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Effect of different treatment on the proximate and antinutritional content of Nigerian cashew apple residue

Faith Iguodala AKINNIBOSUN[a] and Adedayo Michael OYETAYO[*b]

[a]*Department of Microbiology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria*
[b]*Department of Science Laboratory Technology, Faculty of Applied Sciences, Rufus Giwa Polytechnic, P.M.B. 1019, Owo, Nigeria*

Abstract. In this study, cashew apple residue (CAR) was subjected to various treatments (boiling, soaking and fermentation), thereafter, proximate composition and anti-nutrient content were determined. Fermentation significantly ($p < 0.05$) increased the protein content of the CAR by 56.07% and reduced the carbohydrate content to 42.49%. Moreover, soaking and fermentation significantly reduced phytate content of the CAR from 0.4123% to 0.2504% and 0.1106% respectively; all the treatments significantly reduced the oxalate content while boiling and soaking had a significant reducing effect on the tannin content of the CAR. These suggest that pre-treated cashew apple residue may be used for animal feed formulation.

Keywords: cashew apple residue (CAR), soaking, boiling, fermentation, proximate, anti-nutrient.

1. Introduction

Cashew (*Anacardium occidentale* L.) is a member of the Anacardiaceae family and it has a wide distribution throughout the tropical countries. It is one of the major cash crops grown in Africa especially Nigeria who is ranked third and fifth highest cashew producing country in Africa and world respectively [1-3]. The cashew fruit comprise of two distinct parts namely; the nut and the receptacle/pseudofruit also called cashew apple. Cashew is majorly planted for its nut which is about 10% of the cashew fruit while the apple is usually left on the farm to rot away. According to Azevedo and Rodrigues [4], for every ton of cashew nuts, about 15 tons of cashew apples are obtained as a by-product. There have been reports on the nutritional qualities of the juice [5] and pulp [6] of the cashew apple as well as the anti-nutritional properties [7]. There is presently no cashew processing facility in Nigeria as the industry is basically export oriented. Moreover, apart from direct consumption of the apple, there is no reported use of the apple in the country.

Presently, the Nigerian government is trying to diversify the economy of the country from oil-based towards agro-based economy. This has resulted in the increase in production of many crops especially the cash crops of which cashew forms a substantial portion. This has also led to the increase in the waste generated by this sector which may be turned into useable materials. The major drawbacks of cashew apple are its possession of astringent taste and its high tannin content [6]. These properties have made it almost impossible to commercialize the use of the cashew apple as its wide consumption is rejected by man and animals in its raw unprocessed form. However, the cashew apple may be processed into animal feed and fodder if the anti-nutrient content is reduced enough to enhance its feed value in farm animals especially the monogastric animals since tannin is known to prevent the body's full assimilation of dietary protein [8].

This research is therefore carried out with the aim of evaluating the effect of different treatment on the proximate and the anti-nutrient content of the cashew apple residue (CAR) in a bid to convert it to valuable raw material for animal feed production.

2. Experimental

2.1. *Plant collection and identification*

Fresh cashew fruits (*A. occidentale*) were harvested from parent plants at a Farm Plantation in Iyere, 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.

2.2. *Preparation of sample*

The cashew fruits were rinsed in sterile distilled water to remove the debris and sorted to discard the unwholesome ones. Then, the nuts were removed manually by turning; the apples were sliced with the aid of laboratory knife, crushed with a laboratory blender and the juice filtered out with a sieve. The residue was collected for further analyses.

2.3. *Materials*

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.

2.4. *Experimental design*

2.4.1. *Cashew apple residue treatment*

Soaking. A portion of 1 kg of the residue was soaked in a sterile container in the laboratory for 12 h with intermittent stirring during the first 3 h. Afterwards, the soak water was decanted and the cashew apple residue was drained using muslin cloth.

Boiling. A portion of 1 kg of the residue was boiled in a water bath for 30 min at holding temperature of 100 ºC.

[*] Corresponding author. *E-mail address*: michaelococcus@gmail.com (Adedayo Michael Oyetayo)

Thereafter, the water was drained from the cashew apple residue with the aid of muslin cloth.

Fermentation procedure. The cashew apple residue was subjected to spontaneous submerged fermentation. A portion of 1 kg of the residue was weighed into sterile fermentation jar, 2 l of sterile distilled water was added, and the container was tightly covered. The set up was allowed to stand for 72 h at room temperature, samples were taken at 24 h interval for assay starting from 0 h [8, 9].

2.4.2. *Proximate composition*. The moisture, crude fiber, fat, protein (N×6.25), ash and carbohydrate contents of both the raw sample and the treated samples were determined using relevant methods described previously by AOAC [10].

Moisture content. The moisture content was determined by using oven-drying method [10].

Ash content. The ash content was determined by using the dry-ashing process [10].

Fat content. Fat content was evaluated by Soxhlet extraction method, using petroleum ether as solvent [10].

Protein content. Protein was conducted based on the Kjedahl nitrogen method, and protein content was calculated with conversion ratio N × 6.25 [10].

Fiber content. Total fiber is measured according to the AOAC enzymatic-gravimetric method [11]. The basis of this method is the isolation of dietary fiber by enzymatic digestion of the rest of the constituents of the material. The residue is measured gravimetrically.

Carbohydrate content. Carbohydrate content was determined by subtracting from 100 the sum of the percentage moisture, ash, protein, fat and fiber. The remainder value gives the carbohydrate content of the sample.

$$\% \text{ Carbohydrate} = 100 - (\% \text{ Moisture} + \% \text{ Ash} + \% \text{ Fat} + \% \text{ Protein} + \% \text{ Fiber})$$

2.5. *Anti-nutrient analysis of the sample*

Phytate content. Phytate content was determined by the standard method [10].

Determination of tannin. Tannin was determined according to the method of Makker *et al*. [12], 2.2 g of finely ground sample was weighed into a 50 ml sample bottle. 10 ml of 70% aqueous acetone was added and properly covered. The bottles were put into an ice bath shaker and shaken for 2 hours at 30 ºC. Each solution was then centrifuged and the supernatant store in ice. 0.2 ml of each solution was pipette into test tubes and 0.8 ml of distilled water was added. The standard tannic acid solutions were prepared from a 0.5 mg/ml stock and the solution made up to 1 ml with distilled water. 0.5 ml Folin-Ciocalteu reagent was added to both sample and standard followed by 2-5 ml of 20% Na_2CO_3. The solutions were then vortexed and allow incubating for about 40 min at room temperature in the laboratory. The absorbance was read using a Buck Scientific 210VGP spectrophotometer at 725 nm against the reagent blank concentration of the samples from a standard tannic acid curve.

Determination of oxalate. This was carried out using the method of Makker *et al*. [12]. One gram of the samples was weight into 100 ml conical flask. 75 ml of 3M H_2SO_4 was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1 hour and then filtered using Whatman No. 1 filter paper. 25 ml of sample filtrate (extract) was collected and titrated hot (80 – 90 ºC) against 0.1 N $KMnO_4$ solution to a point where a faint pink color appeared that persist for at least 30 s [13].

2.6. *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 the proximate composition of the cashew apple residue subjected to different treatment is presented in Figure 1. The figure revealed that boiling and soaking did not have significant effect on the protein, fiber and carbohydrate contents of the cashew apple residue whereas, fermentation significantly increased the protein content of the cashew apple by 56.07 %. Also, fermentation and soaking reduced the ash content significantly while only fermentation reduced the carbohydrate content of cashew apple residue significantly from 52.24 % to 42.49 %.

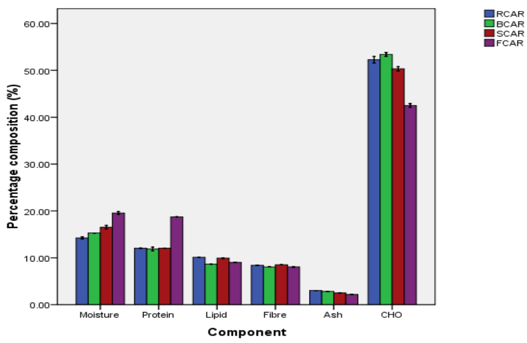

Figure 1. Effect of different treatment on proximate composition of cashew apple residue. Legend: RCAR= Raw cashew apple residue, BCAR= Boiled cashew apple residue, SCAR= Soaked cashew apple residue, FCAR= Fermented cashew apple residue ($p < 0.05$, $n = 4$).

The results of the effect of different treatment on anti-nutrient content of cashew apple residue is presented in Figure 2. The figure showed that soaking and fermentation significantly reduced phytate content of the cashew apple residue from 0.4123% to 0.2504% and 0.1106% respectively while all the treatments significantly reduced the oxalate content of the cashew apple residue. However, only boiling and soaking had a significant reducing effect on the tannin content of the cashew apple residue.

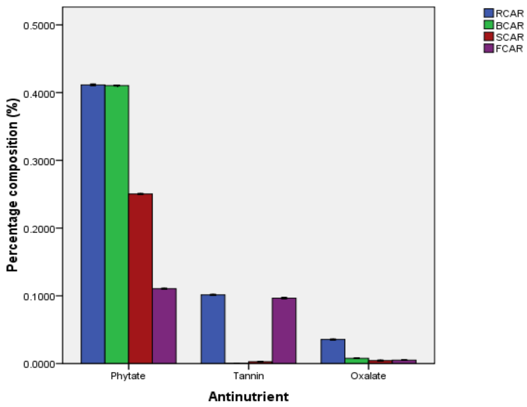

Figure 2. Effect of different treatment on anti-nutrient content of cashew apple residue. Legend: RCAR = Raw cashew apple residue, BCAR = Boiled cashew apple residue, SCAR= Soaked cashew apple residue, FCAR = Fermented cashew apple residue ($p < 0.05$, $n = 3$).

The proximate composition of the fresh cashew apple residue (CAR) obtained in this study is in consonance with the reports of Okpanachi *et al*. [7]. The increase in the moisture content of the boiled, soaked and fermented samples of the CAR may be due to the water absorption during the treatment procedure as the residue may have accumulated water filling the spaces evacuated by the expressed juice. The increase in moisture content of fermented and soaked food materials have been reported earlier [14, 15] and this might lead to high perishability of the products as high moisture content of food substances aid microbial and enzymatic spoilage of such foods [16]. There was increase in protein content of the fermented samples which may be due to the fact that the microorganisms which degrades the samples readily may have secreted extra cellular enzymes which subsequently increases the protein content as well as the microbial biomass [17]. 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 functionality and protein contents. Also, the reduction observed in the ash content of the soaked and fermented CAR samples may be due to dissolution of the minerals in the treatment water. Ash content is the aggregate of all the mineral content of a food material, some of the minerals reported in cashew apple are water soluble and may have been lost in to the treatment water. Further, in the fermented sample, part of the minerals may have been used up by the fermenting microorganisms. The significant ($p < 0.05$) reduction in the carbohydrate content of the fermented CAR is probably due to the conversion of the sugar content of the sample to fermentation products like alcohol and CO_2 by the growing microorganisms in the medium as well as the further dissolution of some of the sugars in the fermentation milieu over the course of the fermentation [19].

In the anti-nutrient assay, the treatments had varying effects on the three major anti-nutrient content of the CAR. The 0.4123%, 0.0981% and 0.0403% values of phytate, tannin and oxalate respectively obtained in this study are slightly higher than the results obtained by Okpanachi *et al*. [7], albeit they worked on a sun-dried sample of cashew apple waste. The reducing effect of both boiling and soaking on all the anti-nutrient suggests that these two treatments may be better adopted for the removal of the anti-nutrients in CAR. These observations are in line with earlier reports of Odedokun [17] who recorded a 80% reduction in tannin content of cashew apple juice. Recent studies have demonstrated that products containing tannins at low dosages (0.1502%) in the diet of chickens may be beneficial [20] also, tannins have been shown to have positive effects on silage quality in the round bale silages, in particular reducing NPNs (non-protein nitrogen) in the lowest wilting level. Therefore, the level of the tannins observed in the CAR is within the acceptable range for consideration in animal feed formulation. Further, phytates are chemicals in plants that bind with minerals, which make minerals from food containing phytates less likely to be absorbed by the body [21]. The reduction of the phytate content by the treatments suggests that treated CAR may be used successfully for feeding farm animals.

4. Conclusions

From the foregoing, it can be concluded that fermentation improved the protein content of cashew apple residue whereas, all the processing methods (boiling, soaking and fermentation) reduced the anti-nutrient content of the cashew apple residue therefore, it can be utilized for animal feed formulation.

Declaration of interest

The authors have declared that there is no conflict of interest in this paper.

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