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Assessment of Cyanide Concentrations in Cassava Peels obtained at different levels of Processing for Resource Reuse

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Abstract

Cassava processing is a year-round activity in Nigeria, especially in southern part and Ibadan city. The wastes generated by the various processing industries are enormous. Cassava peels are a major residue of processing to prepare various food products. The cassava peels have high concentration of cyanide which has toxic and polluting effects. It is therefore important that the peels are properly processed or pre-treated to reduce the cyanide content before using them as livestock feed which is a common practice among livestock rearers. Different portions of cassava peels were subjected to the following pre-treatment/processing techniques: sun drying for 2 days (SD_2) and 4 days (SD_4). Boiling (BL), oven drying at 40 °C (OD_{40}) and 60 °C (OD_{60}) and drying at room temperature (DR) for 14 days. Fresh cassava peels pretreated were analyzed for total (TCN), free (FCN) and bound (BCN) cyanide contents, using standard methods. Mean FCN (mgHCN/100g) in fresh cassava peels was 5.25+ 1.98, various treatments reduced the mean cyanide concentration in SD_2, SD_4 BL, OD_{40}, OD_{60} DR were 1.43 + 1.12, 0.38 + 0.18, 2.68 + 1.65, 0.19 + 0.17, 0.70 + 0.31 and 0.1 + 0.00, respectively.The percentage reduction of cyanide in cassava peels in the six different treatment techniques was of the order BL (55%) < SD_2 (73%) < OD_{60} (80%) < SD_4 (92%) < OD_{40} (95%) < DR (98%) respectively. Sun-drying and further drying at room temperature are the easiest and cheapest method for cyanide reduction in peels but mould control should be planned to prevent aflatoxicosis. Drying cassava products significantly lowers the cyanogenic potential to sufficiently reduce the toxicity risk and maintaining optimum temperatures and duration of drying are critical.

Keywords: Cassava Processing; Cassava Peels; Cyanide; Processing/pretreatment techniques

Introduction

Manihot esculenta crontz commonly called cassava is a woody shrub which belongs to the family Euphorbiacae. The plant is very robust, resistant to drought and cultivationdoes not require high inputs. Cassava originated in South America where it was domesticated, and was introduced into Africa in the 16th century by the Portuguese (Fauqet and Fangetle, 1990) [1]. Cassava production has increased in Africa with Nigeria becoming the largest producer with an annual output of over 34 million tonnes of tuberous roots. Benue and Kogi states in the North Central Zone are the largest producers of cassava (IITA, 2004) [2]. Cross River, AkwaIbom, Rivers and Delta dominate the cassava producing states in the South South. Ogun, Ondo and Oyo dominate in the South West and Enugu and Imo dominate production in the South East (Bokanga, 1994; IITA, 2004) [2,3]. Cassava is one of the most productive crops, and is widely recognised as a good source of energy (Osakwe and Nwose 2008) [4]. Raw cassava is 60% water, 38% carbohydrates, 1% protein and has negligible fat (Tewe 2004) [5]. Cooked cassava starch has a digestibility of over 75% (Tewe 2004) [5]. Cassava served as a major source of food to majority of the people living within African sub-region. The different types of food obtainable locally from cassava range from gari, fufu, tapioca to starch, and industrial starch used in Textiles and adhesives industries (Montagnac *et al,* 2009) [6]. The young leaves of cassava havehigh proteinand are consumed in Africa (Achidi *et al,* 2005; Lebot, 2009; Montagnac *et al,* 2009a) [7-9]. The non-edible parts of cassava can be converted to bioethanol through biochemical routes (Ephraim *et al,* 2012) [10] Cassava during processing producesa large quantity of waste, which may pose a potential hazard to the environment (Achi *et al,* 2018, Olukanni and Olatunji 2018, Omilani *et al,* 2019) [11-13].

Cassava wastes constitute peels, waste water and other components can cause environmental degradation. These wastes contain two cyanogenicglucosides, linamarin and lotaustrain. These are decomposed by linamarase, a naturally occurring enzyme in cassava, liberating Hydrogen Cyanide (HCN) (Fakunang *et al.*, 2001; Kamalu and Oghome 2012) [14]. Hydrocyanic acid (HCN) is one of the highly potent poisons. Andcassava consumption is often linked with cyanide toxicity (Dhas *et al,* 2011) [15]. The intercellular glucosides (linamarin and lotaustalin) when exposed to the extracellular enzyme releases the cyanide. Thus, the cyanide in cassava is found in two forms; the bound cyanide, present as cyanogenicglucosides and free cyanide, present as cyanohydrin or free HCN, which is a gas at above 26 ^{o}C and under alkaline conditions as CN (Peprah *et al,* 2020) [16]. The cyanide ion, CN^{-}, and hydrogen cyanide are collectively called free cyanide. Free cyanide is easier to remove than bound cyanide. High exposure to cyanide in human cause's nausea, vomiting, diarrhea, dizziness, weakness, paralysis (e.g.konzo) and sometimes death (Merck, 2008) [17].

The methods of disposal of cassava waste are dependent upon the place where the processing takes place. In Nigeria the accumulation of waste is accentuated by the continuous year-round production and processing of cassava such that, the waste builds up faster than they are biodegradable.Fresh cassava peels have much higher levels of cyanide than the level present in the fresh roots (Oboh, 2006) [18]. It was reported that traditional sun drying; dry fermentation and wet fermentation are known to destroy the cyanide concentrations (Salami and Odunsi 2003, Montagnac *et al,* 2009, Chikezie and Ajiako 2013) [6,19,20].

The potential toxicity of cyanide can therefore be minimized through proper waste management options and development of safe handling or processing techniques prior to the utilization of cassava peels and wastes as livestock feed. The present study was conducted to assess the cyanide contents of products of cassava peels obtained at different levels of processing in six cassava processing industries from four Local Government Areas in Ibadan.

Materials and Methods

Study Area

The study area is Ibadan, the capital of Oyo State, Nigeria. It is located in the Southwestern part of the country on longitude 3^{o} 5$^{'}$ of Greenwich Meridian and latitude 7^{o} 23$^{'}$ North of the Equator at a distance of about 145km North East city of Lagos. Ibadan has 11 Local Government Administrative areas, 5 within the metropolis and with a mixture of urban, semi-urban and rural communities. The climate is characterizedby rainy season from March to October while dry season stretches from November to February. Geographically, Ibadan is located in the Tropical Rain Forest.

Sampling Area

The cassava processing industries in Ibadan are located in Ibadan North, North West, North East and South West. Samples of fresh cassava peels were collected from Ibadan North (Agbowo, Mokola), North West (Eleyele, Okoro) North East (Old Ife road) and South West (Apata) (Figure 1).

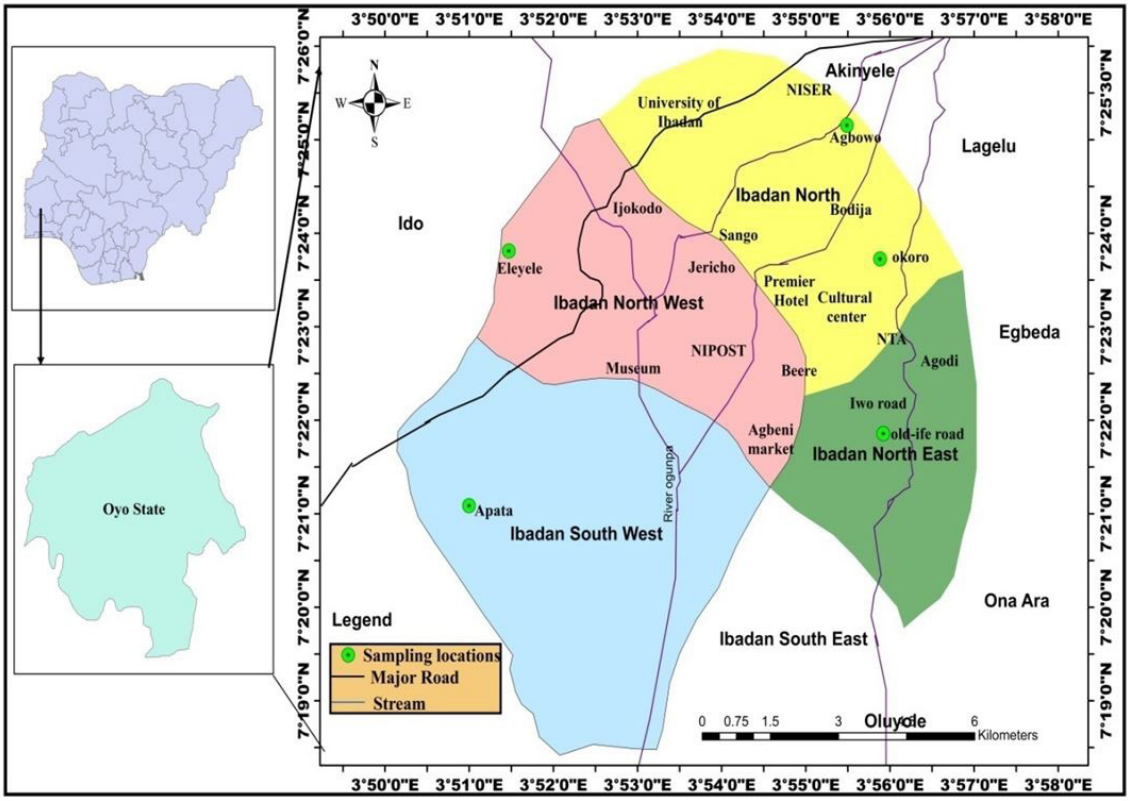

Figure 1: Map showing Sampling by circling

Fresh samples of cassava peels were collected from six processing sites, namely Agbowo, Eleyele, Okoro, Mokola, Old Ife Road, and Apata. The bulk sample was then divided into eight portions of 100g each in the laboratory. The different portions were then used for the following pre-treatment techniques and their cyanide levels were determined:

No treatment: Cassava peels as they were- Control.

Boiling: 100g of cassava peels were boiled in 25ml of water for 25 minutes at 35 °C. The boiled peels were then homogenised in 10ml of orthophosphoric acid, to extract the linamarin present and to prevent any further action of the endogenous enzyme.The homogenate was filtered with cheese cloth and then centrifuged to clarify the solution. The extract obtained from boiled peels was then analysed for total, free and bound cyanide.

Sun-drying (SD_2): Sun-drying for 2 days; 100g fresh peels were sun-dried for two days. The dried peels were homogenised in 160ml of orthophosphoric acid. The homogenate was filtered and the centrifuged. The extract obtained was analysed for total, free and bound cyanide. The study was carried out during the rainy season, when the average daily temperature during drying in the day was 30 °C. The samples were left out to dry in the sun for about 4 hours daily for the respective number of days as indicated below:

Sun-drying (SD_4): Sample was sun-dried for 4 days; 100g fresh cassava peels were sundried for 4 days. After 4 days the weight of sundried peels had reduced to less than 25% of fresh initial weight. The dried peels were pulverised using the 2mm Thomas Pulverizer. 7.5g of milled peels was homogensed in 62.5ml of orthophosphoric acid. The homogenate was filtered and centrifuged. The extract was then analyzed for total, free and bound cyanide.

Over drying at 40 °C (OD 40): 100g fresh cassava peels were dried in the oven at 40 °C for between 12-15hr. The dried peels were pulverised. 7.5g of the milled peels was homogenised in 62.5ml of orthophosphoric acid. The homogenate was then filtered and centrifuged for classification. The extract was then analyzed for total, free, bound cyanide.

Oven-drying at 60 °C (OD60): 100g fresh peels were dried in the oven at 60 °C for between 12 - 15hr. The dried peels were pulverized. 7.5g of the sample was homogenized in 62.5ml of Orthophosphoric acid. The homogenate was then filtered and centrifuged. The extract was analysed for total, free and bound cyanide.

Drying at room temperature for 14 days (DR): 100g fresh peels were spread out to dry inside the laboratory for 14 days. The dried peels was pulverised, 7.5g of which was then homogenised in 62.6ml orthophosphoric acid. The homogenate was then filtered using a cheese cloth and centrifuge to get a clear solution. The extract was analysed for total, free and bound cyanide.The samples were also analysed for proximate composition.

Analysis of Samples

Proximate Composition of Peels: The proximate composition of fresh cassava peels was determined chemically according to the official methods of analysis describes by the Association of Official Analysis Chemist (AOAC). The following parameters were determined from the fresh cassava peels crude protein, crude fat, dry matter, ash and fiber content.

Cyanide analysis in the fresh and processed cassava peels: Fresh and processed cassava peels were analysed for cyanide (total, free and bound). This was carried out using enzymatic assay method of Tweyong and Kantongole (2003) [21]. The total and free cyanide present in the samples, were determined by the Chloramine T., 1-3 demethylbarbituric acid. According to Isonilotinic acid procedures, as described by Essers *et al.* (1993), the bound cyanide value was calculated as the difference between total and free cyanide values.

Results

Results of proximate analysis of cassava fresh peels are represented in Table 1. Tables 2, 3, 4, 5 and 6 is the results of cyanide concentrations of fresh and processed cassava peels analysed for cyanide (total, free and bound).

Proximate Analysis of Fresh Cassava Peels

Table 1 shows the proximate composition of cassava peels the six different sampling locations. The crude protein concentration ranges between 5.26% (Agbowo) to 6.21% (Apata), crude fat ranges from 1.08 to 1.29% (Mokola); crude fibre ranges from 15.50 (Okoro) to 21.2% (Eleyele), while Ash values ranges from 5.98% (Apata) to 6.34% (Okoro).

Sampled Site	% Crude Protein	% Crude Fibre	% Crude Fat	% Dry Matter	% Ash
Agbowo	5.26	20.67	1.14	23.84	6.07
Eleyele	5.31	21.23	1.21	23.47	6.14
Okoro	5.89	15.50	1.17	24.91	6.34
Mokola	5.63	18.50	1.29	22.54	6.18
Old Ife Road	5.97	19.18	1.08	23.02	6.04
Apata	6.21	16.78	1.10	22.98	5.98

Table 1: Proximate Analysis of Cassava Peels

Cyanide Concentrations of Fresh Unprocessed Cassava Peels

The initial cyanide concentration in fresh cassava peels before processing is shown in Table 2. The values of free cyanide (FCN) ranges from 3.20 to 7.0mg HCN/100g with mean + SD 5.25 + 1.78, while values for total cyanide was between 4.60 and 10.50mg HCN/100g and values for bound cyanide (BCN) ranges from 1.45 to 4.30mg HCN/100g.

Sampled Site	Concentration of mg HCN/100g		
	TCN	FCN	BCN
Agbowo	10.40	6.90	3.45
Eleyele	10.50	7.00	3.50
Okoro	9.30	5.00	4.30
Mokola	9.20	6.30	2.88
Old Ife Road	9.80	3.20	2.88
Apata	4.60	3.15	1.45
Mean (SD)	8.97 (1.47)	5.25 (1.78)	3.08 N (0.97)

Note: 100g of fresh peels was homogenized in 250ml orthophoric acid and then analyzed for cyanide
Table 2: Initial Cyanide Concentration in Cassava Peels before Processing (ICC)

Cyanide Concentration in Cassava Peels after Boiling

The results in Table 3 show the changes in cyanide concentrations of the cassava peels after boiling (BL). Mean value of free cyanide averaged 2.68 + 1.65mg HCN/100g and value ranges from 0.96 to 5.40mgHCN/100g, while the values of TCN ranges from 3.70-5.70mgHCN/100g and values for bound cyanide (BCN) range from 0.36 to 2.50mgHCN/100g.

Sampled Site	Concentration of mg HCN/100g		
	TCN	FCN	BCN
Agbowo	5.10	3.10	2.00
Eleyele	4.14	1.60	2.50
Okoro	3.70	1.50	2.13
Mokola	4.70	3.50	1.17
Old Ife Road	5.70	5.40	0.36
Apata	1.50	0.96	0.60
Mean (SD)	4.13 (1.47)	2.68 (1.65)	1.47 (0.87)

Note: 100g of fresh peels was boiled in 25ml of water for 25 minutes at 35 °C and then analyzed for cyanide
Table 3: Cyanide Concentration in Cassava Peels after Boiling (BL)

Cyanide content in cassava after sun-drying for two days (SD_2) and for sun-drying for four days (SD_4)

Changes in cyanide concentration in peels after sundrying for 2 days are shown in Table 4. The values for FCN ranges from 0.58 (Mokola) to 2.66mgHCN/100g (Old Ife road) with mean + SD of 1.43 + 1.12 while cyanide (TCN) and bound cyanide (BCN) ranges from 0.62 (Mokola) to 2.18mgHCN/100g (at Old Ife road) and 0.04 (at Mokola) to 0.19mgHCN/100g (Apata) respectively.

Sampled Site	Concentration of mg HCN/100g					
	Sun-Drying for two days (SD_2)			Sun-Drying for four days (SD_4)		
	TCN	FCN	BCN	TCN	FCN	BCN
Agbowo	NA-	NA-	NA-	0.56	0.48	0.08
Eleyele	NA-	NA-	NA-	0.35	0.29	0.05
Okoro	NA-	NA-	NA-	0.23	0.15	0.07
Mokola	0.62	0.58	0.04	0.37	0.31	0.06
Old Ife Road	2.78	2.66	0.12	0.58	0.38	0.21
Apata	1.15	1.00	0.19	0.77	0.60	0.19
Mean (SD)	1.50 (1.15)	1.43 (1.12)	1.47 (0.86)	0.48 (0.22)	0.37 (0.18)	0.133 (0.004)

Note: 100g peels were dried in the sun 30 °C – for 2 days and 4 days respectively. After which each dried samples were milled and analysed for cyanide.
NA: NOT AVAILABLE
Table 4: Cyanide content in cassava after sun-drying for two days (SD_2) and for sun-drying for four days (SD_4)

The concentration of cyanide (mgHCN/100g) in sun drying for four days is represented in Table 4. The values of free cyanide (FCN) ranged from 0.15 (Okoro) to 0.60 (Apata) with mean +SD as 0.38 + 0.09, while total cyanide (TCN) and bound cyanide values ranged from 0.23 to 0.77 (Apata) and 0.05 - 0.21 (Old Ife road) respectively.

Cyanide concentration in cassava peels after oven-drying at 40 °C (OD_{40}) and after oven-drying at 60 °C (OD_{60})

The results in Table 5 indicate concentration of cyanide in cassava peels after oven dying at 40 °C. The values of free cyanide (FCN) ranged from 0.08 (Mokola) - 0.38mg HCN/100g (Apata); with mean + SD as 0.20 + 0.17. Total cyanide (TCN) and bound cyanide (BCN) values ranges from 0.10 (Mokola) to 0.58mgHCN/100g (Apata) and 0.02 (Mokola) to 0.20mgHCN/100g (Apata) respectively.

Result in Table 5 indicates concentrations of cyanide in cassava peels oven-drying at 60 °C. The value for free cyanide (FCN) ranges from 0.39 (Okoro) to 1.28mgHCN/100g (Agbowo) with mean+SD at 0.68+0.31. Concentrations of total cyanide ranged between 0.42 (Okoro) and 1.61mgHCN/100g (Agbowo), while bound cyanide (BCN) ranges from 0.04 (Mokola) – 0.78mgHCN/100g (Eleyele).

Sampled Site	Concentration of mg HCN/100g					
	Oven-drying at 40 °C (OD_{40})			Oven-drying at 60 °C (OD_{60})		
	TCN	FCN	BCN	TCN	FCN	BCN
Agbowo	NA	NA-	NA-	1.61	1.28	0.33
Eleyele	NA-	NA-	NA-	0.65	0.57	0.78
Okoro	NA-	NA-	NA-	0.42	0.39	0.04
Mokola	0.10	0.08	0.02	0.61	0.58	0.04
Old Ife Road	0.13	0.10	0.04	0.67	0.61	0.06
Apata	0.58	0.38	0.20	0.90	0.61	0.36
Mean (SD)	0.27 (0.29)	0.20 (0.17)	0.07 (0.12)	0.82 (0.42)	0.68 (0.31)	0.27(0.31)

Note: 100g fresh peels of cassava were dried in the over at 40 °C for 15 hours and oven dried at 60 °C for 15 hours respectively. Dried peels were milled and analyzed for cyanide
NA: NOT AVAILABLE.
Table 5: Cyanide concentration in cassava peels after oven-drying at 40 °C (OD_{40}) and after oven-drying at 60 °C (OD_{60})

Cyanide concentration in cassava peels after drying samples at Room Temperature for 14 days (DR)

The result in Table 6 shows the concentrations of cyanide in sample after drying at room temperature for 14 days. The value of free cyanide (FCN) ranges from 0.08 (Old Ife road) to 0.15mgHCN/100g (Agbowo and Eleyele) with mean + 0.10 + 0.00. The values for total cyanide (TCN) and bound cyanide (BCN) ranges between 0.12 (Okoro and Mokola) to 0.17mgHCN/100g (Agbowo, Eleyele) and 0.00 (Apata) to 0.08mgHCN/100g (Old Ife road) respectively.

Sampled Site	Concentration of mg HCN/100g		
	TCN	FCN	BCN
Agbowo	**0.17**	**0.15**	**0.02**
Eleyele	0.17	0.15	0.02
Okoro	0.12	0.06	0.06
Mokola	0.12	0.10	0.00
Old Ife Road	0.15	0.08	0.08
Apata	0.13	0.13	0.00
Mean (SD)	0.13 (0.05)	0.10 (0.00)	0.02 (0.03)

Note: 100g fresh peels were spread out to dry in the laboratory at 37 °C for 14 days. Dried peels was milled and analyzed for cyanide.
Table 6: Cyanide concentration in cassava peels after drying samples at Room Temperature for 14 days (DR)

Percentage reduction of Cyanide by different Processing Techniques

The percentage of cyanide in cassava peels from the survey locations after been subjected to different treatment techniques, which included boiling (BL), Sun-drying for 2 days (SD_2) and 4 days (SD_4), Oven drying at 40 °C (OD_{40}) and 60 °C (OD_{60}) and drying at room temperature for 14 days (DR). Average percentage reduction in initial cyanide in fresh peels is as follows BL 55%, SD_2- 73%, OD_{60} 80%, SD_4- 92%, OD_{40} 95% and DR- 97.5% respectively.

Discussion

Cassava peels are a major residue of cassava processing, however these waste constitute a viable resource for livestock feed. It is estimated that 15 to 25 per cent of cassava roots process will and up as solid waste (Coker *et al.*, 2008; Achi *et al.*, 2018) [11,22]. It has been reported that the residue still contains considerable amount of energy present in various proportions of structural carbohydrate (Karr-Lilienthal *et al,* 2005) [23]. It is therefore, paramount that the peels are properly processed or pre-treated to remove or reduce the cyanide content before being used as livestock feed, thereby minimizing its toxic effect or the animals.

In this study, the enzymatic assay by Tweyong and Katongole (2003) [21] was used in determining cyanide content of the processed/pretreatment of cassava peels. The overall result of the percentage reduction on cyanide content from the processed/pretreatment of cassava peels was of order BL (55%) < SD_2 (72%) < OD_{60} 80%) < SD_4 (92%)) < OD_{40} (95%) < DR (96%).

The cyanide content reduced in the technique of cassava peels by boiling by 55% (Table 3). This could be due to the leaching of the free cyanide into the water used for boiling. This agrees with the research conducted by (Karr-Lilienthal *et al,* 2015) [23], they observed that boiling cassava root pieces for 25 minutes removed 55% of the cyanogenicglucoside. According to (Shi *et al,* 2017) [24] FCN of cassava chips is rapidly lost in water of about 90% of FCN was removed within 15 minutes of boiling fresh cassava chips. Similarly Dhas *et al,* 2011 [15] observed that increasing the volume of water from 1.1% to 1.5 ratio (root: water) increases leaching out of cyanide from 30% 30% to 75%. Cooking destroys the enzyme linamarase at about 72 °C thus leaving a considerable portion of the glucoside intact (Shi *et al,* 2017) [24].

In the study of sun-dry peels for two days, the cyanide content reduced by 73% (Table 4). Similarly, sun-dry peels for four days reduced the cyanide content by 92% (Table 5). The results showed that the longer the peels were exposed to sunlight, the higher reduction/removal of cyanide. This is because the endogenous enzyme linamarase had prolonged contact with the cyanogenicglucosides. (Silayo *et al,* 2013) [25] observed a 73-87% reduction in sun-dried 10mm cassava chips. (Lambri *et al*, 2013) [26] reported that more than 84% of HCN in cassava was lost in sun-drying. Though, it was observed that sun-drying reduces level of cyanogenicglucosides significantly, the growth ofmould on the dried peels after a period of storage is a concern (Kanya and Eboku 2010) [27], and this is in view of afflatoxins.

Effect of oven-drying cassava peels on the reduction of cyanide resulted in a 95% and 80% after fresh peels were dried at 40 °C and 60 °C respectively (Table 5). Oven-drying at 40 °C took a longer period to dry, thereby allowing the enzymes to have a prolong contact with the cyanogenicglucoside and more FCN was lost.The higher glucosidic retention at higher temperature of 60 °C compared to 40 °C is due to depletion of moisture, which results in enzyme activity. This compared to (Alamu *et al,* 2020) [28] they recorded a 50-55% reduction after ovendrying 10mm thick cassava chip at 50% and a 40-47% reduction after oven-drying at 70%. Peprah et al (2020) [16] observed that cyanogens were reduced with increasing temperature, a 29% reduction at 46 °C and 10% at 80 °C.

A more rapid loss of FCN was observed in cassava root slices sun-dried in black containers at 37 °C for four days by (Zainuddin *et al*, 2018) [29]. Thin chips dry faster allowing little time for enzymatic action lower retention was observed in sun-dried chips since drying conditions are ideal for maximum enzymatic degradation of the glucoside (Nambisan, 1994). By contrast with the boiling process, removal of cyanogenicglucosides during drying is primarily controlled by the activity of endogenous linamarase and the duration for which it acts on cyanogenicglucoside present in the tissue affect the drying of cassava peels at room temperature of 37 °C. This technique resulted in the highest reduction of cyanide compared with other techniques; it is not known whether the mould contributed to the degradation and loss of cyanide from the peels. The presence of mouldgives concern; Kaaya and Eboku (2010) [27] reported a remarkable growth depression resulting from high microbial infestation of cassava peels fed to cockerels. Sun-drying and drying at room temperature resulted in significant loss of cyanide, these processes are usually slow and often encourage

the growth of mould and other micro-organisms including pathogens. Mould growth can expose animals to aflatoxins and/or mycotoxic infections (Shi *et al*, 2017) [24]. Such micro-organisms include *Apergillusflavus* (Pathogenic); *A. fumigatus; A. charaben; A. teirenus; A. flaripes; A. Japonicus; A. niger A. ochracuss* and *Penicilliumvibum* (Mousavi 2016) [30-37].

Conclusion

Evaluation of the effect of various processing/treatment techniques on cyanide content reduction in cassava peels from cassava processing industries in Ibadan were assessed. From the laboratory analysis a reduction in cyanigenic potential of cassava peels occurred during every unit operation in the processing/pretreatment techniques resulting in the near detoxification of the product while all the processing/pretreatment method abate the cyanide levels, reduction of cyanide content by boiling of cassava showed the lowest percentage reduction, while effect of drying at room temperature resulted in the highest reduction of cyanide compared to all other methods. Sun-drying and drying at room temperature are easiest and cheapest means of cyanide removal or its reduction in peels but the growth of mould is of concern, because of its ability to cause afflatoxins. In view of the deficient microbial property of sun dried cassava peels, there is need for quicker methods which will eliminate microbial generation and ensure cyanide reduction. Cassava peels contains considerable amount of energy in various forms as carbohydrate, ifproperly processed or pre-treated to remove the cyanide it could be used as animal feed. The uses of processed cassava peels are nutritionally adequate and cheap found locally cheap to reduce cost of feed for livestock. The study therefore recommended that improved technologies on utilization of cassava peels should be encouraged through result demonstration among cassava processors.

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