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EFFECT OF FERMENTATION ON THE CHEMICAL COMPOSITION OF PAWPAW (CARICA PAPAYA) SEEDS

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ABSTRACT

Pawpaw seed is a rich source of phytochemicals with great preservative potentials. However, it is an underutilised seed due to lack of awareness of its use by consumers. As a result, this research was aimed at evaluating the effects of fermentation on the chemical composition of fermented pawpaw (Carica papaya) seed. The traditional method of fermenting locust bean by (Afolabi and Ofobrukweta, 2011 and Dakare 2011) was adopted with some modifications, pre-dried dehulled, pawpaw seed kernels were boiled, incubated and allowed to ferment for 72 h and dried. Analysis was carried out to determine the chemical composition using AOAC (2005). The chemical composition of TEYPS-Tsolo Elongated Yellow papaya seed, which is the variety used for this study contained; 6.41%, ash; 22.32%, protein; 40.29%, fat; 5.47%, fibre; 9.66, moisture content; 15.85%, carbohydrate; 4.69mg/100g, calcium; 5.95mg/100g,iron; 22.52 mg/100g, sodium and 15.51mg/100g, potassium. The fermented sample had the nutritional and chemical composition of; 7.46%, ash; 24.50%, protein; 42.60%, fat; 6.77%, fibre; 7.67%, moisture content; 11.00%, carbohydrate;7.18mg/100g, calcium; 4.33mg/100g, iron; 28.78mg/100g, sodium; 18.38mg/, potassium. The result showed that fermentation greatly improved the nutritional value of the seed.

KEYWORDS

Article History

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INTRODUCTION

Fruits and vegetables are important sources of phytochemicals which are highly beneficial for the maintenance of good health and prevention of diseases (Nnamani *et al*., 2007). Fruits and vegetables are integral parts of agricultural produce in Nigeria. Insignificant proportion of our indigenous fruits and vegetables are cultivated, while some of them remain as wild species (Sheela[*et al*., 2004).

There is a wide variety of indigenous fruits and vegetables found in Africa, which are chief sources of antioxidants, vitamins and minerals (Odhav *et al*., 2007). Insufficient consumption of vegetables and fruits annually cause 2.7 million deaths worldwide and is one of the top ten risk factors contributing to human mortality (Falade *et al*., 2008). This necessitates the inclusion of fruits and vegetables (especially where exotic meals are not affordable) in diets and it is known to have alleviated problems of hunger and malnutrition which is most prevalent in several African countries (Eifediyi *et al*., 2008).

Pawpaw (*Carica papaya*) belongs to the family *Caricaceae*; with four genera. The genus is represented by four species of which *Carica papaya Linn*. is most widely cultivated and best known. The other species are *C. cauliflora*, *C.pubescens* and *C. quercifolia*. Practically, every part of the pawpaw plant is of economic value and its use ranges from nutritional to medicinal (Onibon *et al*., 2007).

Pawpaw plant produce natural compounds (*Annonaceous acetogenins*) in leaf, bark and twig tissues that possess both anti-tumor and pesticidal properties. The fruits are popularly used as dessert or processed into jam, puree or wine while the green leaves are cooked as vegetable (Mauseth, 2003). The fruit is also used as animal fodder and it is usually consumed by humans. It contains high level of vitamins A and C, lycopene, β cryptoxanthin, minerals and fibre (Adetuyi *et al*., 2008). Unripe *Carica papaya* contains terpenoids, alkaloids, flavonoids, carbohydrates, glycosides, saponins and steroids (Adetuyi *et al*., 2008).

Fermentation in food processing is the conversion of macromolecules such as carbohydrates to alcohols and carbon dioxide or organic acids using yeasts, bacteria, or the combination, under anaerobic conditions. Fermentation usually implies that the action of microorganisms is desirable (McGovern *et al*., 2004). Fermentation is sometimes used to specifically refer to the chemical conversion of sugars into ethanol, a process which is used to produce alcoholic beverages such as wine, beer and cider (McGovern *et al*., 2004). It gives physical and nutritional benefits to the food and plays the roles of enhancing flavors, odor and textures of food. It aids food preservation through lactic acid, alcoholic or alkaline fermentations. It also increases the nutritional value of food by producing different vitamins and protein. Furthermore, fermentation helps in reducing toxins substances in foods (McFaeeters, 2004). The preservative quality in food and beverages is due to antimicrobial metabolites formed during fermentation (Caplice and Fitzgerald, 1999). This study therefore studied the effect of fermentation on the chemical composition of pawpaw (*Carica papaya*) seeds.

MATERIALS AND METHODS

Materials

Matured ripe fruits of *Carica papaya* (variety T. solo) were obtained from Akintola Farm in Ogbomoso. The fruits were identified and authenticated at Department of Pure and Applied Biology, Ladoke Akintola University of Technology Ogbomoso. The chemicals and reagents used were of analytical standard. The experiment was carried out in Food Science and Engineering Lipid Laboratory, LAUTECH, Ogbomoso,

Methods

Preparation of *Carica papaya* Seeds

The method of Afolabi and Ofobrukweta (2011) and Dakare, (2011) was adopted with some modications. The raw *Carica papaya* fruit was cut into two longitudinal halves. The seeds were removed and dehulled manually, the hulls were allowed to float and decanted to obtain the seed kernel. The seed kernels were pre-dried in the oven (Model, Uniscope SM9053) at 50 °C for 20 h.

Fermentation of *Carica papaya* Seed Kernel

The traditional method of fermenting locust bean (*Parkia biglobossa*) was adopted with some modifications. Pre-dried dehulled, *Carica papaya* seed kernels (250 g) were poured into a container and 1litre of distilled water was added to give a ratio of 1:4 (w/v). The dehulled dried seeds were boiled for 2 h and while, still hot, they were filtered and spread in a jute bag lined with fresh pawpaw leaves. The seeds were incubated at 37 ºC in a dark room, allowed to ferment for 72 h and dried in the oven (Model, Uniscope SM9053) at 120 °C for 10 h. It was milled and packaged (Dakare, 2011). The flow diagram for the fermentation is shown in Figure 1.

Proximate Analysis

Protein Content

Protein content was determined using the method described by AOAC (2005). Two gram of the sample was weighed into a Kjeldahl digestion flask and one tablet of selenium catalyst was added.

Dried *Carica papaya* Seed Kernel

↓

Rinsing (in water)

↓

Boiling for 2h

↓

Fermentation (for 72h in a jute bag lined fresh pawpaw leaves)

↓

Drying (for 10 hours at 120 °)

↓

Milling

↓

Packaging

Figure 1: Flow Diagram for the Fermentation of Carica Papaya Seed.

The mixture was digested in an electro-thermal heater until a clear and colourless solution was obtained. The flask was then cooled after which the solution was diluted with water to 50 ml and 5 ml of this was transferred into the distillation apparatus. Five (5) mililitre of 2% boric acid was pipetted into 100 ml conical flask and four drops of methyl indicator was added. Fifty percent of NaOH was continually added to the digested sample until the solution turned cloudy which indicated that the solution had become alkaline. The distillation process was carried out into the boric acid solution in the receiver flask with the delivery tube below the acid level. As the distillation process progressed, the pink colour solution in the receiver flask turned to blue which indicated the presence of ammonia.

Distillation process was allowed to continue until the content of the flask was about 500 ml after which the delivery of the condenser was rinsed with distilled water. The resulting solution in the conical flask was then titrated with 0.1ml HCl. The corresponding concentration was taken which was used to calculate the percentage protein as below.

$$\%\ \text{Protein} = \frac{Conc.\ x\ 0.0075\ x\ 6.25}{Wt.\ of\ Sample}$$

The determinations were done in triplicate and the mean value was recorded

Fat Content

The soxhlet extraction method described by (AOAC, 2005) was used. Two grams (2 g) of sample was weighed and the weight of the flat bottom flask taken with the extractor mounted on it. The thimble was held half way into the extractor and the weighed sample. The thimble was plugged with cotton wool. At completion of extraction which lasted for 8 h, the solvent was removed by evaporation on a water bath and the remaining part in the flask was dried at 80 ^{o}C for 30 min in the air oven to dry the fat and then cooled in a dessicator.

% Fat =

$$\frac{Wt.of\ cup\ with\ extracted\ oil - Wt.of\ empty\ cup}{Wt.of\ cup}\chi 100$$

Moisture Content

The moisture content was determined using the method of AOAC (2005). Drying of sample was done in a hot air oven at a temperature of 105 ^{o}C for three hours. After three hours, the petri-dish plus the sample was then transferred to the desiccator to cool before it is weighed. The process was repeated four times until a constant weight was obtained. The weight lost during the drying process was determined and taken as the percentage moisture content.

$$\%\ \text{Moisture content,} = \frac{M_1 - M_2}{M_1 - M_0} x100$$

Where M_0 = wt. in (g) of dish and lid

M_1=Wt. in (g) of dish, lid and sample before drying

M_2= Wt in (g) of dish, lid and sample after drying

Ash Content

The AOAC (2005) procedure was used. Crucible was washed and dried in an oven and allowed to cool in a desiccator before it is weighed. 5g of the sample was weighed into the empty porcelain crucible which was ignited. The sample was ignited over a low flame in fume cupboard to char organic matter. The crucible was placed in a muffle furnace maintained at a temperature of 600 $^{\circ}$C for 8 h. The crucible was transferred directly to a desiccator, cooled and weighed immediately and the % ash was calculated as shown below:

%Ash=

$$\frac{(Wt.of\ of\ crucible + ash) - (Wt.of\ empty\ crucible)}{Sample\ weight}\chi 100$$

Fibre Content

The AOAC (2005) procedure was used. About 2 grams of the sample was accurately weighed into the fibre flask and H_2 SO_4 added. The hot mixture was filtered through a fibre sieve cloth. The filtrate obtained was thrown off and the residue was returned to the fibre flask to which NaOH solution will be added and heated under reflux. The residue was washed with about 50 ml hot water before it was finally transferred into the crucible. The crucible and the residue was oven dried at 105 $^{\circ}$C overnight to drive off moisture. The oven dried crucible containing the residue was cooled in a desiccators and later weighed to obtain the weight W. The crucible with weight W_1 was transferred into the muffle furnace for ashing at 550 $^{\circ}$C for 4 hours. The crucible containing white or grey ash (free of carbonaceous material) was cooled in the desiccators and weighed to obtain W_2. The difference W_1-W_2, gives the weight of fibre. The percentage above was obtained by formula.

$$\% \text{ Fibre} = \frac{W_1 - W_2}{Wt. of\ sample} x100$$

Carbohydrate Content

This was determined by difference using AOAC (2005) procedure.That is, the addition of moisture, ash, protein, fibre, fat and subtracting the sum value from 100 to give the carbohydrate content of each of the samples**.**

Mineral Analysis

The method described by AOAC (2005) procedure using Atomic Absorption Spectrophotometer (AAS) was used for determination of some major minerals like calcium sodium, iron, and potassium. To operate the AAS, the control panel and the pressure regulator was set at 200mark. Thereafter, required hollow cathode (HC) lamp corresponding to the required mineral and the holder as the lamp compartment was installed. The concentration of the various metallic mineral elements was determined using the appropriate lamp current meters. The analysis was carried out in triplicates and mean value recorded. Phosphorus was determined by colorimetric method using the Fiske Subbcrow molybdate yellow method.

RESULTS

Data on the effect of fermentation on the chemical composition of *Carica papaya* seed is presented in Table1. The moisture content of unfermented ground *Carica papaya* seed was 9.66%. This is slightly different from the report of Karuna and Vijaya (2014) who recorded a moisture content of 8.53% for *Carica papaya* seed, when a nutritive assessment of different plant parts of *Carica papaya* was

Table 1: Effect of Fermentation on the Chemical Composition of Carica Papaya Seed

Chemical Composition	Unfermented Sample	Fermented Sample
Ash (%)	6.41±0.02	7.46±0.02
Protein (%)	22.32±0.01	24.50±0.03
Fat (%)	40.29±0.02	42.60±0.03
Fibre (%)	5.47±0.02	6.77±0.02
Moisture content (%)	9.66±0.01	7.67±0.01
Carbohydrate (%)	15.85±0.01	11.00±0.02
Calcium (mg/100g)	4.69±0.03	7.18±0.01
Iron (mg/100g)	5.95±0.02	4.33±0.01
Sodium (mg/100g)	22.52 ±0.01	28.78±0.03
Potassium (mg/100g)	15.51±0.01	18.38±0.03

Values are means and standard deviation of triplicate determination carried out. Similarly, Adesuyi and Ipinmoroti (2011) reported a range of 7.6 - 8.1% for the moisture content of three varieties of *Carica papaya* seed flour.

The moisture content of fermented ground *Carica papaya* seed was 7.67%. There was reduction in the values after fermentation; this could be as a result of hydrolytic action of the fermenting microbes. This indicates that fermentation led to reduction of the moisture content which is an effective way of preventing spoilage. Morris *et al*. (2004) reported that decrease in moisture generally increases the concentration of nutrients and the higher the moisture content of any food product the more susceptible it is to deterioration (Doymaz, 2007; Sobukola *et al*., 2007). The protein content of *Carica papaya* seed increased from 22.30 to 24.50%. This value is a bit lower than the report of Adesuyi and Ipinmoroti (2011) with a record of 29.1-31.9% for the protein content of three varieties of *Carica papaya* seed. Bolu *et al*. (2009) also recorded 30.08% for the protein content of dried *Carica papaya* seeds. However, Maisarah *et al*. (2014) reported a protein content of 25.10% for seeds of *Carica papaya*. In like manner, Dakare *et al*., (2011) recorded a significant increase from 21.72 to 23.56% after fermentation. Increase in the protein content after fermentation may be as a result of proteolytic activity of bacterial being enhanced during fermentation. This increases the bioavailability of essential amino acids (Chaven and Kadams, 1989). Obadina *et al*. (2013) observed a gradual increase in the protein content of soymilk as the time of fermentation increased. The fat content of *Carica papaya* seed sample increased significantly from 40.29 to 42.60% after fermentation. This is in accordance with the result obtained by Dakare *et al*. (2011) that recorded an increase in the fat content of *Carica papaya* seed from 48.50 to 54.19% after fermentation. Afolabi *et al.* (2011) also reported that fermentation enhanced increase in the fat content of *Carica papaya* seed. Similarly, Lasekan and Mehdizadeh (2013) reported a significant increase in the fat content of Rambutan seeds after fermentation. This is also in agreement with the result obtained in this study.

The carbohydrate content decreased after fermentation from 15.85 to 11.00% this may be because fermenting microorganisms might have used up the carbohydrate or converted it to fatty acid. The Ash content increased after fermentation from 6.41 to 7.46%, as well as the fibre content from 5.47 to 6.77%. This result is comparable with that of Ojokoh *et al*. (2015) who reported a decrease in the ash content of pearl-millet and acha flour blends when subjected to fermentation. Dakare *et al.* (2011) reported that the ash content of decorticated *Carica papaya* seed reduced from 4.09 to 3.95% after fermentation while the fibre content increased slightly from 0.57 to 0.59%. This result can be compared with that of Eze and Ibe (2005) that recorded an increase in the fibre content of Achi (*B. eurycoma*) seed after fermentation.The increase may be as a result of the activities of micoorganisms and the conversion of some materials to fibre (Oladele and Oshodi, 2005).

The calcium content of *Carica papaya* seed increased from 40.69 to 65.18 mg/100g after fermentation. The value of potassium also followed an increasing trend which is in conformity with Dakare *et al.* (2011) that recorded increase in the amount of calcium and potassium after subjecting some *Carica papaya* seeds to fermentation. However, iron and sodium content decreased from 5.95 to 4.33mg/100g and from 42.52 to 38.78mg/100g respectively. Dakare *et al.* (2011) observed a decrease in the iron and sodium content of *Carica papaya* seeds after fermentation. This indicates that fermentation enhanced the increase of calcium and potassium while it led to decrease in iron and sodium content. Decrease in some of the mineral content like iron and sodium, may be due to leaching of soluble minerals into processing water during the period of boiling before fermentation or fermenting microorganisms might have used up the minerals for metabolic activities (Osman, 2007).While increase in some mineral content like calcium and potassium, may be due to contribution from the fermenting microorganisms. Jokotagba *et al*. (2015) recorded an increase in the essential minerals such as iron, sodium magnesium, potassium and copper during fermentation of *Phoenix dactylifera L* but there was a slight decrease in calcium which may be due to leaching. Hassan *et al*. (2015) reported that fermentation significantly reduced the amount of sodium, iron and zinc in the samples of fermented cocoyam while phosphorus, potassium, magnesium and calcium were on the increase.

CONCLUSIONS

The result showed that fermentation greatly improved the nutritional value of the seed.

RECOMMENDATIONS

Fermentation of pawpaw seed for 72 h is highly recommended before further processing or analysis is carried out because of improvement in the nutritional value and in order to detoxify the seed.

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