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EFFECT OF DRYING ON SELECTED QUALITY ATTRIBUTES OF PROMINENT CASHEW (*ANACARDIUM OCCIDENTALE*) POMACE IN OGBOMOSO

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Abstract
Cashew pomace (CP), a byproduct of cashew fruit after juice extraction, is often discarded as waste. However, it contains nutrients and bioactive compounds but deteriorates quickly due to high moisture content, causing nutrient and economic loss. This study evaluated the effect of drying temperature on selected quality attributes of CP for industrial potential. Ripe cashew apples were sorted, washed, and juiced to obtain pomace. The pomace was sliced to 2 mm thickness and dried using cabinet dryers (55, 65, 75°C) and a solar dryer. Proximate composition (moisture, ash, fat, protein, fibre, carbohydrate), phytochemicals (ascorbic acid, phenolic, carotenoid), and microbial attributes (total microbial and fungal counts) were determined using standard methods. Data were analyzed by ANOVA, with mean separation using Duncan's Multiple Range Test ($p \leq 0.05$). For cabinet-dried CP, proximate values ranged: moisture (5.15–6.03%), ash (2.03–2.82%), fat (0.93–1.54%), protein (3.49–5.90%), fibre (6.98–9.47%), and carbohydrate (77.24–78.96%). Solar-dried CP had values of 6.80, 2.15, 1.10, 5.22, 9.08, and 75.56%, respectively. Phytochemicals in cabinet-dried CP were ascorbic acid (10.18–19.99 mg/100g), phenolic (2.46–5.69), and carotenoid (648.00–1584.00), compared to solar-dried values of 9.37, 2.19, and 2460.00. Microbial counts for cabinet drying were 20.01–40.66 cfu/ml (total) and 10.13–50.68 cfu/ml (coliform), while solar drying yielded 10.43 and 20.55 cfu/ml, respectively. Comparatively, cabinet drying at 55°C ($p \leq 0.05$) retained the best quality attributes. The study demonstrates that hot-air drying enhances the quality and preservation of cashew pomace, supporting its potential for industrial application and economic value in tropical developing economies.

Keywords
Cashew pomace, drying, industrial waste, ingredient, food-product-development

1. INTRODUCTION

Many types of products are generated during production, distribution, preparation and consumption of food crops which usually range from 8 to 65% of the raw material (Salunkhe and Desphande, 2012). The wastes generated from the processing create disposal and pollution problems and hence contribute to loss of valuable biomass and nutrients in several instances (Salunkhe and Desphande, 2012). Of particular interest is the increasing growth of cashew nut processing industries in Africa, particularly in Nigeria and the consequent availability of large quantities of cashew pomace as waste arising from juice expression from cashew apples. This informed the need to determine the potentials of cashew pomace in human and animal diet and as an industrial ingredient (Akubor et al., 2013).

During the harvest, and after collection of cashew nuts, the cashew apples are discarded and left to rot away. Recently, there is a realization of the nutritional and economic importance that this pomace can provide (Preethi et al., 2021), typically in this regard this pomace serves as raw material in the production of other products which include fruit paste, candied fruit, canned fruit, jam, jelly, juice, wine and vinegar (Akubor, 2016). As a result of these paramount potentials, it is imperative to explore viable methods of preservation in order to make these products accessible at all times. One of such methods is the drying operation of some fruit pomace. After drying, Aderiye et al.(2020) suggested that the pomace could be processed into flour and used as one of the ingredients in food and animal feed formulations.

Drying is one of the major unit operations in food engineering. It does not involve chemical reactions but the physical process of reducing moisture through mass transfer (Shahzad et al., 2013). Therefore, an adequately processed pomace into flour could be used in several ways that other plant by-products are used. This suggests that for efficient utilization and acceptance of cashew pomace flour, studies on its desirable keeping, processing and nutritional properties are important. Consequently, this study investigates the effect of the drying method on selected quality attributes of cashew pomace.

2. MATERIALS AND METHOD

Non-damaged and unspoiled cashew apples were harvested from a local farm in Ogbomoso. The time from harvesting to processing was ensured not to exceed 24h to maintain its freshness and avoid deterioration of its apple. Cashew apples were washed with clean water, then juice was squeezed out from the apple to obtain pomace. The pomace was placed in a tray and kept in the refrigerator for 2 hours. The experiment was conducted at the *Owodunn*i Food Processing Laboratory, LAUTECH, Ogbomoso.

2.1 Cabinet and solar drying

The pomace was sliced to a thickness range of 2mm and placed on the tray of a cabinet dryer. The cabinet dryer was maintained at 55, 65, and 75 ºC, respectively and moisture content was measured at an interval of 1h until constant weight was reached.

The pomace was sliced to a thickness range of 2 mm and kept inside the solar dryer platform. Observations on loss in weight and colour change in sample were recorded at intervals of 1h. Temperature in the solar dryer was recorded throughout the drying period using a thermometer as reported by Asiru (2013).

2.2 Quality Parameter Assessment

Proximate analyses were carried out on the samples to determine the compositions of carbohydrate, ash content, crude fibre, and moisture content according to procedures by AOAC (2019).

2.3 Determination of Total Carotenoids

Carotenoid content of fresh and dried fruit samples was extracted and determined as described by Perez-Lopez et al. (2015) and Zhang et al. (2020) with little modification: Five grams of well pulped sample was placed into a 50 mL falcon tube. Then, 40 mL of extraction solvent; Hexane (Gato Perez, 33-P.I. Mas d'En Cisa, Spain): Acetone (Loba Chemie Pvt. Ltd, India): Ethanol (Wagtech Projects Ltd, Thatcham, Berks) at the ratio of 2:1:1 (vol/vol/vol) was added, and the mixture was centrifuged at 4000 rpm for 5 min. The residue was re-extracted until it became colorless. The top layer of hexane was transferred into a separating funnel and 50 mL of 10%, wt/vol sodium chloride (Uni-Chem, Chemical Reagents) was added to remove residual acetone. The upper phase was recovered, dried over anhydrous sodium sulphate (Loba Chemie Pvt. Ltd, India) and absorbance was measured at 450 nm. The level of carotenoids of the fruit sample was expressed as g/100 g (dry basis) based on the calibration curve of β-carotene (Sigma-Aldrich, USA).

2.4 Determination of Vitamin C (Ascorbic acid)

Exactly 0.1g of the dried sample was taken into a 15 ml test tube. This was extracted with 1ml of 4% trichloroacetic acid (TCA). The mixture was stirred with a vortex mixer and allowed to stay for 15 min. The component was centrifuged at 2000 rpm for 5 min. 500 microliters of Vitamin C color reagent (Dichlorophenolindophenol) was added to 250 microliters of the supernatant. The orange color that developed was measured at 700 nm. Blank was prepared the same way as sample, but TCA used in place of sample supernatant. The standard was prepared by using ascorbic acid at various concentrations. The vitamin C content in each sample was calculated from the standard curve prepared using the standard method (Salunkhe and Desphande, 2012).

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The aliquots of the extracts, 0.1ml (1mg/ml) were taken in test tubes. Then 0.5ml of Folin-Ciocalteu reagent (1:1 with water) was added and mixed. After 2min, 2ml of sodium carbonate solution (7.5%) was added sequentially to the test tubes. Immediately after vortexing the reaction mixture, the tubes were placed in the dark for 40 min and the absorbance was recorded at 760 nm against the reagent blank. Using Gallic acid monohydrates, a standard curve was prepared, while distilled water served as the blank. The linearity obtained was in the range of 20-100 µg/ml. Using the standard curve, the total phenolic content was calculated and expressed as Gallic acid equivalent in mg/100g of the sample (Salunkhe and Desphande, 2012).

2.5 Microbial Analysis of Dried Cashew Apple Pomace

Bacterial and fungal counts of cashew pomace samples were analyzed separately using pour plate technique as described by Zhang et al. (2020) with little modification: Exactly 1 g of dried cashew apple pomace pulp was mixed with 9 mL of sterile peptone salt and vortexed for 5 min. Then, 1 mL of the suspension was transferred into the peptone salt diluents (9 mL) up to 10-3 of dilution series. From each dilution, 1 mL of diluted sample was inoculated into the respective growth media of Plate count agar (PCA) for bacteria and potato dextrose agar (PDA) for yeast and mold. The incubation conditions were 1 day at 30 °C for bacteria and 3 days at 30 °C for yeast and mold.

2.6 Data Analysis

The quality parameters were statistically analyzed using Statistical Package for Social Scientists (SPSS) 25 software package and were subjected to analysis of variance (ANOVA). These were based on the means calculated from the data obtained **(in triplicate).** Duncan multiple range test was used to separate the means ($P \leq 0.05$).

3. RESULTS AND DISCUSSION

3.1 Proximate Analysis of Cashew pomace (*Anacardium occidentale)*

The chemical composition of the dried cashew pomace is presented in Table 1. The moisture content of sample dried with cabinet dryer at 55, 65 and 75^{0}C ranged between 5.15 and 6.03% while the sample solar dried was 6.871%, while there were significant differences between the means of the samples dried at different temperatures, It also showed that cabinet drying was more effective than solar drying. However, the moisture contents obtained from both drying methods are within the suitable range for stable storage of flour products. Moisture content above 15% has been reported to cause mold growth in foods (Rashid and Nakorn, 2018). Mold growth and moisture dependent biochemical reactions are known to be reduced in low moisture foods during storage (Akubor et al., 2013).

The ash contents ranged from 2.14 to 2.81% for cabinet drying across temperature ranges of 55, 65 and 75^{o}C respectively. The ash content of the solar dried sample was 2.25%. Also, there were significant differences between the means of these samples. The high values of ash content of the samples dried at 75^{o}C could be due to inorganic residue left after a sample is dried at higher temperature (Akubor, 2016). The crude fiber and carbohydrate values ranged from 6.97 to 8.22% and 78.21% to 77.24% for samples dried with cabinet dryer at different temperatures, while the values for solar dried samples were 9.08% and 75.56% for crude fibre and carbohydrates respectively with significant differences between the means of the samples. The high level of crude fiber could be of potential usefulness for enriching diets. The therapeutic effects of this fiber in the prevention of heart diseases, colon cancer and diabetes and their role in the treatment of digestive disorders (diverticulosis) and constipation are enormous (Rainha et al., 2011), hence it stands a potential use in food formulations for functional diets.

Table 1: Proximate Analysis of Cashew Pomace

Samples	Moisture (%)	Ash (%)	Carbohydrate (%)	Lipid (%)	Fibre (%)	Protein (%)
Cabinet drying (55^{0}C)	5.155±0.012^a	2.142±0.104^b	78.216±0.455^c	1.540±0.283^b	6.977±0.056^a	5.970±0.000^d
Cabinet drying (65^{0}C)	5.125±0.029^a	2.029±0.154^a	78.964±0.123^d	0.931±0.034^a	9.472±0.107^d	3.478±0.001^a
Cabinet drying (75^{0}C)	6.036±0.024^b	2.815±0.032^d	77.240±0.044^b	1.351±0.127^{ab}	8.211±0.179^b	4.347±0.11^b
Solar drying	6.871±0.077^c	2.152±0.026^c	75.563±0.018^a	1.103±0.020^{ab}	9.085±0.013^c	5.225±0.01

Means with similar letter in the same row and within the same column are not statistically different from each other ($p > 0.05$)

3.2 Phytochemical parameters of dried cashew pomace

Figure 1 shows the phytochemical (ascorbic acid, phenolic and carotenoid acid) parameters of solar dried and cabinet dried cashew pomace. The solar dried samples had significantly ($p < 0.05$) lower total ascorbic acid content when compared with the cabinet dried samples. The lower ascorbic acid content of the solar dried sample could be attributed to the longer drying time. The retained amount of ascorbic acid of 19.985 mg/100g and 9.369 mg/100g for cabinet dried and solar dried samples respectively are higher compared to fresh fruits such as strawberry, lemon, orange and grapefruit reported by Motevali et al. (2012). The retained amount of ascorbic acid in the dried samples suggests that the samples could serve as a good source of ascorbic acid in food formulations.

Cashew apple is known to contain a significant number of polyphenolic constituents such as flavonoids and phenolic acids (Zhang et al., 2015). Polyphenols possess antioxidant and anti-inflammatory activities, hence important in prevention and treatment of chronic diseases such as cancer and cardiovascular diseases (Olamide, 2022). Total phenolic content determined ranges between 2.159 and 5.695 whereby solar dried cashew pomace was significantly ($p < 0.05$) lower in the value than the cabinet dried sample at 55 ^{0}C. This could also be attributed to exposure to sunlight over a long period of time.

Carotenoid contents varied in the samples dried with cabinet dryer and solar dryer. Sample dried with a solar dryer had lower ($p < 0.05$) number of carotenoids compared to fresh fruit. Carotenoid content ranged between 2460 m/g to 648m/g of which the solar dried sample had the significantly higher values when compared to the dried samples across temperature levels in the cabinet dryer. The loss of carotenoids could be due to relatively higher drying temperature compared to the solar dryer. Carotenoids are reported by Zhang et al. (2015) to be more susceptible to drying temperature than drying time. According to Motevali et al. (2012), carotenoids were more retained in the samples dried at 40 °C for a longer time than above 40 °C for a shorter time. The values of carotenoid content of cabinet dried products and solar dried were 2460 m/g to 648 m/g which is similar to those reported by Asiru (2013).

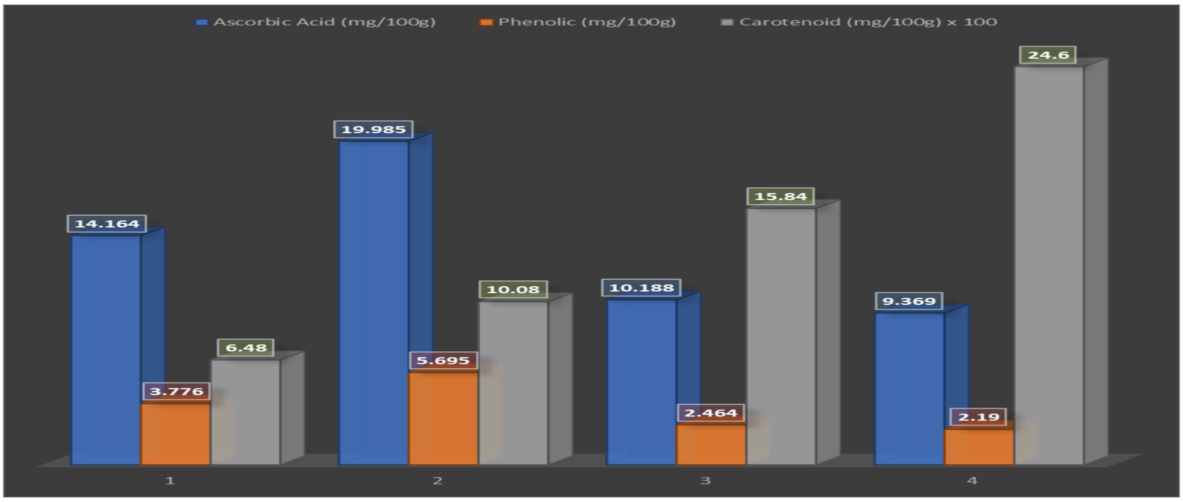

Figure 1: Phytochemical properties of cashew pomace

3.3 Microbial analysis of cashew pomace

Table 2 represents the microbial contents (mean ± SE) of the cabinet and solar dried samples. Cabinet dried pomace at different temperature levels contained varied fractions of fungi and bacteria. Bacteria count for dried pomace ranged between 10.43 and 40.65 cfu/ml, while total fungi (TFC) counts ranged from 10.12 to 50.67 cfu/ml. Cabinet dried at 55^{0}C of cashew pomace dried recorded the highest bacteria count (40.659±0.008 cfu/ml) while (solar dried) had the lowest. Also, cabinets dried at 55 ^{0}C recorded the highest fungi counts (50.675±0.077cfu/ml). This implied that the increase in temperature reduced both the TFC and TBC significantly ($p < 0.05$).

Table 2: Microbial Analysis of Ogbomoso Cashew Apple Pomace

Samples	TBC (cfu/ml)	TFC (cfu/ml)
Cabinet drying (55 ^{0}C)	40.659±0.008^d	50.675±0.077^d
Cabinet drying (65 ^{0}C)	30.156±0.002^c	30.113±0.065^c
Cabinet drying (75 ^{0}C)	20.016±0.001^b	10.128±0.015^a
Solar drying	10.437±0.001^a	20.554±0.036^b

Means with similar letter in the same row and within the same column are not statistically different from each other ($p > 0.05$)

4. CONCLUSION

This study has demonstrated the impact of hot-air drying on the quality attributes of the prominent cashew in Ogbomoso with drying by cabinet producing samples with better industrial potentials. This indicates the possibility of sustaining the cashew pomace for industrial growth and additional income for the small holder farmers and consequently as a valuable index to revert the nutritional and economic loss associated with cashew apples in tropical developing countries.

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