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EFFECT OF FERMENTATION ON THE PROXIMATE COMPOSITION OF CASHEW APPLE RESIDUE

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ABSTRACT

This study was designed to investigate the effect of fermentation on proximate composition of cashew apple residue using standard methods. The result showed a microbial population changes during the fermentation revealing a significant reduction in the total heterophlic bacteria and lactic acid bacteria (LAB) counts from 203.00±0.10[a] (0 hrs) to 22.67±0.03[c] (72 hrs) and 115.00±0.00[a] (0 hrs) to 17.33±0.02[a] (48 hrs) respectively. However, the fungal count increased steadily from 54.33±0.02[d] (0 hrs) to 107.00±0.10[a] (72 hrs). Moreover, five (5) bacteria and five fungi were isolated from the cashew apple residue, they were Staphylococcus aureus, Micrococcus luteus, Bacillus subtilis, Bacillus licheniformis, Lactobacillus fermentum (bacteria) Saccharomyces cerevisiae, Aspergillus niger, Aspergillus fumigatus, Geotrichum candidum and Rhizopus stolonifer (fungi). There was a decrease in the pH from 4.47±0.00[a] to 3.70±0.02[d] with concomitant increase in TTA from 0.19 ±0.02[c] to 0.26 ±0.10[a] whereas, there was an increase in temperature from 0 hrs (27.03 ±0.15[c]) to 48 hrs (30.05 ±0.01[a]) then declined (29.11 ±0.00[ab]) at 72 hrs. In the proximate analyses, moisture (30.02±0.00[a]), fibre (23.01 ±1.00[a]), ash (1.44 ±0.03[a]) and carbohydrate (36.39 ±0.02[a]) contents of fresh cashew apple residue were higher than that of the fermented sample while the protein (2.88 ±0.02[a]) and lipid (14.00 ±0.05[a]) contents of the fermented sample were higher than that of the fresh sample. From the foregoing, both bacteria and fungi are responsible for cashew apple residue fermentation and this improved the nutritional properties of cashew apple residue therefore, it can be utilized as animal feed.

***Keywords:** cashew apple residue, proximate, microbial, waste*

1. INTRODUCTION

Cashew (*Anacardium occidentale* L.) a tropical evergreen tree plant is one of the highly underutilized/underexploited plants [1]. There have been several researches on various aspect of cashew production and marketing, these include assessment of morphological and molecular characteristics, ploidy status, reproductive biology, development of improved technology for large scale production of value added cashew products, formulation of comprehensive farm management practices, soil and mineral requirements assessments and effective strategies for pest and disease control [2, 3]. These efforts have led to improved cashew production in Nigeria with increase in the tonnage of cashew nuts being exported annually [4].

Cashew is majorly planted for its nut (about 10% of the cashew fruit) which is a highly valued commodity for its shell oil also known as cashew nutshell liquid (CNSL), while the apple is usually left on the farm to rot away. Moreover, apart from direct consumption of the apple, there is no reported use of the apple in Nigeria [5].

It has been observed that the cashew industry plays a major role in the economic development of countries like Vietnam, India, Ivory Coast, and Ghana [6]. Therefore, the waste generated during the production (harvesting) of cashew on farm in cashew industry could be exploited for empowering smallholder farmers with a particular focus on women, creating revenues and employment opportunities, and promoting small- to-medium-scale industrialization processes, especially in rural areas.

Hence, this study was carried out with the aim of evaluating the effect of fermentation on proximate composition of cashew apple residue with the vision of turning it to a usable material in animal feeding.

2. MATERIALS AND METHODS

2.1 Plant collection, identification and preparation

Fresh cashew apples (*A. occidentale*) were harvested from parent plants at the Research Farm Plantation of Rufus Giwa Polytechnic, Owo, Ondo State Southwest Nigeria. The plant material was identified at the herbarium section of the Department of Crop Production Technology and a voucher specimen (XV-201AO) was deposited. The nuts were removed manually by turning, the apples were crushed with a laboratory blender and the juice filtered out with a sieve. The residue was collected for further analyses.

2.2 Reagents /chemicals

All reagents and chemicals were of analytical grade and were obtained from the Department of Science Laboratory Technology, Rufus Giwa Polytechnic, Owo, Ondo State Nigeria.

2.3Experimental design

i. Fermentation procedure

The cashew apple residue was subjected to spontaneous fermentation by packing 1 kg of the residue inside a wooden box and maintained at room temperature (27±2^{o}C) for 72 hrs [7]. The changes pH, temperature and total titrable acidity as well as the microbial population changes were monitored at 24hrs interval.

ii. Microbiological Analysis

The raw and fermenting samples were subjected to microbiological analysis using serial dilution and pour plated in triplicates on the following media (1) Nutrient agar for estimation of bacteria (2) Mann Rogosa Soy Agar for estimation of Lactic acid bacteria, (3) PDA agar for estimation of fungi, these were incubated at appropriate temperatures for 24, 48 and 72hrs respectively. Discrete colonies were isolated to get pure cultures, bacteria were identified based on the method of [8] while fungi were identified using the method of [9].

iii. pH and total titrable acidity

A 10g portion of each of the raw and fermented samples was used for pH and temperature determination using an automated pH-Temperature analyzer while Total titratable acidity (TTA) was determined by titrating 20ml of the same sample against 0.1M NaOH.

iv. Proximate composition

The moisture, crude fibre, fat, protein (N×6.25), ash and carbohydrate contents of both the fermented and raw samples were determined using relevant methods described previously by AOAC [10].

v. Statistical analysis

Unless otherwise indicated results are expressed as means ± SD of three replicates. Data were subjected to one –way analysis of Variance (ANOVA) using SPSS version 17.0. The Duncan's Multiple Range test was used to separate the means at the 5% level of probability.

3. RESULTS AND DISCUSSION

The result of microbial population changes during the fermentation of cashew apple residue is presented on Table 1. The table revealed that the total heterophlic bacteria and lactic acid bacteria (LAB) counts reduced significantly during the fermentation period from 203.00±0.10^{a} (0 hrs) to 22.67±0.03^{c} (72 hrs) in total bacteria count on the cashew apple residue while the LAB count reduced from 115.00±0.00^{a} (0 hrs) to 17.33±0.02^{a} (48 hrs) after which it disappeared from the fermentation mass. However, the fungal count increased steadily from 54.33±0.02^{d} (0 hrs) to 107.00±0.10^{a} (72 hrs).

Five (5) bacteria and five fungi were found on the fermented cashew apple residue, they were *Staphylococcus aureus, Micrococcus luteus, Bacillus subtilis, Bacillus licheniformis, Lactobacillus fermentum* (bacteria) *Saccharomyces cerevisiae, Aspergillus niger, Aspergillus fumigatus, Geotrichum candidum* and *Rhizopus stolonifer* (fungi). Previous studies suggest that these microorganisms are associated with fruit spoilage [11, 12].

The presence of *S. aureus* and *M. luteus* may be due to environmental contamination while the presence of *B. subtilis, B. licheniformis* and *L. fermentum* may be due to the natural tendency of these organisms to ferment substances in nature for their metabolism [13]. Albeit, the disappearance of LAB after 48 hrs indicates the inability of this organisms to survive in the fermenting cashew residue. *S. cerevisiae* have been implicated in fermentation of fruit juice and residues from fruit processing industries since these plant materials contain high sugar content which is fermented by this yeast to produce alcohol [14]. The isolated moulds have been implicated in fermentation of many sugary materials, however, *A. niger* is also known to be an environmental contaminant [15].

Table 1: Changes in microbial population during the fermentation of cashew apple residue

Time (hrs)	TBC (cfu/g)	TFC (cfu/g)	LBC (cfu/g)	Isolates
0	203.00±0.10^{a}	54.33±0.02^{d}	115.00±0.00^{a}	*S. aureus, B. subtilis, B. licheniformis, L. fermentum, M. luteus, S. cerevisiae, R. stolonifer, A. niger*
24	189.00±0.01^{a}	79.67±0.02^{c}	76.00±0.10^{b}	*B. licheniformis, B. subtilis, L. fermentum, G. candidum, A. fumigatus, R. stolonifer*
48	97.33±0.01^{b}	98.33±0.07^{b}	17.33±0.02^{c}	*B. licheniformis, L. fermentum, A. niger, R. stolnifer, G. candidum*
72	22.67±0.03^{c}	107.00±0.10^{a}	0.00±0.00^{d}	*B. licheniformis, G. candidum, R. stolonifer*

Key: TBC= total bacteria count, TFC= total fungal count, LBC= lactic acid bacteria count. Values are presented as Mean±S.E.M and values followed by different superscript along the column are significantly different.

The result of the changes in the pH, temperature and total titrable acidity of the cashew apple residue during fermentation is presented in table 2. The table showed a decrease in the pH from 4.47±0.00^{a} (0 hrs) to 3.70±0.02^{d} (72 hrs) with concomitant increase in TTA from 0.19 ±0.02^{c} (0 hrs) to 0.26 ±0.10^{a} (72 hrs) whereas, there was an increase in temperature from 0 (27.03 ±0.15^{c}) to 48 (30.05 ±0.01^{a}) hrs then declined (29.11 ±0.00^{ab}) at 72 hrs

Fermentation was observed to cause a reduction in the pH with time with the products becoming more acidic with increase in fermentation time with concomitant increase in the titratable acidity of the fermented cashew apple residue. The observed increase in titrable acidity and decrease in pH could be due to the production of acid by these organisms during degradation of carbohydrates resulting in acidification. These observations are in agreement with earlier report of Nout *et al*. [16].

The result of the proximate analyses of the fermented cashew apple residue is present in Table 3. The table showed that moisture (30.02±0.00^{a}), fibre (23.01 ±1.00^{a}), ash (1.44 ±0.03^{a}) and carbohydrate (36.39 ±0.02^{a}) contents of fresh cashew apple residue were higher than that of the fermented sample while the protein (2.88 ±0.02^{a}) and lipid (14.00 ±0.05^{a}) contents of the fermented sample were higher than that of the fresh sample.

Table2: Changes in pH, Temperature and TTA during fermentation of cashew apple residue

Time	pH	Temperature	TTA
0	4.47±0.00^{a}	27.03 ±0.15^{c}	0.19 ±0.02^{c}
24	4.22±0.01^{b}	28.00 ±0.00^{c}	0.23 ±0.00^{ab}
48	3.84±0.05^{cd}	30.05 ±0.01^{a}	0.25 ±0.10^{a}
72	3.70±0.02^{d}	29.11 ±0.00^{ab}	0.26 ±0.10^{a}

Values are presented as Mean±S.E.M and values followed by different superscript along the column are significantly different.

Table 3: Changes in proximate composition of fermented cashew apple residue

Parameters	Fresh (%)	Fermented (%)
Moisture	30.02±0.00^{a}	28.01 ±0.04^{b}
Protein	0.69±0.00^{b}	2.88 ±0.02^{a}
Fibre	23.01 ±1.00^{a}	21.28 ±0.30^{b}
Ash	1.44 ±0.03^{a}	1.12 ±0.01^{ab}
Lipid	9.01 ±0.02^{b}	14.00 ±0.05^{a}
Carbohydrate	36.39 ±0.02^{a}	32.00 ±0.10^{a}

Values are presented as Mean±S.E.M and values followed by different superscript along the column are significantly different.

In the proximate analyses of both raw and fermented samples, there was a significant reduction in moisture, ash and carbohydrate contents after fermentation and this suggest that the fermented flour blends may have a good keeping quality as high moisture content has been associated with rapid spoilage of materials. The reduction in ash and carbohydrate contents suggests that the growing microbial population may have utilized part of the minerals and sugars for growth. There was increase in protein content of the fermented samples which is probably due to the fact that the microorganisms in the course of fermentation may have secreted extra cellular enzymes which subsequently increases the protein content as well as the microbial biomass [17] (Odetokun, 2000). The increase in protein contents agrees with the work of Afoakwa *et al*. [18] who reported that the use of fermentation may prove a means of improving product's functionality and protein content.

The fat content of the fermented cashew apple residue increased after fermentation, this suggests that the microorganisms were unable to utilize the lipids in the residue during metabolic activities. There was a reduction in in ash content after fermentation of the cashew apple residue, since ash content is a measure of the total amount of minerals present within a food sample, a decrease in its level during microbial fermentation could be as a result of utilization of minerals by fermenting organisms during their metabolism [19]. The crude fibre content of the fermented cashew apple residue decreased after 72 hrs fermentation and this may be due to the enzymatic breakdown of the fibre during fermentation by the microorganisms.

4. CONCLUSION

From the foregoing, the microorganisms responsible for the spontaneous fermentation of cashew apple residue include *Staphylococcus aureus, Micrococcus luteus, Bacillus subtilis, Bacillus licheniformis, Lactobacillus fermentum, Saccharomyces cerevisiae, Aspergillus niger, Aspergillus fumigatus, Geotrichum candidum* and *Rhizopus stolonifer* Also, fermentation improved the nutritional properties of cashew apple residue as shown in the increase in the protein content therefore, it can be utilized for animal feed.

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