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Quality Assessment of *Tetrapleura tetraptera* Fruit Subjected to Different Drying Methods

[*1]Adebayo, T.K., [1]Folorunsho, O.O., & [2]Aroyehun, O.J.
[1]Department of Food Science and Technology, Federal Polytechnic, Offa, Kwara State, Nigeria
[2]Department of Hospitality Management, Federal Polytechnic, Offa, Kwara State, Nigeria

***Corresponding author email:** tesleemkayodeadebayo@gmail.com

Abstract
Tetrapleural tetraptera (Schum and Thonn), fruit is a perishable fruit with numerous benefits for human consumption and health where-in its qualities need to be preserved. One way to do this is through drying. This study investigates the effect of selected drying methods on the proximate, phytochemical, mineral composition and functional properties of *Tetrapleural tetraptera* flour. Four samples were formulated using sun, oven, microwave drying method and a control sample. The study focused on evaluating proximate, phytochemical, mineral composition and functional properties using standard method. Analysis of variance was evaluated using SPSS version 21.0 and the difference between the mean values were evaluated at $p<0.05$ using Duncan multiple range test. Significant difference ($p<0.05$) were observed in proximate, phytochemical, mineral composition and functional properties as compared with the control sample. Proximate composition values for moisture, ash, protein, fat, fibre and carbohydrate were within the range of 6.01-9.62%, 4.33-7.37%, 4.20-7.73%, 9.86-12.24%, 3.90-6.20% and 62.20-67.83% respectively. Phytochemical; saponin, tannin, flavonoids, phytate and HCN were 62.20-67.83%, 0.37-0.56%, 4.20-11.88%, 1.05-2.48% and 3.04-4.96 mg/g. Mineral content; calcium, iron, potassium, magnesium, zinc and sodium were 120.77-173.62, 0.68-1.96, 167.20-230.73, 72.05-92.24, 0.42-0.98 and 8.02-11.45 mg/100 g respectively. Functional properties; WAC, B.D, OAC and S.I were 17.24-24.39%, 0.46-0.87 g/ ml, 10.95-17.98%, and 14.83-18.04%. This study therefore ascertains that these drying methods are employable to improve and preserve the nutritional content of t*etrapleural tetraptera* flour.

Keywords: *Tetrapleura tetraptera*, Proximate, Phytochemical, Functional, Mineral

Introduction
Tetrapleura tetraptera (Schum and Thonn), otherwise called "*Aridan*" fruit, is a plant native to West Africa and belongs to the family Fabaceae. It has been traditionally used for its medicinal properties and as a spice in cooking. The fruit is blessed with essential nutrients such as proteins, carbohydrates, vitamins, and minerals, making it a valuable food source. Recently, there has been a growing interest in exploring alternative drying methods to preserve the nutritional and functional qualities of *Tetrapleura tetraptera* (Zhao, 2021). Drying is a crucial process in food preservation, significantly affecting the quality of the final product. Traditional sun drying is widely used due to its low cost and simplicity. However, it can be inconsistent and subject to contamination. Oven drying, on the other hand, offers more control over the drying conditions but can be more expensive. Understanding how these drying methods affect the quality properties of *Tetrapleura tetraptera* flour is essential for optimizing its use in food products and ensuring its nutritional benefits (Adadi & Kanwugu, 2020). Hence, purpose of this work was to investigate the quality properties of *Tetrapleura tetraptera* flour as influenced by sun, oven and microwave drying methods.

Materials and Methods
Material
Tetrapleura tetraptera used in this study were procured from Owode market, Offa, Kwara state, Nigeria. All the required equipment was sourced from the processing laboratory of the food technology department, Federal Polytechnic Offa, Kwara State, Nigeria.

Methods
Preparation of *Tetrapleura tetraptera* flour

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The method described by Imade et al. (2024) with slight modification. Mature pods of *Tetrapleura tetraptera* were procured, washed manually with distilled water and dried (sun, oven and microwaved dried). The dried fruits were grinded into fine powder using a grinder (Binatone: BLG-400), sieved through mesh sieves (1mm) and stored in air tight bottles. These were then subjected to further analyses. See Figure 1

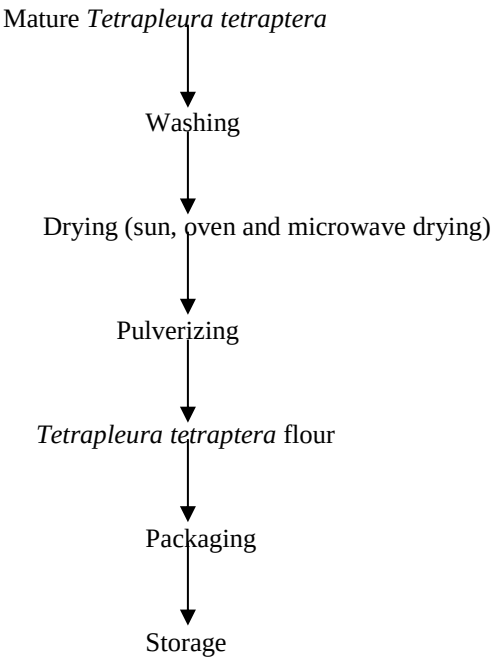

Figure 1: Flow chart for the preparation of *Tetrapleura tetraptera* flour

Source: (Imade et al., 2024)

Procedure for analysis

Proximate Composition

Proximate composition was determined using method described by the Association of Official and Analytical Chemist (AOAC, 2000).

Determination of Moisture Content

5.0 g of each sample was weighed using analytical balance into previously weighed Petri-dishes (W). The weighed samples in the petri dish were allowed to dry in an oven at 105 ^{0}C for 3 hours. The samples were removed and cooled in desiccators and the weight was noted, this was then returned into the oven at 105 ^{0}C for 30 min until a constant weight was obtained for each sample. Differences in weight between each Petri-dish and dried residue were recorded as the percentage of the initial sample.

The percentage moisture was calculated as:

$$\%\, moisture\ content\ = \frac{W1 - W2}{Ws}\ x100$$

$Where$

$W\ =\ Initial\, weight\, of\ crucible\ +\ Sample$

$W1 =\ Final\, weight\, of\ crucible\ +\ Sample$

$Ws\ =\ Weight\, of\ sample$

Protein Content

0.5 g of sample was weighed into a digestion flask and kjeldahl, followed by the addition catalyst tablet. 10 ml of conc. H_2SO_4 was added and digested for 4 hours until a clear solution was obtained (blue green color). The

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digest was transferred into 100 ml volumetric flask after cooling and made up to mark with distilled water. 20 ml of boric acid was dispensed into a conical flask and 5 drops of indicator and 75 ml of distilled water was added to it. 10 ml of the digest was dispensed into Kjedahl distillation flask, the conical and the distillation flask were fixed in place and 20 ml of 2% NaOH was added through the glass funnel into the digest. The steam exit was closed and timing started when the solution of the boric acid and indicator turned green. The distillation was done for 15 minutes and the distillate was titrated with 0.05 N HCl solutions till the appearance of pink color. A blank was also run through all steps as above.

Therefore, the crude protein content was determined by multiplying percentage Nitrogen by a constant factor of 6.25

i.e. % $crudeprotein$ = % Nx 6.25.

% $Total\ Nitrogen$ (%N)

= titr$e\ Value\ x\ Atomic\ mass\ of nitrogen\ x\ Normality\ of\ HCl\ used\ x$ 4

Fat content

1.0 g of sample was weighed into filter paper and then wrapped. This was then placed in fat free thimble plugged lightly with cotton wool and extracted with petroleum ether (N-Hexane) in soxhlet apparatus set up for 5 hours. Water and heater were turned on to start extraction process. After 4-6 siphoning, ether was allowed to evaporate and beaker was disconnected before the last siphoning. Extract was moved into clean glass dish with ether washing and evaporated ether on water bath. The residue extract in dish was then transferred into an oven at 105 ^{o}C for 2 hours and cooled in a desiccator and weighed. The fat content will be calculated as;

Ash content

Empty crucible that is very clean was placed in a muffle furnace at 600 ^{o}C for an hour, cooled inside dessicator and weighed (W_1). 1.0 g of each sample was weighed in crucible (W_2). The sample was ignited over a burner until it is charred. The crucible was then placed in a muffle furnace set at 550 ^{0}C and allowed to stay for 12-24 h. The appearances of gray white ash indicated complete oxidation of all organic matter in the sample. The crucible with the sample was cooled and weighed (W_3).The crucible with the sample was weighed and the percentage ash calculated as;

$$\%\ Ash\ content\ = \frac{W3 - W1}{W2} \quad x\ 100$$

Where W_3 = weight of the sample with crucible before ashing

W_2 = weight of the sample with crucible after ashing

W_1= weight of the sample

Crude fiber content

Sample of exactly 5.0 g was weighed into flask, 200 ml of running water and 1.25 ml H_2SO_4 was added. The mixture was subjected to heating under reflux for 30 minutes. The hot mixture was filtered through a fibre muslin cloth. The obtained filtrate was thrown off and the residue was returned to the fibre flask of which 200 ml of running water and 1.25 g NaOH was added and heated for another 30 minutes. The residue was separated using N-hexane and ethanol and finally moved into already weighed crucible. The crucible and the residue was oven dried at 105 ^{0}C overnight in order to drive off the moisture. The oven dried crucible containing the residue was allowed to cool in a dessicator and weighed to obtain the W_1. The crucible with W_1 was transferred to the muffle furnace for ashing at 550 ^{0}C for 4 hours. The crucible containing white or grey ash (Free of carbonaceous materials) was cooled in the dessicator and weighed to obtain W_2.

The difference $W_1 - W_2$ gives the weight of crude fibre.

$$\%Fibre\ = \frac{W1 - W2}{weight\ of\ sample} \quad x100$$

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Carbohydrate content

The total carbohydrate was determined by difference. The sum of percentages moisture, ash, crude lipid, crude protein and crude fiber was being subtracted from 100%.

$Carbohydrate = 100 - (\%\ moisture + \%\ ash + \%\ protein + \%\ lipids + \%\ fiber)$.

Mineral Composition

This was determined using the standard illustrated by Coțovanu et al. (2022) and two stages involved in the analyses: the mineralization of the sample and the metal dosage by spectrophotometry. Under mineralization, the organic matter in the sample (5.00 ± 0.001 g) was eliminated by carbonization and combustion in the calciner, with the temperature increasing from 250 °C to 450 °C, up to 900 °C, for 8 h. A total of 5 mL HCl 6 mol/L (STAS 13013/1-91) was added to the ash obtained, and then the acid was evaporated using a sand bath. Left over residue was dissolved with 730 µL HNO_3 69% and brought to the mark (50 mL) with deionized water. As a control sample, deionized water was used following the same procedure as for the analyzed sample. Spectrophotometric determination method involved the following steps: activating the cathode lamp corresponding to the elements (Ca, Fe and Zn), adjusting the operational parameters, activating and adjusting the flame, and establishing the curve standard by absorbing four working standard solutions of different concentrations. In the flame system used, the nebulizer and the atomizer play a decisive role: the nebulizer aspirates a liquid sample with a controlled flow and the atomizer creates a fine aerosol and mixes the aerosol with the oxidizing gas. The mineral elements are expressed as mg/100 g of flour and were calculated with Equation below:

$E = C \cdot F \cdot VM$

Where:

- E—mineral element concentration, mg/100 g;
- C—the concentration measured on the calibration curve, mg/L;
- F—dilution factor;
- V—sample volume, mL;
- M—sample mass taken in the analysis, g.

Determination of Phytochemicals

Total Phenolic Contents

Total soluble phenolics in the extracts were determined using a method by Singleton et al. (1999) and a chemical called Folin–Ciocalteu reagent. 20 µL of the aliquot samples was added to a container; after that, 1.58 mL of DI water was added, this was then followed by 100 µL of Folin–Ciocalteu reagent; the mixture was thoroughly mixed and incubated for 5 min at room temperature. After this, 300 µL of the Na_2CO_3 (20% w/v) solution was added and the mixture was allowed to stay at room temperature in the dark for 2 h. Absorbance was measured at 765 nm using a spectrophotometer (Biochrom Libra S22, Cambridge, UK). Gallic acid (50, 100, 250, 500, and 750 ppm (mg/L)) was used as the standard. Results were expressed as gallic acid equivalents.

Total Flavonoid Contents

The method described by Wasiu et al. (2011) was employed. Aluminum chloride was applied and catechin as a reference was used to measure the total flavonoids in the extracts. An aliquot (250 µL) of the samples was added to a container. After that, 1.25 mL of DI water was added, followed by 75 µL of 5% $NaNO_2$; the mixture was then incubated for 6 min. Thereafter, 150 µL of the 10% $AlCl_3$ solution was added, followed by 0.5 mL of 1 M NaOH and 275 µL of DI water, respectively. The mixture was properly mixed and incubated for 5 min. Absorbance was measured at 510 nm using a spectrophotometer (Biochrom Libra S22, Cambridge, UK). Catechin (0–350 ppm (mg/L)) was used as the standard. Results were expressed as catechin equivalents.

Determination of Functional properties

Bulk Density

This was determined using a standard laboratory method AOAC, (2006). Sample blends were weighed (7 g) into a 50 ml graduated measuring cylinder. The cylinder was gently tapped against the palm until a constant volume was obtained. It was calculated as:

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Bulk density (g/ml) $= \frac{\text{Weight of sample}}{\text{Volume of sample after tapping}}$

***Water Absorption Capacity** (WAC)*

This was determined using the method described by Wasiu *et al.* (2011). 10 ml of distilled water were added to 1.0 g of flour and blended for 30 seconds. The samples were allowed to stand for 30 minutes and centrifuged at 1300 rpm for another 30 min at room temperature (27 ± 2 °C). The supernatant was decanted. The weight of water absorbed by the flour was calculated and expressed as percentage WAC.

Oil absorption capacity (OAC)

Onwuka, (2018) method was employed. 1.0 g of the sample was mixed with 10 ml refined corn oil in a centrifuge tube and stand at room temperature (30 ± 2 °C) for 1 h. This was then centrifuged at 1600 rpm x *g* for 20 min. Free oil volume was recorded. Oil absorption capacity was expressed as ml of oil bound by 100 g dried flour.

Swelling Index

The method employed by Verem *et al.*, (2021) was used. 10 g of the sample was measured into a 300 ml measuring cylinder. Thereafter, 150 ml of distilled water was added to the sample and allowed to stay for 4 h. The final volume after swelling was recorded. The percentage swelling was calculated as:

Swelling Index (%) $= \frac{\text{Final volume} - \text{Initial volume}}{\text{Initial volume}} \times 100$

Statistical Analysis

The mean and standard deviation of the triplicate determinations of the proximate, mineral, functional and phytochemical values were calculated. One-way analysis of variance was used to test for significant differences in the proximate, mineral, functional and phytochemical properties of the flour samples.

Results and Discussion

Table 1: ***Proximate composition of the samples***

Sample	%Moisture	% Ash	% Protein	% Fat	% Fibre	CHO %
A	9.62 ± 0.21^{c}	4.33 ± 0.06^{a}	7.73 ± 0.09^{d}	12.24 ± 0.02^{d}	3.90 ± 0.02^{a}	62.20 ± 0.18^{a}
B	7.13 ± 0.01^{b}	5.90 ± 0.02^{b}	5.97 ± 0.03^{c}	10.14 ± 0.04^{c}	4.15 ± 0.02^{b}	66.73 ± 0.03^{b}
C	6.77 ± 0.14^{b}	7.37 ± 0.01^{d}	4.20 ± 0.14^{a}	9.05 ± 0.05^{a}	6.20 ± 0.01^{d}	66.42 ± 0.33^{b}
D	6.01 ± 0.08^{a}	6.43 ± 0.52^{c}	4.53 ± 0.06^{b}	9.86 ± 0.05^{b}	5.31 ± 0.04^{c}	67.83 ± 0.49^{c}

Means that do not share the same superscript in the same column are significantly different ($p<0.05$).

KEYS: Sample A: control, Sample B: sun drying, Sample C: oven drying, Sample D: microwave drying

Table 1 shows the results of the proximate composition of the samples for moisture, ash, protein, fat, fiber and carbohydrate of the dried samples. There was significant difference among the samples as statistically analyzed. The mean score value of the sample ranged from 6.01-9.62% with sample A having the highest mean score value (9.62%) while sample D had the least mean score value (6.01%). Ash content of the samples differed significantly from one another. The mean score values ranged from 4.33-7.37% with sample C having the highest ash content (7.37%) while sample A had the least ash content (4.33%). Protein content of the samples differed significantly from one another as statistically analyzed. The mean score value of the samples ranged from 4.20-7.73% with sample A having the highest mean score value (4.20%) and sample C had the least mean score value (4.20%). Fat content of the sample are significantly different from one another. The mean score value ranged from 9.86-12.24% with sample A having the highest mean score value (12.24%) and sample C had the least mean score value (9.05%). There was significant difference in the fiber content of the samples as statistically analyzed. The mean score values of the samples ranged from 3.90-6.20% with sample C having the highest mean score value (6.20%) while sample A had the least means score value (3.90%). There was significant difference in the carbohydrate content of the samples as statistically analyzed. the mean score value ranged from 62.20-67.83%

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with sample D having the highest means core value (67.83%) while sample A had the least mean score value (62.20%).

Phytochemical Analysis

Table 2: ***Phytochemical composition of the samples***

Samples	Saponin (%)	Tannin (%)	Flavonoids (%)	Phytate (%)	HCN (mg/g)
A	0.89±0.01^{d}	0.56±0.02^{d}	11.88±0.01^{d}	2.48±0.026^{d}	4.56±0.04^{c}
B	0.72±0.01^{c}	0.49±0.01^{c}	9.97±0.03^{c}	2.14±0.03^{c}	4.96±0.04^{d}
C	0.46±0.01^{a}	0.37±0.01^{a}	4.20±0.14^{a}	1.05±0.01^{a}	3.04±0.01^{a}
D	0.63±0.01^{b}	0.44±0.01^{b}	8.53±0.05^{b}	1.86±0.05^{b}	4.34±0.01^{b}

Means that do not share the same superscript in the same column are significantly different ($p<0.05$).

KEYS: Sample A: control, Sample B: sun drying, Sample C: oven drying, Sample D: microwave drying

Saponin content of the sample differed significantly from one another. The mean score value ranged from 0.46-0.89% with sample A having the highest mean score value (0.46-0.89%) while sample C had the least mean score value (0.46%). Tannin content of the samples showed significant difference from one another. The means score value ranged from 0.37-0.56% with sample A having the highest mean score value (0.56%) while sample C had the least mean score value (0.37 mg/100 g). Flavonoids of the sample are significantly different from one another. The mean score value ranged from 4.20-11.88% with sample A having the highest mean score value (11.88%) while sample C had the least mean score value (4.20%). Phytate of the samples are significantly different from one another. The mean score value ranged from 1.05-2.48% with sample A having the highest mean score value (2.48%) while sample C had the least mean score value (1.05%). Hydrogen cyanide content of the samples differed significantly from one another as statistically analyzed. The mean score value ranged from 3.04-4.96 mg/g with sample B having the highest value (4.96 mg/g) while sample C had the least mean score value (3.04 mg/g).

Mineral Analysis

Table 3: ***Mineral composition of the samples***

Sample	Ca (mg/100g)	Fe(mg/100g)	K (mg/100g)	Mg (mg/100g)	Zn (mg/100g)	Na (mg/100g)
A	173.62±0.21^{d}	1.96±0.01^{d}	230.73±0.09^{d}	92.24±0.02^{d}	0.98±0.01^{d}	11.45±0.02^{d}
B	150.13±0.01^{b}	1.24±0.01^{c}	200.97±0.03^{c}	88.14±0.04^{c}	0.86±0.02^{c}	9.14±0.04^{c}
C	120.77±0.14^{a}	0.68±0.01^{a}	167.20±0.14^{a}	72.05±0.05^{a}	0.42±0.01^{a}	7.46±0.04^{a}
D	152.06±0.08^{c}	1.08±0.02^{b}	179.53±0.06^{b}	81.86±0.05^{b}	0.66±0.03^{b}	8.02±0.01^{b}

Means that do not share the same superscript in the same column are significantly different ($p<0.05$).

KEYS: Sample A: control, Sample B: sun drying, Sample C: oven drying, Sample D: microwave drying

Table 3 above shows the results of the mineral composition of the samples for calcium, iron, phosphorus and magnesium of the samples.

Calcium compositions of the samples are significantly different from one another as statistically analyzed. The mean score value ranged from 120.77-173.62 mg/100 g with sample A having the highest mean score (173.62 mg/100 g) and sample C had the least mean score value (120.77 mg/100 g). There was significant difference in the mean score of the iron samples. The mean score values ranged from 0.68-1.96 mg/100 g with sample A having the highest mean score value (1.96 mg/100 g) while sample C had the least mean score value (0.68 mg/100 g). In potassium, there was significant difference among the samples as statistically analyzed. The mean score value ranged from 167.20-230.73 mg/100 g. Sample A had the highest mean score value (230.73 mg/100 g) while sample C had the least mean score value (167.20 mg/100 g). The magnesium composition of the samples was significantly different from one another. The mean score value ranged from 72.05-92.24 mg/100 g with sample A having the highest mean score value (92.24 mg/100 g) while sample C had the least mean score value

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(72.05 mg/100 g). Zinc composition of the samples showed significant difference in the mean score value as statistically analyzed. The mean score value ranged from 0.42-0.98 mg/100 g with sample A having the highest mean score value (0.98 mg/100 g) while sample C had the least mean score value (0.42 mg/100 g). Sodium composition of the samples showed significant difference in the mean score value as statistically analyzed. The mean score value ranged from 8.02-11.45 mg/100 g with sample A having the highest mean score value (11.45 mg/100 g) while sample C had the least mean score value (7.46 mg/100 g).

Functional properties

Table 4: ***Functional properties of the samples***

Samples	WAC (%)	BD (g/ml)	OAC (%)	SI (%)
A	24.39 ± 0.05^{d}	0.87 ± 0.01^{d}	17.98 ± 0.01^{d}	14.69 ± 0.01^{a}
B	20.98 ± 0.01^{b}	0.65 ± 0.00^{c}	14.96 ± 0.01^{c}	15.83 ± 0.02^{b}
C	17.24 ± 0.02^{a}	0.46 ± 0.01^{a}	10.95 ± 0.00^{a}	18.04 ± 0.01^{d}
D	18.95 ± 0.02^{b}	0.61 ± 0.01^{b}	12.89 ± 0.01^{b}	16.21 ± 0.01^{c}

Means that do not share the same superscript in the same column are significantly different ($p<0.05$).

KEYS: Sample A: control, Sample B: sun drying, Sample C: oven drying, Sample D: microwave drying

Table 4 above shows the results of the functional properties of the samples for water absorption capacity, bulk density, oil absorption capacity and swelling index. Water absorption capacity (WAC) is the ability of the starch or flour to absorb water, swell for improved consistency and texture. The water absorption capacity of the sample differed significantly from one another. The mean score value ranged from 17.24-24.39% with sample A having the highest mean score value (24.39%) and sample C having the least mean score value (17.24%). The bulk density of the samples differed significantly from one another. The mean score value ranged from 0.46-0.87 g/ml with A having the highest mean score value (0.87 g/ ml) while sample C had the least mean score value (0.46 g/ml). The oil absorption capacity of the samples differed significantly from one another. The mean score value ranged from 10.95-17.98% with sample A having the highest mean score value (17.98 g/ml) and sample C having the least mean score value (10.95 g/ml). The swelling index is an indication of presence of amylase which influences the quantity of amylose and amylopectin present in the flour. The samples differed significantly from one another, the mean score value ranged from 14.83-18.04% with sample C having the highest mean score value (18.04%) and sample A having the least mean score value (14.69%).

Discussion

The major findings from Table 1 showed that the moisture content of the samples differs which is solely dependent on the drying method adopted. The result obtained in the study agreed with the observed report of Sinh et al. (2021) for spice formulations based on *Coelocaryonoxy carpum* (Cox), ginger and pepper. High moisture content in fresh sample decreases the quality of stored samples because the water content may possibly cause microbial growth (Sospedra, et al., 2020). The low moisture content of recorded for the dried samples shows they were <10% which means long shelf life (Ojo, et al., 2014). According to Agoreyo et al. (2021), the low moisture content decreases the perishability and increases the value and shelf life of the food. Drying improved the ash content of the samples as compared with the control sample. Morris et al. (2020) stated that the samples showed a significant increase in ash content after drying due to water removal, thereby increasing the nutrient concentration. Moreover, the increased ash content after drying can also be explained by the low volatility of minerals, which are not destroyed by heating. The values reported for the dried samples in this study agree with the reported values of Okonkwo and Ogu (2021) for evaluation of some selected spices commonly used in the south-eastern part of Nigeria who reported values ranging from 5.23-11.78%, but higher than the reported values of Ajayi et al. (2020) for effect of drying method on nutritional composition, sensory and antimicrobial properties of Ginger *(Zinginber officinale)* who reported values ranging from 1.30-4.60%. The ash in food refers to the inorganic content residue remaining after the organic matter has been burnt, and It contributes to the nutritional quality of food. The difference observed in the protein content of the samples could be attributed to the difference in drying and heat source adopted. The result showed that drying affected the protein content in the dried samples as compared with the control sample. This was also observed in the study of Eyenga et al.

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(2020) for temperature dependent studies on nutritional, total polyphenols, flavonoids content and antioxidant activities of *Aframomum citratum* (*C. pereira*) *K. schum* and *Tetrapleura tetraptera* (Schum. & Thonn.) fruits and the values reported in this study were in agreement with his reported value of 4.80-18.45%, but higher than the reported values of Asogwa et al. (2021) for influence of cooking methods on *tetrapleura tetrapetra* who reported values ranging from 3.25-5.64%. Protein helps in the replacement of worn-out tissue (Van Hal, 2000). Drying methods employed reduced the fat content of the dried samples as compared with the control sample. The values recorded in this study were higher than the values reported by Okonkwo and Ogu (2021) for evaluation of some selected spices commonly used in the south-eastern part of Nigeria of 2.14% and 2.06% respectively. Fat is also a good source of energy, fat soluble vitamins and helps to increase food palatability as it absorbs and retains flavors. However, drying tremendously improved fiber content based on drying method. This report agrees with the previous study of Onimawo et al. (2019) for three Traditional Spices, but the values recorded were lower to the reported values ranging from 7.98-9.89%. Dietary fibers are non-starch polysaccharides (anti-nutrient), which bind minerals and accelerate their passage through digestive tract, as a result bioavailability and absorption of nutrients is reduced. Human dietary fiber comes from plant sources, such as fruits, vegetables, and seeds. Crude fiber is a measure of cellulose, hemicellulose, and lignin (Ogunlakin et al., 2022). Carbohydrates content of the dried samples in this study were in range with the reported values of Ajayi et al. (2020) for effect of drying method on nutritional composition, sensory and antimicrobial properties of Ginger *(Zinginber officinale)* who reported values ranging from 34.28-65.69%, but lesser than the reported values of Sinh et al. (2021) for spice formulations based on *Coelocaryonoxy carpum* (Cox), ginger and pepper who reported values ranging from 44.79-50.19%.

As for the phytochemical studies (Table 2), the saponin values obtained here were in range with the reported values 0.20-9.65% of Akinola et al. (2021) for phytochemical Constituents of three west African Vegetable Spices, but lesser than the reported values of Eyenga et al. (2020) for Temperature dependent studies on nutritional, total polyphenols, flavonoids content and antioxidant activities of *Aframomum citratum* (*C. pereira*) *K. schum* and *Tetrapleura tetraptera* (Schum. & Thonn.) taub. Fruit, who reported values ranging from 40.96-57.26%. Tannin reported were lesser than the reported values of Oloruntola *et al.,* (2021) Composition of *Momordica charantia* and *Ocimum gratissimum* who reported values ranging between 0.61-1.20%, also lesser with the reported values of Sinh *et al.,* (2021) for spice formulations based on *Coelocaryonoxy carpum* (Cox), ginger and pepper who reported values ranging from 0.81-9.83 mg/100 g. The high amount of tannins is well known to form complexes with proteins and reduced the solubility of proteins and make protein less susceptible to proteolytic attack than the same proteins alone (Olatunde et al., 2019). Flavonoids values of the samples differ which could be attributed to difference in the intensity of the drying method employed. The values obtained in this study were higher than the reported values of Ajayi *et al.,* (2020) for effect of drying method on nutritional composition, sensory and antimicrobial properties of Ginger *(Zinginber officinale)* who reported a value of 2.00% while the values reported in this study were in agreement with the reported value of Akinola *et al.,* (2021) for scent leaf and celery leaf with reported values of 2.14% and 2.06% respectively who reported values ranging from 2.45-12.17%. Phytate values obtained in this study were higher than the reported values of Asogwa et al. (2021) for the influence of cooking methods on the antioxidant status of *tetrapleura tetrapetra* who reported a values ranging from 0.12-0.37%. The values of hydrogen cyanide content obtained in this study are higher than the reported values 0.84-2.12 mg/g of Nwokoro et al. (2021).

Moreover, calcium composition of the samples (Table 3), varied from one another which was influenced by the heat treatment with the control sample having the highest calcium content, The values obtained in this study were higher than the reported values of Eyenga et al. (2020) for temperature dependent studies on nutritional, total polyphenols, flavonoids content and antioxidant activities of *Aframomum citratum* (*C. pereira*), *K. schum* and *Tetrapleura tetraptera* Fruits who reported values ranging from 63.36-110.16 mg/100 g. Calcium is necessary for blood clotting, functioning of certain enzymes. Calcium is good for bone and teeth development and strengthening. The result of iron composition of the samples varied from one another which were influenced by the heat treatment with the control sample having the highest iron content. The values obtained in this study were lesser than the reported values of Okonkwo and Ogu (2021) for evaluation of some selected spices commonly used in the south-eastern part of Nigeria who reported values ranging from 11.00-18.50 mg/100 g. The major function of iron in human nutrition is related to the synthesis of hemoglobin and myoglobin in the blood (Usman & Bolade, 2020). The values of potassium obtained in this study were lesser than the reported values of Danso et al. (2020) for effect of drying on the nutrient and anti- nutrient composition of *Bombax buonopozense* sepals who reported values ranging from 422.80-1117.64 mg/100 g. Potassium is crucial to heart function and plays a key role in skeletal and smooth muscle contraction, making it important for normal digestive and muscular function. Magnesium values obtained in this study were higher with the reported values of Dusuki et al. (2020) who reported values ranging from 2.78-3.12 mg/100 g, but lesser than the reported value of Onimawo et al. (2019) for mineral composition of three traditional spices who reported values ranging from 251.14-261.93

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mg/100 g. Magnesium plays an essential role in calcium metabolism for bone development, and is also involved in the prevention of circulatory diseases (Otolowo, et al., 2021). The zinc result showed that the zinc composition of the samples varied from one another which were influenced by the heat treatment with the control sample having the highest zinc content. The values reported in this study were lesser than the reported values 1.49-2.25 mg/100 g of Danso et al. (2020) as well as the reported values of Sanusi et al. (2022) who reported values ranging from 53.14-61.56 mg/100 g. Our bodies require zinc in small amounts to support the immune system, aid in cell division and growth, facilitate wound healing, and assist in the breakdown of carbohydrates. Zinc is also essential for our sense of smell and taste (Otolowo et al., 2021; Adeyeye et al., 2019). Sodium composition of the samples varied from one another which were influenced by the heat treatment with the control sample having the highest magnesium content. The values reported in this study were lesser than the reported values 22.18-34.18 mg/100 g of Oluwole et al. (2019) as well as the reported values of Fagbenro and Usman (2022) who reported values a value of 378.5 mg/100 g.

The values of WAC obtained in this study (Table 4) were higher than the reported values of Adebayo et al. (2023) for complementary food formulated from sorghum, walnut and ginger the reported values ranging from 0.67-1.20 g/100 g. The highest value of BD obtained in this study was in range with reported values of Oke et al. (2022) who reported values ranging from 0.70-0.74 g/100 g. The lower the bulk density value, the higher the amount of flour particles that can stay together and thus increasing energy content that could be derivable from such flour. The bulk density is generally affected by particle size and the density of flour or flour blend and it is very important in determining the packaging requirement, raw materials handling and application in wet processing in food industry (Adebowale et al., 2021; Ajanaku et al., 2022). The oil absorption capacity values obtained in this present study were higher than the reported values of Ojinnaka et al. (2020) who reported values ranging from 1.04-1.45 g/ml. Oil absorption capacity is important since oil acts as flavor retainer and increases mouth feel of foods (Aremu et al., 2008). Hence, make the flour suitable in facilitating enhancement in flavor and mouth feel when used in food production. The ability of proteins of these flours to bind with oil makes it useful in food system where optimum oil absorption is desired (Adegunwa et al., 2017). The values of swelling index obtained in this study are lower as compared with the reported values of Aderinola et al. (2023) who reported values ranging from 62.00-68.00%. Adegunwa et al. (2021) for fermentation length and Varieties on the qualities of corn starch (*Ogi*) Production reported that the presence of naturally occurring non-carbohydrates such as lipid and formation of amylase lipid complexes can restrict swelling and solubilisation. High swelling capacity of flour could be an advantage in dough development in baked foods.

Conclusion

The study investigated the selected quality properties of *Tetrapleural tetraptera* flour as affected by selected drying methods. The result revealed that selected drying methods showed significant difference ($p<0.05$) in proximate, phytochemical, mineral composition and functional properties as compared with the control sample which could be attributed to the drying methods applied. The result further showed that oven and microwave drying reduced the phytochemical content of the samples as well as the mineral composition of the samples, but had good functional properties. Sun drying on the other hands, gives the optimum results in terms of nutrients retainment. This study therefore ascertains that the applied drying methods can be adopted in the production of *Tetrapleural tetraptera* flour and related samples.

Recommendations

1. Further research should focus on the color measurement
2. Microbial analyses of the flours produced.
3. Impact of the drying methods on the pasting properties of the flour produced.

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