EFFECT OF SELECTED VEGETABLE OILS ON THE CYANIDE CONTENT OF CASSAVA (*Manihot esculenta* Cranz.)

Olorunfemi, D. I.* and Afobhokhan, C. O.

Department of Plant Biology & Biotechnology, University of Benin, Benin City, Nigeria
*Corresponding author: E-mail: udanfem@gmail.com Tel: +234 (0) 802 337 2455
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ABSTRACT

The cyanide content in dried cassava cake (*garri*) in two varieties of the tubers (Tropical Manoic Selection 1 and Tropical Manoic Selection 91954) treated with palm oil, groundnut oil and coconut oil were determined enzymically. Results obtained from the study revealed that treatment of cassava mash with the vegetable oils yielded about 99.8% reduction in the total cyanogenic content at seven days of fermentation. From an initial concentration of 10.35 mg HCN eq/mg in the sweet variety of fresh cassava tubers (Tropical Manoic Selection 1), the cyanogenic content at the end of fermentation period was reduced to 0.02500, 0.02550 and 0.0253 mg HCN eq/mg by palm oil, groundnut oil and coconut oil respectively. Similarly, the bitter cassava variety (Tropical Manoic Selection 91954) was reduced from 14.54 mg HCN eq/mg to 0.03080, 0.02520 and 0.02560 mg HCN eq/mg by palm oil, groundnut oil and coconut oil respectively. The vegetable oils increased the temperature of grated cassava varieties to allow breakdown of cyanogenic glycosides and for easy volatilisation after processing into *garri*.

Key words: Cassava, Cyanide Content, Vegetable Oils, Palm Oil, Groundnut Oil, Coconut Oil.

INTRODUCTION

Cassava, *Manihot esculenta Cranz* is grown for its enlarged starch-filled root which contains nearly the maximum theoretical concentration of starch on a dry weight basis among food crops. In addition to its high starch content, cassava contains cyanide in the form of cyanogenic glycosides; linamarin and a small amount of lotaustralin (Tewe *et al*., 1989) which is broken down in the presence of linamarase above pH 5 to hydrogen cyanide when the cells of the tubers are ruptured during processing (Cooke *et al*., 1985). In many parts of Africa, cassava is consumed in various forms as; chips, flakes, cubes, peelers, starch and flour. Consumption of cyanide-rich cassava or cassava based delicacies could result in the endermic goitre, cretinism and tropical ataxic neuropathy (Ermans *et al*., 1980; Osuntohin *et al*., 1969), hence the need for proper processing of the tubers to reduce the total cyanogenic content to liberate hydrogen cyanide, a deadly poison.

A wide variety of different methods of processing the cassava tuber to reduce their cyanogenic potential and toxicity is known. One of the measures is by processing it traditionally into *garri*, which is a free flowing product consisting of cassava particles that have been gelatinized and dried. *Garri* is either creamy white or yellow depending on the type of cassava used or whether palm oil has been applied. In some localities, palm oil is thoroughly mixed with cassava mash before fermentation while in others; the palm oil is added during roasting.

Palm oil extracted from the husk of the fruits of *Elaeis guineensis Jacq* (Hahn, 1995) consists mainly of neutral lipid and phospholipids and has a melting point of 29°C - 34°C and a boiling point greater than 20°C (Chow *et al*., 2002). Normally, palm oil is added to cassava mash to give the garri an aesthetic value (i.e. yellow colour). Previous investigations on the role of palm oil in *garri* production revealed that cassava cakes with palm oil have lower cyanide content and finer granular texture than the samples without palm oil (Fomuyan *et al*., 1981; Agbor, 2005, Odoemelam, 2005). The present study was carried out to assess the effect of selected vegetable oils on the cyanide content of cassava varieties during processing.

MATERIALS AND METHODS

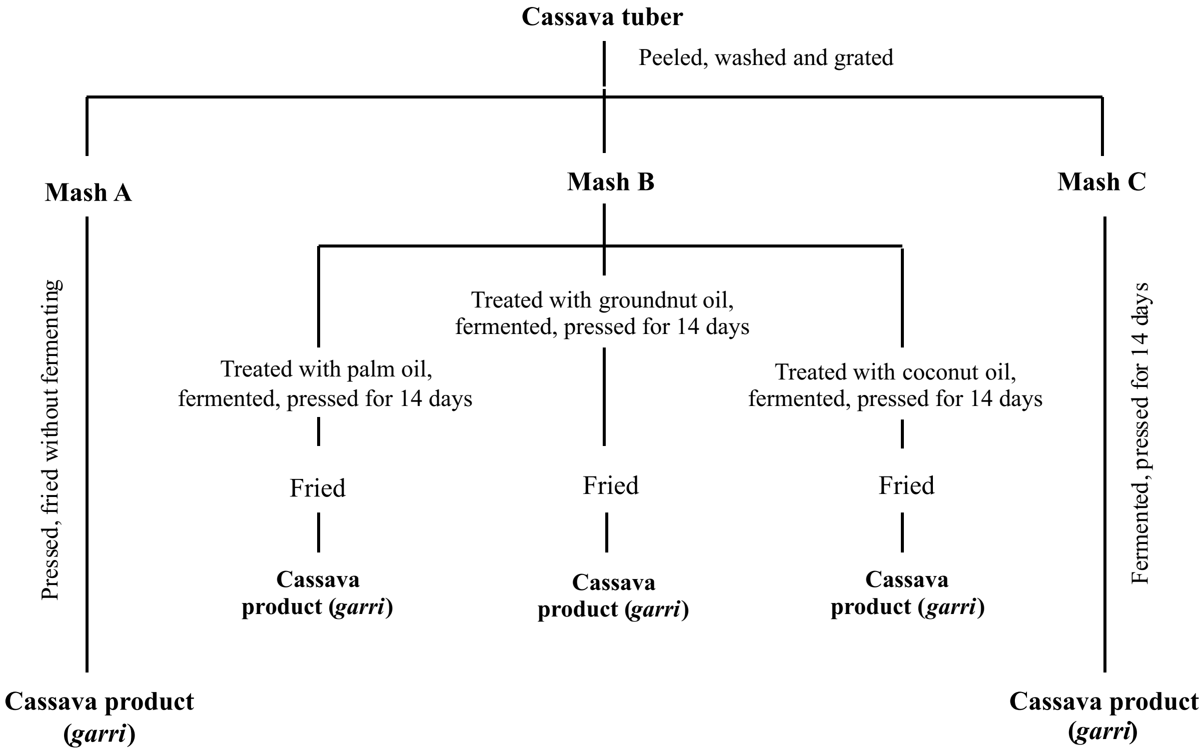
Collection of Cassava Plant Materials and Vegetable Oils

Sweet and bitter varieties of *Manihot esculenta* (Tropical Manioc 1 and Tropical Manioc Selection 91934), were obtained from International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. Thirty-four woven polypropylene sacks were used as carriage materials for cassava mashes. Three types of vegetable oils: palm oil, groundnut oil and coconut oil were obtained from the Nigeria

Institute for Oil Palm Research (NIFOR), Edo State, Nigeria.

Preparation of Cassava Tubers for Fermentation

The two varieties of cassava tubers were subjected to a processing scheme as shown below:



The two varieties of cassava tubers were peeled using a stainless steel knife, the fleshly portion washed with clean water and grated into mash using a mechanical grater. These were weighed using a spring balance and divided into three equal portions. The first set was placed in a piece of woven polypropylene sack, dehydrated by compression using hydraulic press and taken for frying without undergoing fermentation and no vegetable oil was added. The second set was further divided into three equal portions. Using a measuring cylinder, 10ml each of palm oil, groundnut oil and coconut oil were thoroughly mixed to each portion respectively. Each of these was further subdivided into four equal portions and each of these were fermented in woven polypropylene sacks and dewatered by compression using hydraulic press (Blitz, Model HPL 652, Stuttgart, Germany). The third set of the grated sweet cassava variety was further divided into four equal portions. Each of these was collected into a piece of woven polypropylene sack, fermented without the addition of vegetable oil and dewatered by compression using a hydraulic press. After fermentation, the semi-dried cassava cakes of the two varieties were sieved through a cane net sieve into small particles which where fried and dried in a metal frying pan over a fire.

pH and Temperature Determination

The temperature of the cassava mash varieties were taken at three different spots in the heap grated cassava variety for 14 days at 24 hours interval during the period of fermentation. The temperature values were measured using a mercury thermometer. Fresh portions of varying weights of each portion of the pressed grated cassava varieties were transferred to an oven-drier (Gallenhamp) at 67°C for 48 hrs to obtain constant weight, dry weights. The moisture content was calculated using the formula:

$$\%\ moisture\ content = \frac{fresh\ weight\ (g)\text{-}dry\ \ weight\ (g)}{(fresh\ weight\ (g)} \times 100$$

The pH values of the different mashes were measured using a pH meter (Jenway-370, Burlworld Scientific, England) digital pH meter. Briefly, about 2 g of the different mashes were dissolved in 10ml of distilled water, stirred and the pH of the suspension was then measured. The pH values were taken every 24 hours for 14 days during the period of fermentation.

Determination of Cyanide Content

The cyanide content in each of the cassava product, *garri*, was determined by the procedure of Cooke (1979). 30 g of *garri* was homogenized in 250ml of 0.1M orthophosphoric acid at room temperature in a warring blender for 15 seconds at low speed. The homogenate was centrifuged and the supernatant was divided into four portions. To each of four tubes containing 0.4ml of 0.2M phosphate buffer (pH 6.0) was added 0.1ml aliquots of the test extracts followed by pH adjustment to 7.0 using NaOH. To duplicate tubes containing the reaction mixture 0.1 ml of linamarase enzyme solution (was) added while only phosphate buffer was added to the other duplicate tubes. All four tubes were then incubated at 30°C for 15 mins and the reaction stopped by the addition of 0.6 ml 0.2 M NaOH.

The cyanide present in each tube was then determined by the modified chloramine T, Pyridine/pyrazolone method, in which 2.8ml of 0.1M phosphate (pH 6.0) was added to each tube followed by 0.2ml of chloramine T. The solutions were mixed and the tubes placed in ice water for about 5 minutes; thereafter 0.8ml of the pyridine/pyrazolone reagent was added to each tube followed by thorough mixing with a magnetic stirrer. The absorbance of the mixture was measured spectrophotometrically with Pye Unicam (UK) SP8-100 Spectrophotometer at 490 nm.

RESULTS

All the vegetable oils used in this study (palm oil, groundnut oil and coconut oil) significantly ($p<0.001$) reduced the cyanide content in *garri* made from sweet cassava during the fermentation period of 7 days. Fig. 1a shows that the cyanide content of *garri* fermented and treated with palm oil was lower than that fermented without oil during the fermentation period of 3 days.

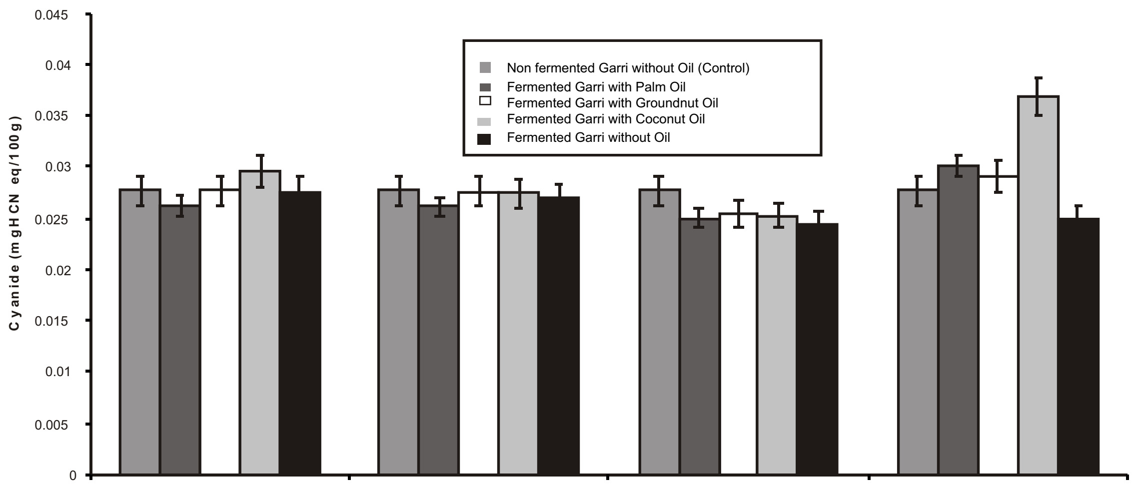


Fig. 1(a):Effect of Different Vegetable Oil Treatment on Cyanide Content of Cassava Product (*garri*) Made from Sweet Cassava

The cyanide content of sweet and bitter cassava tubers which was initially 14.54mg HCN eq/mg, and 10.35mg HCN eq/mg respectively, dropped drastically below 10mg HCN eq/mg, the World Health Organization (WHO) safe level of 1 mg/100 g (FOA/WHO, 1991). It was observed that palm oil played a more effective role in reducing cyanide content in *garri* than groundnut oil and coconut oil. Fermentation reduced the cyanide content far more than vegetable oils on the 7th day. There was increase in cyanide level of *garri* treated with vegetable oils on the 14th day. Similarly, there was significant reduction in the cyanide content of *garri* made from bitter cassava when subjected to the same treatments and days of fermentation with *garri* from sweet cassava (Fig. 1b).

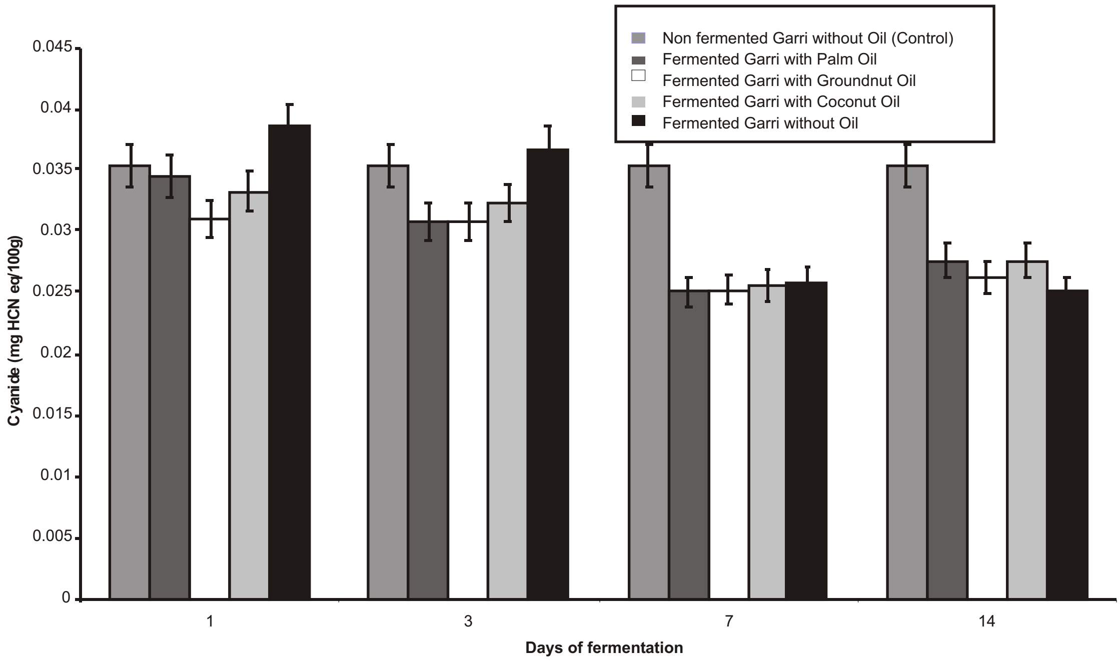


Fig. 1(b): Effect of Different Vegetable Oil Treatment on Cyanide Content of Cassava Product (*garri*) Made from Bitter Cassava

Garri treated with vegetable oils were lower in cyanide content than that fermented without oil. The cyanide content of fermented *garri* with palm oil was the least followed by that treated with groundnut oil and coconut oil during the fermentation period of 7 days. Cyanide content in *garri* increased on the 14th day except for that which was fermented without oil. Furthermore, it was observed that the cyanide content of *garri* made from sweet and bitter cassava as influenced by different forms of vegetable oils were almost the same on the 7th day.

The effect of the vegetable oils on the temperature of grated cassava is shown in Fig 2a. It was observed that the vegetable oils raised the temperature of the mashes during the period of fermentation. There was no significant difference in the temperature values of grated sweet cassava treated with groundnut oil and coconut oil. However, palm oil reduced the temperature of the mash far more than groundnut oil and coconut oil on the 1st day. There was significant increase in the temperature values of the grated sweet cassava treated with vegetable oils from the 1st day to the 5th day. This then decreased from the 6th day to the 14th day of fermentation. No change in the temperature of the mash with vegetable oils was noticed on the 2nd, 3rd, 6th, 7th, 8th, 12th, 13th and 14th day of fermentation. The temperature of grated bitter cassava increased significantly with the application of vegetable oils. Temperature increased gradually from 1st to the 5th day and roughly decreased from 6th to the 14th day of fermentation. However, there was no temperature difference in the mashes treated with palm oil and coconut oil on the 3rd, 4th, 7th and 14th day of fermentation (Fig. 2b).

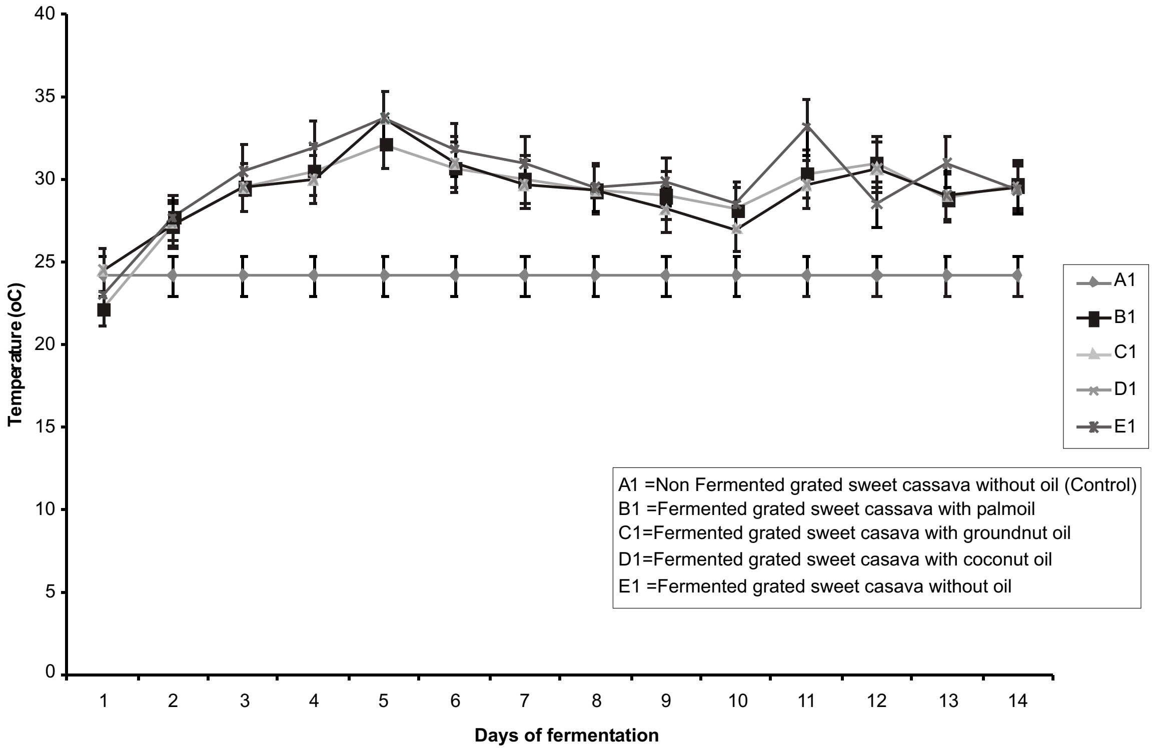


Fig. 2a: Changes in Temperature During Fermentation of Sweet Cassava Following Treatment with Different Types of Vegetable Oils.

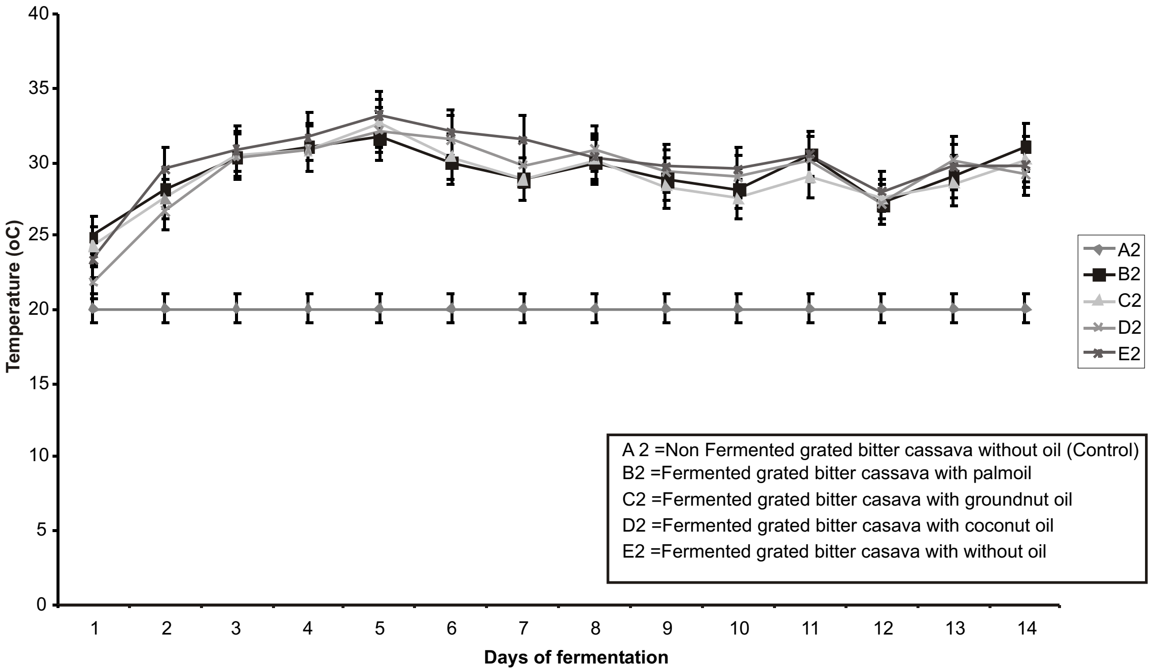


Fig. 2b: Changes in Temperature During Fermentation of Bitter Cassava Following Treatment with Different Types of Vegetable Oils.

The variation in daily pH of grated sweet cassava as influenced by the different types of vegetable oils applied is presented in Fig. 3a. Palm oil, groundnut oil and coconut oil significantly increased the pH of the grated sweet cassava throughout the days of fermentation except on the 10th day. Groundnut oil lowered the pH below the control on the 7th day. The pH of mashes with vegetable oils increased during the fermentation period of 3 days. Coconut oil reduced the pH of the mash on the 4th day. It was observed that the mash with different forms of vegetable oils except groundnut oil increased significantly on the 5th day. Slight decreases in pH values were noticed from the 6th day to the 10th day of fermentation but from 11th day to the 13th day, there was significant increase in pH. On the 14th day, the pH of the mash with groundnut oil dropped slightly. In comparison, palm oil, groundnut oil and coconut oil raised the pH of the bitter cassava mashes in the first 3 days of fermentation respectively. Palm oil lowered the pH on the 4th day while groundnut oil and coconut oil reduced the pH on the 5th day. From the 6th day to the 10th day of fermentation, the pH of the mashes treated with vegetable oils showed slight reduction. Except that treated with groundnut oil, the mashes with vegetable oils gradually showed an increase from 11th day to the 14th day (Fig. 3b).

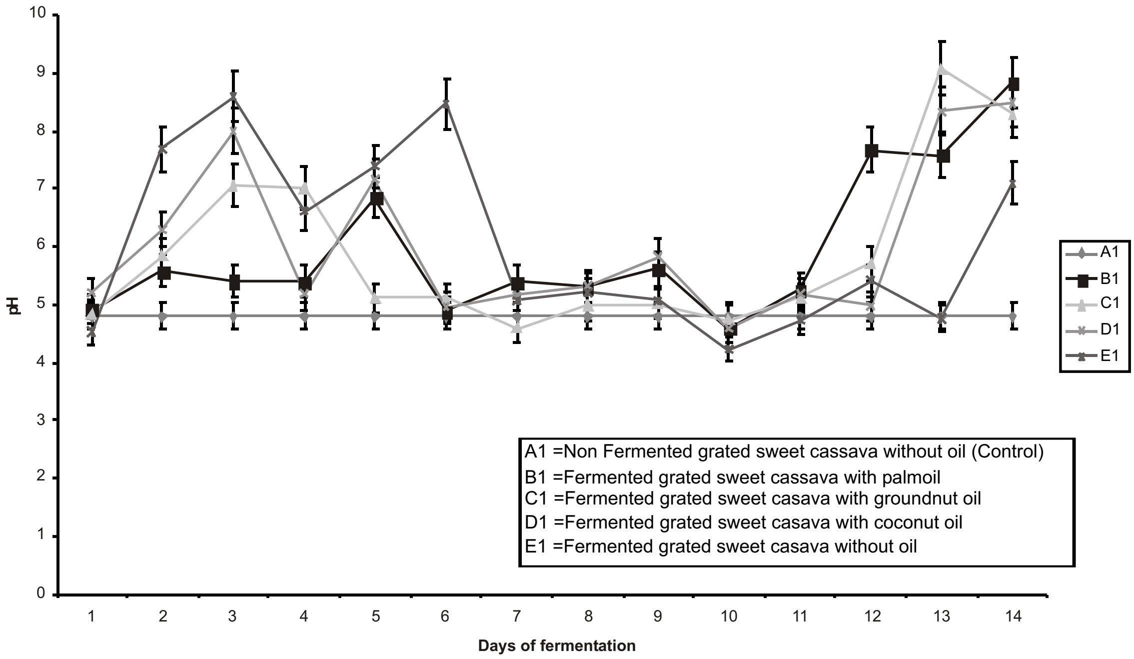


Fig. 3a: Changes in Ph During Fermentation of Sweet Cassava Following Treatment with Different Types of Vegetable Oils.

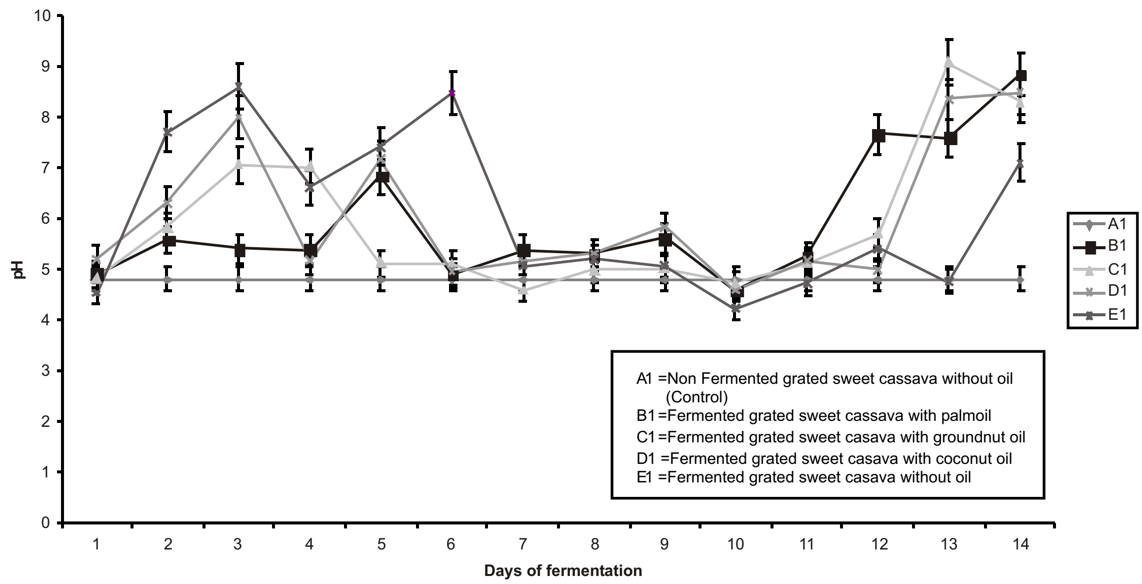


Fig. 3b: Changes in Ph During Fermentation of Bitter Cassava following Treatment with Different Types of Vegetable Oils.

The percent moisture content of grated sweet and bitter cassava treated with vegetable oils on the 14th day was higher than the control (Tables 1 & 2).

Table 1: Percentage moisture content of sweet cassava varieties on the 14th day of fermentation.

Treatment	**Fresh weight (g)**	**Dry weight (g)**	**Percent moisture content(%)**
Sweet cassava with oil	2600.00	550.00	78.85
Sweet cassava with palm oil	216.00	25.00	88.46
Sweet cassava with groundnut oil	216.00	25.00	88.46
Sweet cassava with coconut oil	216.00	25.00	88.46
Sweet cassava without oil fermented	650.00	125.00	80.77

Table 2: Percentage moisture content of bitter cassava varieties on the 14th day of fermentation

Treatment	**Fresh weight (g)**	**Dry weight (g)**	**Percent moisture content (%)**
Bitter cassava with oil	3266.66	725.00	77.80
Bitter cassava with palm oil	272.22	35.00	87.10
Bitter cassava with groundnut oil	272.22	25.00	87.10
Bitter cassava with coconut oil	272.22	25.00	87.10
Bitter cassava without oil fermented	816.66	175.00	78.50

DISCUSSION AND CONCLUSION

The cyanide contents of sweet and bitter cassava tubers which were initially 14.54 mg HCN eq/mg, and 10.35mg HCN eq/mg respectively, dropped drastically below 10 mg HCN eq/mg, the World Health Organization (WHO) safe level of 1 mg/100 g (FOA/WHO, 1991). Results obtained from this study are in agreement with previous workers who found that *garri* produced from cassava tubers with palm oil has lower cyanide content and finer granular texture than the samples without palm oil (Fomuyan *et al.*, 1981; Agbor, 2005, Odoemelam, 2005). This reduction may be due to the facilitation of volatilization of cyanohydrin and hydrogen cyanide by the vegetable oils thus making drying process easier and quicker during roasting (Vasconcelos et *al.,* 1992). The vegetable oils could also have acted as lubricants between the cassava particles in the mash thereby preventing these particles from aggregating and thus, increase the surface area for linamarase action during fermentation (Westby *et al.*, 1992).

It was observed in this study that the pH of the grated sweet and bitter cassava tubers increased compared to the control. The enzyme linamarase has been reported to break down cyanogenic glycosides into sugar and cyanohydrin at pH 5 and above, and this undergoes spontaneous hydrolysis to yield hydrogen cyanide which readily dissolves in water and is eliminated (Cooke *et al.*, 1985). Cyanohydrins and hydrogen cyanide are volatile therefore, the vegetable oil may have raised the temperature of the mashes to facilitate the evaporation of both substances. Furthermore, this study has shown that palm oil played a better role in reducing cyanide level in sweet and bitter cassava than groundnut oil and coconut oil.

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