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Research Article

Effect of Different Processing Methods on the Proximate Composition of Cassava Peels

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Fresh sweet cassava (*Manihot esculenta* Crantz) peels were collected at Orile-Ilugun; an industrial layout in Oyo State, Nigeria, where cassava is being processed to dry granules (garri). The peels were subdivided into four portions and subjected to submerged fermentation, ensiling, boiling and sun-drying treatments. These were further sundried for 3-5 days till they were crispy. Each of them was subjected to proximate analysis and chemical quantification for hydrogen cyanide. The result showed, with respect to crude protein, that ensiled (10.69%) and fermented (9.25%) cassava peels were statistically similar ($p<0.05$) and superior to boiled (4.92%) and sundried (4.86%). Similarly, the fermented (16.88mg/kg) and ensiled (21.62mg/kg) cassava peels reduced HCN content to permissible levels when compared to boiled (55.21mg/kg) and sun-dried (46.44mg/kg). It is therefore recommended that fermentation and/or ensiling enhance the nutritional value and usability of cassava peel as ingredient in pig's diet.

Keywords: Cassava peels, processing, fermentation, ensiling, boiling, sun-drying

INTRODUCTION

Cereal grains supply the bulk of livestock feed, especially for poultry and pigs. However, in developing countries like Nigeria, cereal grains are in high demand for human uses and the production has never been adequate to meet the need of the ever increasing population, consequently, there is little or no excess grain for livestock feed (Adesehinwa et al., 2011). The problem of increasing feed cost in monogastric animal production is an age-long one for which cheaper alternative feedstuffs have been developed to replace the expensive conventional ones (Salami and Odunsi, 2003). One of such alternatives for partial replacement of maize in animal diets is the processed cassava peel meal (Abu and Onifade, 1996; Ikurior and Onuh, 1996; Eruvbetine et al., 1996; Salami, 1999; Salami, 2000). Cassava peel is the outer covering (first layer being brownish red, followed by a whitish mesoderm) of the tuber, which is usually removed manually with sharp knife, with little or no pulp in the process of turning the raw pulp into various human foods such as *garri, fufu, lafun*, and tapioca among others in many tropical countries (International Institute of Tropical Agriculture, IITA, 1990).

Cassava peel which constitute about 10-13% of tuber weight (Oyebimpe et al., 2006), is of no use to the human populace and often constitute waste disposal problems could be of great potential in livestock feeding. Also the recent campaign to increase the production of cassava for industrial use will further increase the availability of cassava peels for livestock feeding (Irekhore et al., 2006).

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Cassava peel meal could serve as a cheap source of energy for farm animals but should be fortified with additional protein source because of its low protein level (Obioha and Anikwe, 1982). However, there are reports on the valorization/utilization of cassava peel to produce biotechnological products. These include production of enzymes such as fructosyltransferase (Lateef and Gueguim-Kana, 2012) and amylase (Sani et al., 2012), citric acid (Ogunka-Nnoka et al., 2011; Adeoye et al., 2015), bio-oils (Ki et al., 2013), bio-ethanol (Siyamani and Baskar, 2015), carrier for rhizobium inoculants (Ogbo and Odo, 2011) as well as microbial upgrading to enhance nutritional qualities (Lateef et al., 2008).

Considerable evidence has emerged for long of the possibility of using processed cassava peel as an energy source for pigs and poultry (Iyayi, 1986; Longe et al., 1997). High inclusion of the by-product in monogastric feed or formulation of diets with cassava peels, as sole energy source is limited because of its fibrous nature (Adesehinwa et al., 2011). Fakolade (1997) and Arowora et al. (1999) have reported the occurrence of high amounts of non-starch polysaccharides (NSPs) in cassava peels.
The greatest limitation in the use of cassava peels as substitute for maize is that of its hydrogen cyanide (HCN) content which is harmful to the monogastric animals. The HCN content of fresh cassava peels has to be reduced greatly in the peels in order to promote its acceptability and utilization (Salami and Odunsi, 2003). Several processing methods have been applied to fresh cassava peels to reduce the cyanide content. These include grating and sun-drying (Tewe et al., 1976), ensiling (Obioha and Anikwe, 1982), fermentation (Tewe and Kasali, 1986), boiling (Longe, 1980), freezing (Obioha et al., 1983), oven-drying (Tewe and Kasali, 1986; Osei and Twumasi, 1989), sun-drying (Osei and Duodu, 1988; Esonu and Udedibia, 1993), parboiling and sun-drying (Salami, 2000). Studies (Tewe et al., 1976; Obioha and Anikwe, 1982; Tewe and Kasali, 1986) indicated that ensiling and fermentation are the most efficient methods while oven-drying is the least efficient method for cyanide reduction in fresh cassava peels. It is also evident from the studies conducted by Esonu and Udedibia (1993) and Salami (2000) that parboiling prior to sun-drying had no advantage over sun-drying alone in terms of reduction of cyanide content of cassava peels.

Although the nutrient composition of the peel is affected by the variety of cassava, soil condition and rainfall distribution (Osei and Twumasi, 1989), processing method does not seem to influence the chemical composition of the peel meal (Salami, 2000). According to Eshiett and Ademosun (1981) and Salami (2000), oven-dried cassava peel meal and parboiled cassava peel meals contain 5.98 versus 5.31% crude protein, 9.3 versus 12.30% crude fibre, 0.65 versus 1.13% ether extract, 65.87 versus 63.29% nitrogen free extract and 7 versus 9.88% total ash respectively while the metabolizable energy of oven-dried cassava peel meal was reported to be 2044.8kcal/kg (Eshiett and Ademosun, 1981). It was therefore the aim of this study to evaluate the effect of different processing methods on cassava peel so that risk or safety will be factored into its use as a component of animal feed, particularly with reference to crude protein and HCN differentials.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the piggery unit (Bora Farm) of the Research Farm of The Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, Oyo State. Ibadan is geographically located at latitude 7° 22' 39" N and longitude 3° 54' 21" E. Ibadan has a tropical wet and dry climate, with a lengthy wet season and relatively constant temperature throughout the course of the year. It has mean total rainfall of 1420.06 mm, mean maximum temperature of 26.46 °C with 21.42 °C as the minimum and relative humidity of 74.55%.

Source and Processing of Cassava Peels

Fresh cassava peels from the predominantly cultivated sweet cassava (*Manihot esculenta* Crantz), was sourced from Orile-Ilugun; an industrial layout in the outskirt of Ibadan, Oyo State, Nigeria; where women that bought cassava root tubers from the market and farms for *garri* processing come together to peel and heap the wastes. The fresh cassava peels were collected in 50kg sacks for onward washing with clean bore-hole water. After which the cassava peels were divided into four places (2kg each) for different processing methods as hereunder:

1. **Fermentation**: The washed fresh cassava peels which had not stayed for longer than 4-6 hours since peeled off were immersed in clean bore-hole water in a plastic container (vat) and left at an ambient temperature of 26-30 °C for four days. Sign of fermentation which include foaming was looked out for. After four days, the cassava peels were separated from the broth and spread on a clean polythene sheet under the full blare of the sunlight for 3-5 days during which it dried to constant weight (Okpako et al., 2008; Naa et al., 2010).
2. **Ensiling**: Washed fresh cassava peels were put into air-tight plastic container, made sure that as much air as possible was expressed out by filling the container to the brim. Intense pressure via heavy stone and other heavy materials was mounted on the cassava peels-filled air-tight bag to compact and express out air. This bag was put into another air-tight polythene bag to make sure that there was no source of air. This was left at the ambient room temperature of 26-30 °C for 3 weeks (21days). In the end of 3 weeks, the sack was opened and the cassava peels were spread on a clean polythene sheet

Table 1: Proximate composition of treated cassava peels

Variable	Fermented	Ensiled	Boiled	Sundried
Dry matter	92.12	93.67	87.31	89.73
Crude protein	9.25[a]	9.37[a]	4.92[b]	4.86[b]
Crude fiber	9.87[b]	10.69[b]	13.67[a]	14.21[a]
Ash	2.23[b]	3.96[a]	3.57[a]	4.62[a]
Ether extract	1.19	1.37	1.63	1.74
Moisture	7.88[b]	6.33[b]	12.69[a]	10.27[a]
HCN (mg/kg)	16.88[b]	21.62[b]	55.21[a]	46.44[a]
DE (kcal/kg)	2896	2783	2922	2983

ab, means on the same row with different superscripts are statistically different ($p<0.05$)

under the sun for 3-5 days till it dried to constant weight (Obioha and Aniekwe, 1982).

3. **Boiling**: Washed fresh cassava peels were boiled in 100°C boiling water for 30 minutes. The pot was brought down and the water decanted leaving behind the boiled cassava peels. The cassava peels were spread on a clean polythene sheet under direct sunlight for 3-5 days to dry to constant weight (Perera, 2010).
4. **Sun-drying**: Washed fresh cassava peels were spread on a clean polythene sheet on a concrete platform and left under direct sunlight for 3-5 days until dried to constant weight. This was collected and packed in an air-tight container for grinding and analysis as described by Perera (2010).

The above processes were replicated thrice.

Data Collection

Each of the above cassava peels got from different processing methods was packaged in an air-tight container for onward grinding to powdery state and appropriately labeled for ease of identification. They were taken to the laboratory for composite chemical composition analysis using procedure of AOAC (1990). The hydrogen cyanide content was determined using the method of Cooke (1978). The most suitable, based on the processing method that best reduced hydrogen cyanide to a tolerable level of not more than 50mg/kg (Iyayi and Tewe, 1992) as well as the method that best improved the crude protein value of the cassava peels was determined.

Nutrients and Cyanide Analysis

Moisture content was estimated by oven drying method at 105°C (Osborne and Voogt, 1978). Protein and fat contents were determined by the Kjeldahl and Soxhlet methods. Crude fiber and ash were determined by the standard method of AOAC (1990). Cyanide level in cassava peels was analyzed both qualitatively using picrate paper (Egan et al., 1998) and quantitatively using acid hydrolysis of cyanogenic glucosides as described by Bradbury et al. (1991).

Statistical Analysis

The data were subjected to one-way analysis of variance and where difference in means was observed, Duncan's Multiple Range Test was used to separate the means (Duncan, 1955).

RESULTS AND DISCUSSIONS

Table 1 shows the proximate compositions of differently processed cassava peels. The results showed that the dry matter (DM) for ensiled was the highest, followed by fermented, sundried and boiled respectively. The crude protein content of the ensiled was the highest followed by fermented, boiled and sundried respectively. There was no significant difference ($p>0.05$) between ensiled and fermented as well as between boiled and sun-dried but a significant difference ($p<0.05$) between ensiled/fermented and boiled/sun-dried. The cyanide (HCN) content was lowest for the fermented followed by ensiled, sundried and boiled. In a reverse stance, there was a significant difference ($p<0.05$) between boiled/sun-dried and ensiled/fermented in respect of HCN.

Dry Matter

From the proximate analysis, the dry matter content of the fermented cassava peels was similar to the report of Irekhore et al. (2006) and Ahamefule et al. (2006) that reported 93% and 94.76% respectively. In the same vein, the dry matter (DM) content of the ensiled cassava peels was also similar to 95.55% reported by Ahamefule et al. (2006). For the boiled and sundried cassava peels, the DM contents were similar to 80.75, 82.55, 86.22, 89.24 and 87.36% as reported by Adesehinwa et al. (2008), Udoyong et al. (2010), Ukanwoko and Ukandu (2011), Adesehinwa et al. (2011) and Akpabio et al. (2012) respectively. The DM was however higher than that of Adegbola and Asaolu (1986) and Mako et al. (2013) that reported 66.25 and 66.79% respectively.

Crude Protein

The crude protein for fermented and ensiled cassava peels were similar to results of Okeke et al. (1985), Ijaiya (2001), Ahamefule et al. (2003), Aderemi and Nworgu (2007) and Aro and Aletor (2012) that had 8.83, 9.23, 9.30, 9.46 and 10.9% respectively but contradicted the result of Ahamefule et al. (2006) that reported 3.63%. The lower content of crude protein as reported by Ahamefule et al. (2006) could be attributed to the fact that the samples were not dried but in this study and those whose report compared favorably with this work, the samples were dried. Higher crude protein contents of fermented and

ensiled cassava peels could be attributed to the possible secretion of some extracellular enzymes (protein) such as amylases, linamarase and cellulase (Oboh and Akindahunsi, 2003). Also the increase in the growth and proliferation of fungi/bacteria complexes in the form of single cell proteins might possibly account for the apparent increase (Antai and Mbongo, 1994; Oboh et al., 2002). The crude protein contents of the boiled and sundried cassava peels were similar to the findings of Davendra (1977), Onyimonyi and Ugwu (2007) and Ahamefule et al. (2006) that reported 4.8%, 4.5% and 4.38% respectively. The results differed from the reports of Eshiett and Adeosun (1981), Salami (2000), Irekhore et al. (2006), Adesehinwa et al. (2008), Udoyong et al. (2010), Adesehinwa et al. (2011), Akpabio et al. (2012) and Mako et al. (2013) who reported 5.98%, 5.31%, 3.06%, 5.69%, 5.46%, 3.15%, 5.48% and 6.16% respectively. These variations in nutrients could be attributed to the methods of peeling, varieties of cassava, soil conditions and rainfall distributions (Osei and Twumasi, 1989).

Crude Fibre

From the analysis of the results, the crude fiber content for fermented and ensiled cassava peels were similar to the results obtained by Ahamefule et al. (2006) and Aro and Aletor (2012) that got 9.20 and 13.64% respectively while Ukanwoko and Ukandu (2011) got a value of 21.61% for ensiled cassava peel which is higher than the result of this experiment. The crude fibre could be attributed to variety of cassava, soil condition, method of peeling and rainfall distribution (Osei and Twumasi, 1989). In the same vein, the values for boiled and sundried cassava peels were closely related to results of Irekhore et al. (2006), Akpabio et al. (2012) and Abu et al. (2015) that got 7.9, 10.78 (sweet variety) and 9.03% respectively, the findings of Adesehinwa et al. (2008), Udoyong et al. (2010), Adesehinwa et al. (2011), Akpabio et al. (2012) and Aro and Aletor (2012) were higher than this, with the values of 20.49, 18.81, 33.96, 16.12 (bitter variety) and 38.40% respectively. This high fibre content could be traceable to the maturity of the cassava used, peeling process and possible contamination with the tuber stumps. Also soil condition and variety of cassava could be the reasons (Osei and Twumasi, 1989).

Ash

The results of the ash content in the fermented and ensiled cassava peels were comparable to the values obtained by Okeke et al. (1985), Ijaiya (2001), Ahamefule et al. (2003), Ahamefule et al. (2006) and Ukanwoko and Ukandu (2011) that got 3.62, 3.18, 3.71, 3.48 and 3.81% respectively. The values were lower than the values obtained by Aro and Aletor (2012) and Mako et al. (2013) which were 6.62% and 7.05% respectively. The studies by Tewe et al. (1976), Obioha and Anikwe (1982), Tewe and Kasali (1986), Salami and Odunsi (2003) and Ahamefule et al. (2006) indicated that fermentation and ensiling are the most efficient methods of processing cassava peels and their reports agreed with the present study. Also, there was no discernible trend in fat, crude protein, crude fibre and ash content of the differently processed cassava peels in the study of Oboh (2006). The results obtained were quite low compared to 7.0, 6.50 and 5.89% reported by Adegbola and Asaolu (1986), Irekhore et al. (2006) and Akpabio et al. (2012) respectively. The difference could be due to environmental factors or difference in varieties as well as edaphic factors since ash represents the mineral content which is usually derived from the soil.

Ether Extracts (Fat Content)

The ether extract values were comparably similar to values of 1.10, 1.75, 1.13 and 1.31% reported by Ahamefule et al. (2006), Udoyong et al. (2010), Ukanwoko and Ukandu (2011) and Akpabio et al. (2012) respectively. The values of 4.0, 3.11 and 17.24% documented by Irekhore et al. (2006), Aro and Aletor (2012) and Mako et al. (2013) were higher than these values. In the same vein, the values of 0.75, 0.34 and 0.70% reported by Adesehinwa et al. (2008), Adesehinwa et al. (2011), and Abu et al. (2015) respectively are lower than the values obtained in this experiment. The difference in values could be as a result of cassava varieties, soil factors and processing methods.

Cyanide

The hydrogen cyanide contents of fermented and ensiled cassava peels in this experiment were similar. The results were also similar to the values obtained by Adesehinwa et al. (2008) and Akpabio et al. (2012) who reported 27 and 19.99mg/kg respectively but different from the values obtained for boiled and sundried cassava peels in this experiment. The reduction in the HCN contents in all the samples could be attributed to processing methods. Osei (1992) and Onyimonyi and Okeke (2005) got similar results of 47.8 and 64mg/kg respectively for sundried cassava peels. Adegbola and Asaolu (1985) recorded reduction in HCN levels of cassava through drying on concrete floor for 4 days. In the same vein, Gomez et al. (1985) recorded similar reduction due to sun-drying. Also, Adeyemi and Balogh (1985) documented that ensiling cassava roots aided considerable reduction of the HCN level. However, especially for varieties which are high in cyanogens, the most popular and efficient processing method for their removal is fermentation (Nambisan, 2011) and is highly a desirable technique in the rural communities (Chelule et al., 2010). The possible reason for higher HCN in the boiled and sundried cassava peels vis-à-vis fermented and ensiled could be due to lack of fungi and bacteria (cyanohydrophylic micro-organisms) that help to decrease cyanogenic glycoside content (Padmaja et al., 1993; Essers, 1994; Oboh and

Akindahunsi, 2003; Oboh, 2006). Sundrying is only partially effective in reducing cyanogenic glycoside content (Tewe, 1989). Peeling which disrupts tissues helps to release linamarase and hydroxynitrile lyase enzymes that catalyse the degradation of cyanogenic glycosides to release HCN (Kimaryo et al., 2000). Boiling of cassava parenchyma in water for 30 minutes reduces cyanide better than steaming, baking or frying (Nambisan and Sundaresan, 1985). This result was not in consonance with the finding of Olafadehan (2011) that recorded 710.98, 299.21, 165.36 and 98.10mg/kg for unfermented, ensiled, sun-dried and retted CPM (bitter cassava) respectively. Indeed, the chemical composition of the processed CPM compared well with the values obtained elsewhere by Okeke et al. (1985) and Sogunle et al. (2007)

CONCLUSIONS

Fermentation and ensiling of cassava peels proved advantageous with respect to reduction in the HCN contents and improvement in the crude protein unlike the boiled and sun-dried counterparts. Therefore, fermentation or ensiling is veritable in the treatment of cassava peels for enhancement of crude protein and reduction of cyanide.

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