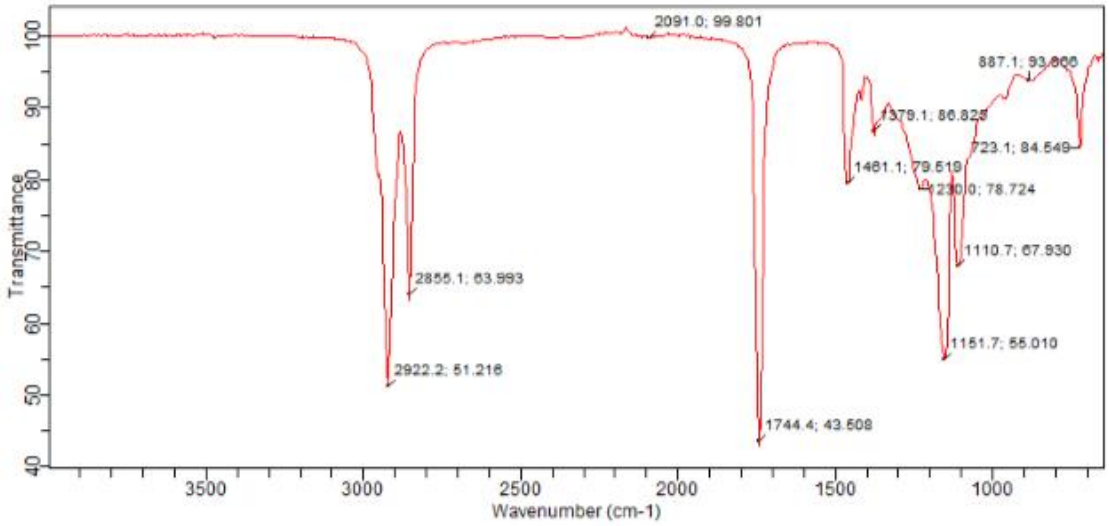

Fig. 1. FTIR analysis of coconut oil

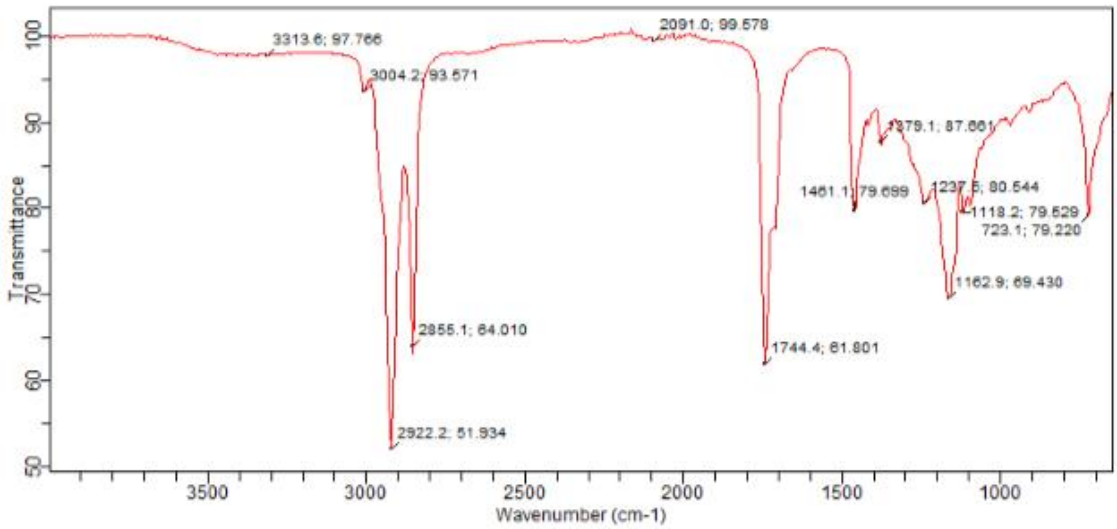

Fig. 2. FTIR analysis of avocado oil

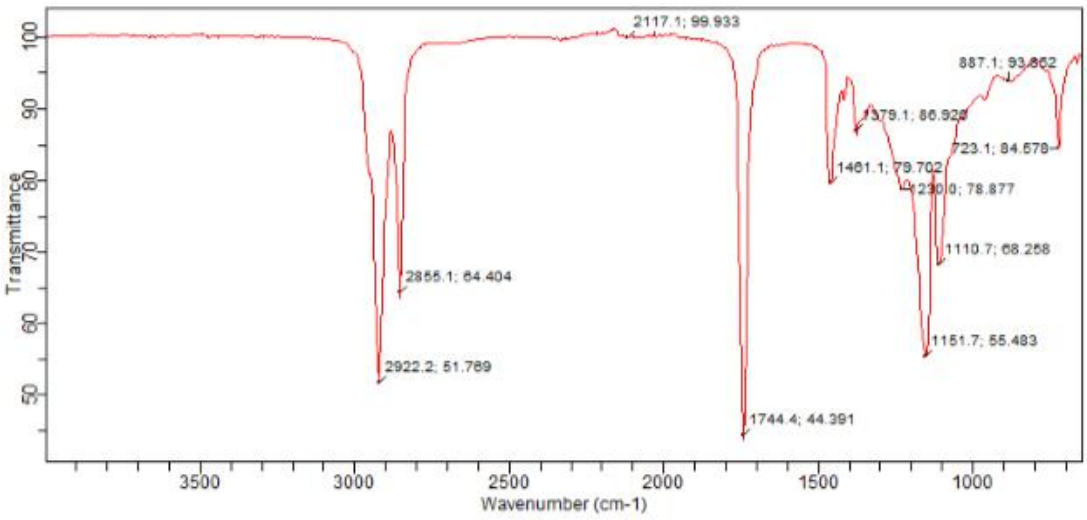

Fig. 3. FTIR analysis of carrot oil

the presence of O-H of carboxylic acid; there was another peak at 2855.1cm^{-1} which shows the presence of O-H of carboxylic acid and 1744.4 cm^{-1} showing the presence of an aromatic overtone of ring bends. In the finger print region, there is also a variable intensity of wave number of 1461.1 cm^{-1} in between 1470-1460 cm^{-1} which shows the presence of C-H deformation combined with aromatic ring vibrations according to [8]. The peaks at 1151.7 cm^{-1} and 1110.7 cm^{-1} show C-O stretch in Esters. A peak at 723.1 cm^{-1} shows the presence of an aromatic out-of-plane ring bends.

3.2 Comparative Study of the FTIR Scans Analysis of Extracted Coconut, Avocado and Carrot Carrier oils

From the figures above, it is shown that all three oils possess similar major compounds present in them which include the O-H group of carboxylic acids aromatics and C-O stretch in esters. The band peak of 1744.4cm^{-1} showing the presence of an aromatic overtone of ring bends presnts a deep peak for coconut and carrot oils whereas a narrow peak is observed for avocado oil.

From Figs. 1 and 3, it is shown that both coconut and carrot oil contains the same major band peaks. This indicates that coconut oil exhibited its dominance of its properties over that of the carrot oil. This is due to the fact that coconut oil was used as base oil in the extraction of carrot carrier oil.

4. CONCLUSION

This research has shown that carrier oils of coconut, avocado and carrot are edible and have nutritional qualities that can improve the health status of consumers as indicated by the percentage free fatty acid values. All the physicochemical properties of the oil have shown distinctive characteristics of these oils. The color and odor of each carrier oils was agreeable and can be used on a commercial scale as indicated by their specific gravities.

The peroxide and acid values have shown that each of the oils possess a high storage quality and can be stored for a long time without going rancid. Results have shown that these carrier oils can be applied in vast industrial processes such as soap making due to their low saponification values. The iodine value presented high level of unsaturated fatty acids resulting in their liquid state on storage at room temperature. This makes the oils good cooking oils. This shows that these carrier oils are good edible oils and can serve as an excellent base for other oils (essential oils) due to their applications in industrial processes such as soap making as the name “carrier oil” implies.

The FTIR scan analysis showed the various compounds present in the oils and by indication presented that coconut oil have dominant properties over that of carrot oil and should not be used as base oil for its extraction. Carboxylic acid (effective in providing antioxidant and anti-

aging protection as well as improving moisture retention) and aromatic groups were found present as well as esters (excellent hydrating and softening agents). These compounds are found in all vegetable oils thereby validating their quality and explain the excellent properties of carrier oils and why they are used in conjunction with essential oils for aromatherapy purposes as well as for human consumption. Finally, the utilization of coconut, avocado and carrot for oil production could provide extra income and contribute to the economic growth of Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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