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Chemical Properties of Aidan fruit (*Tetraplueratetraptera*) and Unripe Oil Palm Kernel (*Elaeis guineensis*) Powder

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Abstract

The study analyzed the chemical properties of aidan fruit (*Tetrapluera tetraptera*) and unripe oil palm kernel (*Elaeisguineensis*) powder. Specifically determined the proximate; minerals; and vitamins composition of the nutrient powder. The study adopted experimental research design. Aidan fruit and unripe palm kernel nut were processed into powder and formulated at the ratios of 90:10, 80:20 and 70:30. The powder was evaluated using the standard methods. Results of proximate compositions are in the range of; moisture 2.30 - 17.23, fats 2.65- 8.85, protein 11.55- 12.53, fibre 14.00- 19.50, ash 2.75-3.50 and carbohydrates 43.70- 62.30. Mineral composition includes; calcium 0.31- 1.57mg/100g, magnesium 3.05- 3.43mg/100g and zinc 0.63- 1.38mg/100g. The beta-carotene composition obtained were; 0.30 - 0 47mg/100g and Vitamin C content were 0.20 - 0.22mg/100g. In conclusion, based on the results, the chemical composition presented a product that is medicinal and beneficial for human consumption. The chemical benefits improved with increase in the introduction of unripe palm kernel. However, further studies are needed to assess the overall nutritional composition and potential health benefits of aidan fruit and unripe palm kernel powder.

Keywords: Nutrient, Powder, Aidan fruit, Unripe, Palm Kernel, Chemical Composition

Introduction

Nutrient powders are food additive which provides micro and macro nutrients. They are shelf life stable compounds that can be mixed with water, smoothies, soups etc to add, enhance and establish specific nutritional needs (British Association for Parenteral and Enteral Nutrition {BAPEN} 2025). They are commonly made from meat and seldom from fish (Okwu, 2023). Nutrient powders consist of nutrients such as protein, fiber, vitamins and minerals essential for body functions which contribute positively to human health (Rahul 2020). Plants are also used as raw materials to produce nutritious products from a variety of plant components such as fruits, nuts, seeds, or plant bark. They are used either in fresh or dried forms.

Nutrient powders have a wide range of applications in the food industry such as

flavoring, coloring and functional foods (Tze et al 2012). They are highly portable and cost effective compared to their fresh products (Saifullah et al 2016). The aidan fruit and unripe oil palm kernel are used significantly for their functional purposes such as boosting immune system, management of inflammation and hormonal imbalances, etc.

The palm tree (*Elaisguineensis*) is an ancient tropical plant native to many West African countries where local populace uses its oil for cooking and other household purposes. Most of its parts are not only edible but also healthy and nutritious with numerous useable potentials (Nwaiwu and Akali, 2016). It has medicinal and antioxidant properties and contains a variety of proteins, vitamins and minerals. Unripe palm kernel is the hard seed within the fruit of oil palm harvested early, typically black instead of the red colour of the ripe fruit. It is extremely low in fat, possesses anti-inflammatory properties and contains no harmful cholesterol. Unripe palm kernel also has various bioactive constituents that can regulate hormone levels in the body (Agbadua 2020; Nwinuka *et al*., 2015,).

Aidan fruit (*Tetrapleura tetraptera*) on the other hand is a culinary spice used in Nigerian homes especially the eastern part to spice yam and for lactating mothers as it is believed to aid postpartum recovery, boosting milk production and replenishing lost nutrients (Okwu 2023, Mensah 2024). The deciduous plant is from the family *Fabaceae – Mimosoideae*. The plant is native to West Africa, and is highly distributed in tropical African secondary forest and rainforest where they perform best. *Tetrapleura tetraptera* has a characteristic distinctive four-winged fruits consisting of woody shell, a fleshy pulp and small brownish-black seeds (Ojewole, *et al*., 2023; Schmidt *et al*., 2015). Aidan fruit has been reported to contain bioactive compounds. The most important being ascorbic acid which prevents and cures scurvy. It also contains polyphenols (Shahnah *et al*., 2017). Research has also shown that aidan fruit has rich antioxidant properties which plays vital role in the production of collagen needed in the relief of asthmatic symptoms. It has high potentials to protect against cancer and stroke and also contain many polymethoxylated flavones which are rarely present in other plants (Okwu, 2023). Aidan fruit is rich in minerals, amino acids, vitamins and beta-carotene. It also contains a rare combination of health-promoting antioxidants; quercetin, sitosterol, and kaempferol (Okwu, 2023).

The sensory perception of a product by a consumer is very crucial for it to thrive in the market irrespective of its health or nutritional benefits (George *et al*., 2021). Phenolic compounds such as tannins prominent in aidan fruit are well known for eliciting negative consumer's response because of their astringency and bitter taste. The perceived astringency and bitter taste therefore, could be one major factor limiting its use as sole components for herbal tea production (Ojewole *et al*., 2023), hence the need to combine it with another

functional but non astringent plant such as the unripe palm kernel to boost its acceptance among consumers. More so, the awareness among consumers of the detrimental health effect of consuming synthetic foods that cause uterine fibroids (noncancerous growths of the uterus) have created greater demands for additives formulated or prepared using natural fruits and nuts that are phthalates and parabens (Shahnah*et al*., 2017). Research reviewed that unripe palm kernel contains chemical substances that lower oestrogen, progesterone and cholesterol in animals under laboratory conditions to prevent and treat fibroid as well as reduce the distortion that fibroid causes in the womb (Ojewole *et al*., 2023), aidan fruit extract on the other hand produces dose-dependent, significant analgesic effects against thermally and chemically induced pain during childbearing. It is also rich in beta-carotene, vitamins and health promoting antioxidants. It may therefore be necessary to combine aidan fruit with unripe palm kernel in developing a powder that will serve as an additive with improved nutritional benefits suitable for households.

Objectives of the study

The main objective of this study was to evaluate chemical attributes of aidan fruit and unripe palm kernel powder. Specifically, the study determined:

1. proximate composition of aidan fruit and unripe palm kernel powder.
2. mineral composition of aidan fruit and unripe palm kernel powder.
3. vitamin content of aidan fruit and unripe palm kernel powder.

Materials and Methods

***Design of the study*:** The study adopted laboratory- based experimental design.

***Sources of raw materials*:** Unripe palm kernel was obtained from fresh strands of oil palm in Abakaliki metropolis. Aidan fruit was also sourced from the international market in Abakaliki metropolis, Ebonyi State.

Sample Preparation: The samples were prepared using the method described by Essiet et al (2013) with little modifications. Samples were manually washed with distilled water, the Aidan fruit was size reduced to achieve fast drying. The unripe palm kernel was deshelled. The samples were separately sun-dried for three days, and oven dried to a constant weight in a conventional oven at 60◦ C. The samples were grounded separately into fine powder and stored in airtight plastic bags for formulation and chemical analyses.

Sample formulation and coding: Samples were formulated in aidan fruit and unripe palm kernel ratios of; 90:10, 80:20 and 70:30.

***Chemical Analysis*:** The samples were analyzed in triplicates. Parameters determined include proximate, minerals and vitamins. The proximate, minerals and beta-carotene were determined using the Association of Official Analytical Chemist (AOAC) (2016).

Moisture: Sample was placed in clean dry crucible and was weighed. It was then dried in oven and cooled in a desicator.

Fat: Two milliliters of each sample was extracted with acetone (BP 400C – 600C) using "Sohxlet extractor" for 1 hour. The solvent free samples were dried in an oven, cooled in a dissector and reweighed prior to calculation of crude fat content.

Protein: Kjeldahl method was used**.** After distillation and titration, nitrogen was corrected using a factor of 5.25.

Fiber: Sample was hydrolyzed with sulphuric acid (H_2SO4), boiled, filtered, and boiled again with NaOH and HCl acid. The residue was then dried, cooled, and burned in a muffle furnace at 500°C for five hours.

Ash: 2g of sample was heated in a ceramic crucible at 550C for 3 hours. The sample were then weighed using the formular for ash% =(w2-w1)/(weight of sample) x100.

Carbohydrate: was determined by Difference that is, subtracting the sum of the % of protein, fat, moisture, and ash from 100%. Carbohydrate percentage was calculated.

Calcium: Previous ash sample was dissolved in 5ml of 30% HCl and 45ml of distilled water. The diluted samples were filtered and the filtrates were used to analyze for calcium using atomic absorption spectrophotometer.

Magnesium and Zinc: One gram of dried sample was digested with 2.5ml of 0.03N hydrochloric acid (HCl). The digest was boiled for five minutes, allowed to cool to room temperature and transferred to 50ml volumetric flask and made up to the mark with diluted water. The resulting digest was filtered with ashless Whatman No. 1 filter paper. Filtrate from the sample was analyzed using an Atomic Absorption Spectrophotometer.

Vitamin C: Two grammes of each sample was weighed into 250ml flat bottom flask and dissolved with 2 ml of distilled water.

Beta-carotene: One gram of the sample was weighed out followed by addition of 3ml of absolute ethanol. A precipitate of protein was formed, and the extract of vitamin with 5ml of heptanes layer taken to corvette and read 450nm against a blank of heptanes in a spectrophotometer. These analyses were carried out in the food analytical laboratory of food science and technology department, Ebonyi State University, Abakaliki.

***Data Analysis techniques*:** Data analysis was done using mean separation determined through Duncan's multiple range tests while the Analysis of Variance (ANOVA) was used to determine significant differences among the samples at 5 % level of significance.

Findings

Table 1: Proximate composition of aidan fruit and unripe palm kernel powder

Parameters (%)	90% aidan fruit	80% aidan fruit	70% aidan fruit
Moisture	$17.23^{a} \pm 0.035$	$2.30^{c} \pm 0.283$	$4.75^{b} \pm 0.354$
Fat	$3.65^{b} \pm 0.919$	$2.65^{b} \pm 0.459$	$8.85^{a} \pm 0.212$
Protein	$12.43^{a} \pm 0.240$	$11.55^{b} \pm 0.240$	$12.53^{a} \pm 0.127$
Fibre	$19.50^{a} \pm 2.121$	$18.00^{ab} \pm 0.948$	$14.00^{b} \pm 1.414$
Ash	$3.50^{a} \pm 0.707$	$3.25^{a} \pm 0.354$	$2.75^{a} \pm 0.014$
Carbohydrate	$43.70^{c} \pm 0.113$	$62.30^{a} \pm 0.919$	$57.12^{b} \pm 1.075$

Values are means ±standard deviation of triplicate determinations. Means with different superscripts along the same row are significantly different (p < 0.05). 101=90% aidan fruit and 10% immature palm kernel, 102=80% aidan fruit and 20% immature palm kernel and 103=70% aidan fruit and 10% immature palm kernel.

Table 1 describes the proximate composition of the powder. The moisture content ranged from 2.30 -17.23%. Sample containing 90% aidan had the highest value of 17.23% while sample with 80% aidan had the least value of (2.30%). There was a significant difference ($p<0.05$) among the samples. The fat content of the powder ranged from 2.65-8.85%. It was observed that sample with 70% aidan had the highest fat (8.85%) while sample with 80% aidan had the least (2.65). There was no significant difference ($p>0.05$) between sample with 90% aidan and 80% aidan respectively and sample with 70% was significantly higher ($p<0.05$). The protein content of the powder ranged from 11.55-12.53%. Sample with 70% aidan had the highest protein content (12.53%) while sample with 80% aidan had the least value (11.55%) and there was no significant difference ($p<0.05$) between sample with 90% aidan and sample with 70% aidan but was significantly ($p<0.05$) higher in sample with 80% aidan. The fibre content ranged from 14.00-19.50%. Sample with 90% aidan had the highest value (19.50%) while sample with 70% had the lowest (14.00%). There was no significant difference ($p>0.05$) between samples 90% and 80% aidan but were significantly ($p<0.05$) higher than sample with 70% aidan fruit. The ash content of the blends ranged from 2.75-3.50% and there was no significant difference ($p>0.05$) among the samples. The highest value of ash (3.50%) was obtained from sample with 90% aidan while the lowest value (2.75%) was from sample with 70% aidan. The carbohydrate content obtained ranged from 43.70-62.30%, sample with 80% aidan fruit had the highest value of (62.30%) and sample with 90% aidan had the lowest (59.87%). There were significant differences ($p<0.05$) from each of the samples in the carbohydrate contents.

Table 2: Mineral composition of aidan fruit and unripe palm kernel powder

Parameters(mg/100g)	90% aidan fruit	80% aidan fruit	70%aidan fruit
Calcium	$1.57^{a} \pm 0.050$	$0.80^{b} \pm 0.283$	$0.31^{b} \pm 0.134$
Magnesium	$3.05^{b} \pm 0.071$	$3.10^{b} \pm 0.141$	$3.43^{b} \pm 0.034$
Zinc	0.68 ± 0.035	$0.63^{b} \pm 0.028$	$1.38^{a} \pm 0.035$

Values are means ±standard deviation of triplicate determinations. Means with different superscripts along the same row are significantly different (p < 0.05). 101=90% aidan fruit and 10% immature palm kernel, 102=80% aidan fruit and 20% immature palm kernel and 103=70% aidan fruit and 10% immature palm kernel.

Table 2 shows the mineral composition of the powder blend. The calcium content ranged from 0.31-1.57mg/100g. The sample containing 90% aidan fruit had the highest calcium content while the sample containing 70% aidan fruit had

the least calcium content. The magnesium content ranged from 3.05-3.43mg/100g, the sample containing 70% aidan fruit had the highest value while sample with 90% aidan fruit had the least. The zinc contents obtained from the findings ranged from 0.63-1.38mg/100g. There was no significant difference ($p>0.05$) between samples with 90% and 80% aidan fruit but significantly different ($p<05$) from the sample with 70% aidan fruit that had the highest value of 1.38mg/100g.

Table 3: Vitamin composition of idan fruit and unripe palm kernel powder

Parameters (mg/100g)	90%aidan fruit	80% aidan fruit	70% aidan fruit
Beta-carotene	$0.45^{a} \pm 0.007$	$0.30^{b} \pm 0.007$	$0.30^{b} \pm 0.007$
Vitamin C	$0.20^{a} \pm 0.007$	$0.21^{a} \pm 0.007$	$0.22^{a} \pm 0.007$

Values are means ±standard deviation of triplicate determinations. Means with different superscripts along the same row are significantly different ($p < 0.05$). 101=90% aidan fruit and 10% immature palm kernel, 102=80% aidan fruit and 20% immature palm kernel and 103=70% aidan fruit and 10% immature palm kernel.

Table 3 shows the vitamin contents of the powder. Beta-carotene content ranged from 0.30-0.45mg/100g. The highest value (0.45mg/100g) was obtained in the sample with 90% aidan fruit while the least value (0.30mg/100g) was obtained in samples with 80% and 70% aidan fruit respectively. There were significant differences ($p<0.05$) among the samples. Vitamin C content of the fruit powder ranged from 0.20-0.22mg/100g and there was no significant difference ($p>0.05$). The highest value of vitamin C was 0.22mg/100g and it was obtained from sample with 70% aidan fruit while the lowest value was obtained in the sample with 90% aidan fruit (0.20mg/100g). There was a slight increase in the vitamin C content as the immature palm kernel increased in the blends.

Discussion of Findings

The moisture content of the nutrient powder ranged from 2.30 -17.23%. Moisture content for powdered fruits and nuts is ideal at 6% and 8% (Isreal 2014). Sample with 90% Aidan fruit is high at 17.23%, the value was more than the value reported by Tze et al (2012) for Pitaya fruit powder (4.07%) and that obtained by Isreal (2014) for Palm kennel (4.68%) indicating that the sample with 90% Aidan (17.23%) may not be stable but the other two samples can keep. The moisture content is important as it affects the texture, taste, and overall quality of the product (Almeida et al., 2018). Moisture content of the nutrient powder reduced with the increase of the immature palm kernel thus the immature palm kernel can contribute to its stability. The fat content of the powder (2.65-8.85%) were lower compared to the minimum recommendation by FAO/WHO (1991) also lower than that of peanut powder (22%) (Bonku et al 2020). According to FAO/WHO (1991), nutrient powder should have (10-25%) fat content. Fat content refers to the total lipid content in the product. It is an important source

of energy and contributes to the flavor and texture of the nutrient powder (AOAC International, 2016). The protein content of the nutrient powder (11.5-12.5%) was lower than the recommended value of 20-25g per scoop of the nutrient powder which is equivalent to 80% (Rogerson 2020). The value was also lower than that obtained by Banku et al (2020) for Indian raw kernel peanut (22-34%) but higher than Pecan nut powder (USDA 2018). Protein content represents the amount of nitrogen present in the powder, which is then converted to amino acids. Proteins are essential for growth, repair and maintenance of the body (Almeida et al., 2018). The fibre content (14.00-19.50%) obtained meets the dietary guideline for Americans, (14g daily) (Dietary guidelines for Americans 2025), but is lower (25-30g) as prescribed by (UCSF Health 2022) for daily intake. It was observed that as the immature palm kernel was increasing in the powder the fibre content decreased. Notwithstanding, the low crude fibre content is nutritionally appreciated because it traps less protein (Asoba *et al.*,2018). Fiber content refers to the indigestible portion of the food that provides bulk to the diet and has various health benefits such as aiding digestion and reducing the risk of chronic diseases (AOAC International, 2016). The ash content of the nutrient powder ranged from (2.75-3.50%). The ash content reduced as the quantity of the immature palm kennel nut increased. Ash is simply what is left over after food has been burnt. The value obtained was higher than the recommended value of ash in powder/ flour foods (0.1-2.5%) (Bilge et al 2016) and also higher than that obtained for peanuts (1.2-2.3%) (Subedi 2023). They also opined that high ash content reflects high moisture content and represents the mineral content of the food. It determines the overall nutritional value of the food (AOAC International, 2016). The carbohydrate content of the nutrient powder ranged from (43.70-62.30%). The value is within the expected daily intake of 45%-65% (225-325g), (RDA 2023). Finding is higher than that obtained for fruits (15-30%) and nuts (10-25%) as obtained by (Canadian Nutrient File 2022). Carbohydrates represent the total amount of sugar, starch, and fiber present in the food. Carbohydrates are an essential source of energy for the body (Almeida et al 2018). The nutrient powder could be suitable for individuals seeking a carbohydrate-rich dietary option.

The calcium content ranged from (0.31-1.57mg/100g). Sample with 90% Aidan fruit had the highest value. The result indicates a progressive decrease in calcium content. WHO recommends a daily intake of approximately 1000mg of calcium for adults aged 19-50. A lower intake may be recommended for certain age groups. Therefore, based on these recommendations, the calcium levels in the nutrient powder, particularly at the higher proportions of Aidan may not meet the WHO (2019) recommended daily intake. The magnesium content ranged from (3.05-3.43mg/100g) and sample with 70% Aidan fruit had the highest value of (3.43mg/100g). It was observed that the increased addition of

the immature palm kernel to the blend increased the magnesium content of the blend. According to (WHO 2019) the recommended daily intake of magnesium for adult is 300-400mg per day. Comparing the results, it can be observed that all three blends of the powder contained magnesium within the recommended range. Therefore, incorporating Aidan fruit and immature palm kernel powder into the diet could potentially help individuals meet their daily magnesium needs. Magnesium supports a healthy immune system, keeps the bone healthy and helps in proper adjustment of blood glucose levels ({NIH} 2021). The zinc contents ranged from (0.63-1.38mg/100g). The value obtained is higher than that in peanuts (0.8mg) and lentil (0.3mg) (Health Directory 2023). WHO recommends a daily intake of zinc to be (8-11mg) for adults (WHO, 2019). The zinc value increased with the increase of the immature palm kennel. It is evident that sample with 70% Aidan fruit has a significantly higher zinc content compared to other samples. The powder can contribute to meeting the daily zinc requirements. The beta-carotene content ranged from (0.30-0.45mg/100g). The highest value (0.45mg/100g) was obtained in the sample with 90% Aidan. Beta-carotene is an essential nutrient required for healthy vision, immune function, and cell growth. According to WHO, the recommended daily intake of beta-carotene for an adult male is 0.90mg while for an adult female is 0.70mg. All three blends fall below the daily recommended intake level. The Beta-carotene content of sample with 90% Aidan fruit is closer to the recommended intake compared to the other two samples (0.30mg). The well known basic function of beta-carotene is the formation of retinal ligaments of the eye. Its biologically active derivatives, the retinoids also regulate key processes in the body (Bennasir *et al.,* 2010). Vitamin C content of the nutrient powder ranged from (0.20-0.22mg/100g). The highest value of vitamin C was 0.22mg/100g and it was obtained from sample with 70% Aidan Fruit. The vitamin C value obtained is lower than the value obtained in strawberry powder (USDA 2019). The value is also lower than the recommended daily intake of 75-90mg (Zeratsky 2022). There was a slight increase in the vitamin C content as the immature palm kernel increased in the blends. Vitamin C is an antioxidant; it plays a vital role in various metabolic processes and aids in the absorption of iron (Taraj et al 2021).

Conclusion

The findings affirmed that the proximate composition of the sample with 90% Aidan fruit had the highest moisture and fibre content. Sample with 80% Aidan had the highest carbohydrate content and sample with 70% Aidan had the highest fat and protein content. The mineral content of the nutrient powder made from Aidan fruit and immature palm kernel demonstrated significant levels of magnesium and zinc in all the three samples. This suggests that the powder could serve as a valuable dietary

supplement for meeting the recommended daily intake of minerals. The Aidan fruit and immature palm kernel powder revealed varying concentrations of beta-carotene. However, all three samples fell below the WHO's recommended daily intake. Nutritional qualities of a product are key consideration in product selection, thus the powder can be accepted to its target market.

Recommendations

In view of the findings of the study, the following recommendations were made.

1 Aidan fruit and unripe palm kennel powder can be used in households for food fortification
2 Further studies are needed to assess the overall nutritional composition and potential health benefits of the blends of Aidan fruit and unripe palm kennel powder**.**
3 The sensory attributes of the aidan fruit and unripe palm kernel nutrient powder should be explored.
4 A pilot study of the product can be conducted to determine community acceptance.

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