The Synergistic Effect of Nail, Linear Alkyl Benzene Sulphonate and Trona on the Rate of Fermentation of Cassava for 'Fufu'.

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ABSTRACT

The effect of some process variables on the rate of cassava fermentation for 'fufu' production was investigated. The rate of acidification of the fermenting root increased with time for all observations as indicated in pH values and total titratable acidity. Generally, nail and trona have positive effect on the rate of cassava fermentation. In set A, the pH values of control sample at zero hour were higher than that of decanted homogenate solution. This was attributed to a more stable condition (enzyme concentration) within the tubers. This was a common observation throughout the period of the experiment. In set B, there was no positive effect of the combination of research materials. Varied concentration of the research materials did not favour the culture and activity of linamarase due to increased alkaline concentration in trona and linear alkyl benzene sulphonate (LABS). It was concluded that nail affected the rate of acidification of cassava root positively followed by trona. Recommendations of the research materials for 'fufu' production were also included.

Keyword: Synergistic, fermentation, rate, acidification

INTRODUCTION

The enlarge roots of the cassava plant (Manihot esculenta Cranta) is consumed all over the tropical world, in Africa, Asia and the Carribean. In West Africa including Ghana, Cote d'Ivoire, Togo, Cameroon and Nigeria, it is consumed by over 200 million which forms a major supply of Carbohydrate in these countries (Okafor and Anike, 2008). Cassava is a perennial vegetative propagated shrub that is grown throughout the lowland tropics (Wenham, 1995). It is one of the most important food crops in the tropics (Fanquet and Taylor, 2002). Cassava is a tropical root crop that serves as a food security and income generation crop for many millions of people in developing world (Scott etal, 2002). It is grown in Nigeria and in many regions of tropics where it serves as one of the basics food source for about 500 million people in the world (abu etal., 2006). Cassava is normally processed before consumption as a means of detoxification, preservation and modification (oyewole, 1991). Fermentation is an important processing method for the crop.

It is an important unit operation for the processing of cassava for human consumption in Africa (Mahungu etal., 1987). Common fermented cassava product of West Africa include 'gari', 'fufu', 'lafun' among others (Oyewole, 1991). Among these fermented cassava products 'fufu' is unique because in the traditional processing, the product is not subjected to any other processing after fermentation before cooking (Oyewole and Ogundele, 2001). 'Fufu' is produced by the hydrolysis of cassava cyanogenic glycoside (Adedeji, 2004). The toxic cyanohydrins structure is removed in the process. Cyanohydrin is very unstable hence it dissociates into volatile hydrogen cyanide (HCN) and acetone, leaving glucose starch – paste in suspension (Adedeji, 2004). Acetone is leached out of the solution with water leaving edible cassava (dry or paste) while hydrogen cyanide evaporates at room temperature. Enzymes like linamarase catalyses the hydrolysis but like most enzyme catalysed reactions, the progress is very slow taking up to 96 hours to be completed. The very slow rate of reaction necessitates the use of certain substances to affect the rate of fermentation which is the objective of this work.

One major problem with 'fufu' processing is that the quality of the product varies from one processor to the other and from one processing batch to the other by the same processor (Oyewole and Ogundele, 2001). The derivation may be affected by varieties of microbial that is enzymes and some variations in process conditions or research materials such as heavy metals (nail), linear alkyl benzene sulphonate (LABS) and Trona (kannu) which is a dried lake salt. The effect of the research materials on the rate of fermentation of cassava for 'fufu' is studied in this work. The result will be useful for determining conditions for optimizing the fermenting process of cassava for 'fufu' which justifies this work.

MATERIALS AND METHOD

Cassava roots of the variety TM30572 were obtained from the Polytechnic farm of Lagos State Polytechnic, Ikorodu, La gos, Nigeria. The cassava roots were peeled and washed with tap water. The roots were 11 -12 months old plants. 500g of the cassava pieces of an average thickness of 2cm were steeped in 600ml tap water contained in 1000ml beaker. The sample solution was labelled U_0. This was repeated three more times and samples were labelled U_1, U_2 and U_3. Three different set of experiments were carried out. In each set, the duration of fermentation was varied from 0hr to 72hrs at 9hrs interval except in set C where it was varied from 0hr to 63hrs at 9hrs interval. 5g portion of the fermenting root was homogenised in $20cm^3$ sterile distilled water. The resulting homogenised suspension was also labelled U_{oH}, U_{1H}, U_{2H} and U_{3H}. The pH of samples were determined using pH meter model 7020 equipped with a glass electrode. The Total Titratable acidity (TTA) of the fermenting roots was determined by titrating $20cm^3$ of the decanted homogenate sample used for the pH determination against 0.1M NaOH solution to pH 8. The volumes of base used were recorded in cm^3.

INSERT SET (A) ABOUT HERE

U_o was a blank sample used as control for assessment of the effect of the research materials on the cassava hydrolysis. U_1 was injected with $10cm^3$ of 5% LABS solution. U_2 contained 6 inches clean iron nail while U_3 was injected with $10cm^3$ of 5% trona solution. The same was repeated using homogenate samples. U_{oH} replaced U_o, U_{1H} for U_1, U_{2H} for U_2 and U_{3H} for U_3.

INSERT SET SET (B) ABOUT HERE

Fresh samples of U_o, U_1, U_2, U_3, U_{oH}, U_{1H}, U_{2H}, and U_{3H} were produced. U_o was also a blank sample used as control. $5cm^3$ of 5% LABS solution with $5cm^3$ of 5% trona solution was added to U_1. $5cm^3$ of 5% trona solution together with 3 inches nail was added to U_2. $5cm^3$ of LABS solution and 3 inches nail were added to U_3. The same was repeated using homogenate samples. U_{oH} replaced U_o, U_{1H} for U_1, U_{2H} for U_2 and U_{3H} forU_3.

INSERT SET SET (C) ABOUT HERE

Fresh samples of U_o, U_1, U_2, U_3, U_{oH}, U_{1H}, U_{2H} and U_{3H} were produced. U_o was still a blank sample used as control. $25cm^3$ of 25% LABS solution was injected into U_1, 4 inches nail was added to U_2 and $20cm^3$ of 15% trona solution was added to U_3. The same was repeated using decanted homogenate samples. U_{oH} replaced U_o, U_{1H} for U_1, U_{2H} for U_2 and U_{3H} for U_3.

RESULTS AND DISCUSSION

The behaviour and effect of the research materials – nail, LABS and trona in relation to the fermenting rate of cassava are studied. The plot of the sample solution against time in each set of the experiments determines the effect of the research materials on the external environment of the cassava tuber while the plot of decanted homogenate solution relate the inside and outside effect of the research materials on the rate of fermentation of cassava root. The total titratable acidity (TTA) helps to evaluate the approximate quantity of cyanohydrin's (lactic acid) that was removed from the root since the volume of the base required to neutralise the acid is proportional to the quantity of acid present. The values from table 1 to table 9 were used to plot the graphs in figure 1 to figure 9. For all the three sets of the experiments, there was an irregular drop in the pH value over the duration of soaking the tuber in water for 72hours.

Oyewole (1990) reported that the acidic condition of the Fermenting roots encourages the predominance of bacteria action necessary for the hydrolysis to take place. Therefore the drop in pH indicates the presence of microbial which affect cassava tuber hydrolysis and this indicates that fermentation occurred. In figure 1and figure 2, LABS has the highest pH value which does not encourage the culture of linamarase enzyme. In figure 3, the volume of the base required for LABS was very low hence little fermentation only occurred. The pH value of control sample was the lowest on average in figure1 and in figure 2, the pH value of nail was the lowest on average. Figure 4 followed similar trend with figure 1 but the rate of acidification is higher in figure 1.

The control sample has the highest rate of acidification in figure 4 over the combination of research materials. In figure 5, the control sample also led in the acidification rate followed by trona + nail which is similar to the case in figure 4. Figure 6 followed the trend with figure 3 but the base used as shown in figure 6 was smaller than that of figure 3. This shows that results in set A have a better effect on the rate of fermentation than those in set B. The effect of varying the concentration of the research materials on the rate of fermentation of cassava tuber is shown in figure 7 to figure 9. The values of pH in figure 7 to figure 9 fall from left to right, confirming that fermentation took place as in set A. The rate of acidification is faster in set A more shown in figure 1 to figure 3 than set C as shown in figure 7 to figure 9. In figure 7, nail took the lead since it appears to have a more stable effect on the sample at varied concentration. The inside of the tuber is more acidic than the sample solution as shown in table 8 when compare with table 7. From figure 8, the nail has the highest rate of acidification followed by control sample. Trona and LABS whose concentrations were varie had a low acidification rate , showing that the varied concentration have a negative effect on the rate of fermentation. Comparing figure 3 and figure 9, the average volume of base required in figure 9 is greater than that of figure 3. This was attributed to the varied concentration.

CONCLUSION

The results of all the experiments fall in pH value hence increasing acidification. The total titratable acidity of the fermenting sample increased since the volume of base required to titrate the sample to pH 8 increased with increasing fermentation time therefore there was fermentation of cassava root. Nail affected the rate of fermentation of cassava more positively followed by trona while LABS retarded the rate of fermentation. A combination of research materials in pair could not be said to have achieved a better result since the highest fermenting pair (trona + nail) have a very close average in total titratable acidity with the control sample. Upon varying the concentration of the research materials, it was discovered that there was no much significant effect in case of nail but trona and LABS hindered the activities of microbial to aid fermentation. Therefore nail (iron) is the most preferred.

RECOMMENDATIONS

- For ‘fufu’ production, a six inches nail (iron) could be used to enhance the rate of fermentation which produces a complete hydrolysis for at least 72 hours.
- When trona is used, it should be of low concentration like 5%.
- LABS should not be used since it has a negative effect on the rate of fermentation.
- In the absence of nail and trona for any reason, a normal blank fermentation should be used.

Table 1: pH of Sample Solution for Set A

Time(hr)	0	9	18	27	36	45	54	63	72
LABS	7.5	7.10	5.45	5.50	4.85	4.85	4.60	4.40	4.60
Nail	6.80	6.00	5.00	4.35	4.35	4.75	4.60	4.20	4.30
Trona	7.10	6.40	5.15	4.10	4.15	4.35	4.15	3.70	4.10
Control	6.80	6.05	5.00	4.00	4.10	4.50	4.40	3.90	4.20

Table 2: pH of Decanted Homogenate Solution for Set A

Time(hr)	0	9	18	27	36	45	54	63	72
LABS	7.40	6.35	6.30	6.10	5.75	5.60	5.20	5.60	5.20
Nail	6.70	5.40	5.15	4.85	4.90	4.65	4.05	4.45	4.35
Trona	7.35	5.70	5.60	4.95	4.70	4.55	3.50	4.20	4.00
Control	6.70	5.95	5.55	4.80	4.95	4.90	4.05	4.55	4.45

Table 3: Total Titratable Acidity for Set A

Time(hr)	0	9	18	27	36	45	54	63	72
LABS	0.07	0.10	1.70	2.70	2.00	1.90	3.30	7.10	6.60
Nail	0.15	0.28	1.60	4.30	8.00	11.30	12.20	17.20	16.80
Trona	0.12	0.25	0.90	0.50	5.00	7.50	10.30	23.70	21.80
Control	0.14	0.27	0.50	2.30	6.80	9.30	8.30	23.90	20.30

Table 4: pH of Sample Solution for Set B

Time(hr)	0	9	18	27	36	45	54	63	72
Trona + LABS	6.90	6.00	5.70	4.90	4.75	4.80	4.50	4.15	4.00
Trona+ Nail	6.85	5.30	4.30	4.30	3.85	4.00	3.70	3.60	3.50
LABS + Nail	6.85	5.60	5.40	4.45	4.45	4.50	4.30	4.05	3.95
Control	6.30	5.10	3.90	3.80	3.80	3.95	3.55	3.50	3.50

Table 5: pH of Decanted Homogenate Solution for Set B

Time(hr)	0	9	18	27	36	45	54	63	72
Trona+ LABS	6.90	5.70	6.20	5.85	5.30	5.30	4.55	4.30	4.21
Trona + Nail	6.85	5.50	5.50	4.90	4.30	4.50	4.20	3.60	3.50
LABS + Nail	6.85	5.30	5.40	5.55	5.50	5.00	4.75	4.50	4.48
Control	6.80	6.10	5.50	4.40	4.35	4.60	3.95	3.60	3.50

Table 6: Total Titratable Acidity for Set B

Time(hr)	0	9	18	27	36	45	54	63	72
Trona+ LABS	0.50	0.70	1.00	1.30	2.30	2.50	4.20	6.10	6.12
Trona + Nail	1.35	1.40	1.20	2.40	6.90	6.90	10.30	13.60	13.73
LABS + Nail	1.80	1.90	2.00	1.00	1.70	2.90	2.40	5.60	5.74
Control	0.55	1.20	1.40	5.20	6.20	8.30	9.20	11.00	3.59

Table 7: pH of Sample Solution for Set C

Time(hr)	0	9	18	27	36	45	54	63	72
LABS	9.20	7.20	6.75	6.00	6.00	5.75	5.00	5.90	5.60
Trona	9.40	7.70	6.35	5.70	5.40	5.70	5.90	5.80	5.35
Nail	7.00	5.10	4.70	4.65	4.90	4.85	4.85	4.00	4.50
Control	6.90	4.90	4.40	4.45	4.35	4.85	4.00	4.85	4.90

Table 8: pH of decanted Homogenate Solution for Set C

Time(hr)	0	9	18	27	36	45	54	63	72
LABS	6.70	6.45	6.40	6.20	6.15	6.10	6.10	6.30	6.25
Trona	6.69	6.60	6.20	6.00	5.50	5.70	5.70	5.50	5.00
Nail	6.65	6.25	5.40	4.50	5.00	4.95	4.95	4.70	4.65
Control	6.65	6.15	5.35	4.65	5.10	5.00	4.90	5.00	4.90

Table 9: Total Titratable Acidity for Set C

Time(hr)	0	9	18	27	36	45	54	63	72
LABS	1.50	2.00	3.40	3.75	3.60	4.00	5.30	4.50	5.30
Trona	1.20	2.20	3.00	3.25	5.90	6.10	8.00	9.70	11.20
Nail	3.20	4.20	4.60	13.60	14.40	18.30	17.10	19.20	21.70
Control	2.00	3.80	5.20	18.57	11.00	12.90	15.20	17.50	17.30

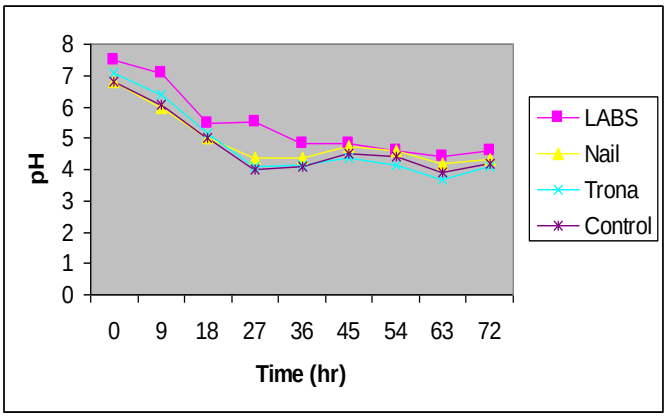

Fig. 1: pH of Sample Solution against Time for Set A

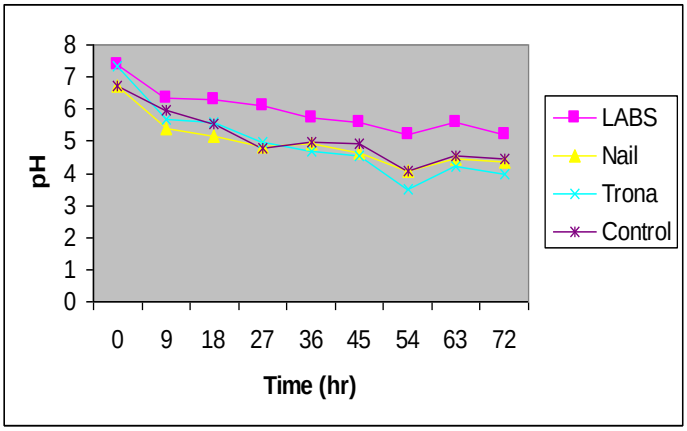

Fig. 2: pH of Decanted Homogenate Solution against Time for Set A

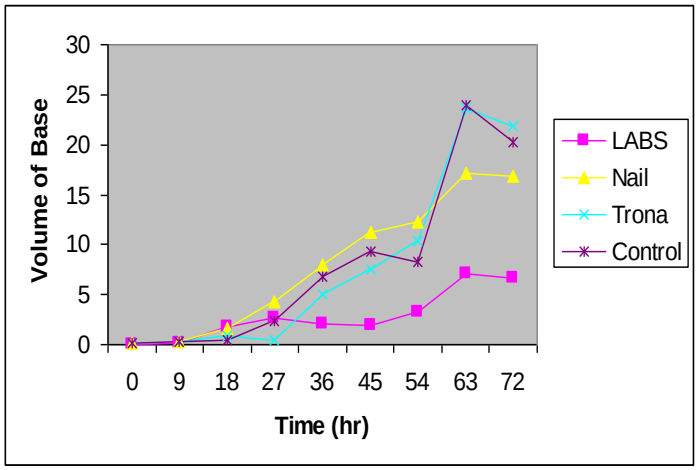

Fig. 3: Total Titratable Acidity against Time for Set A

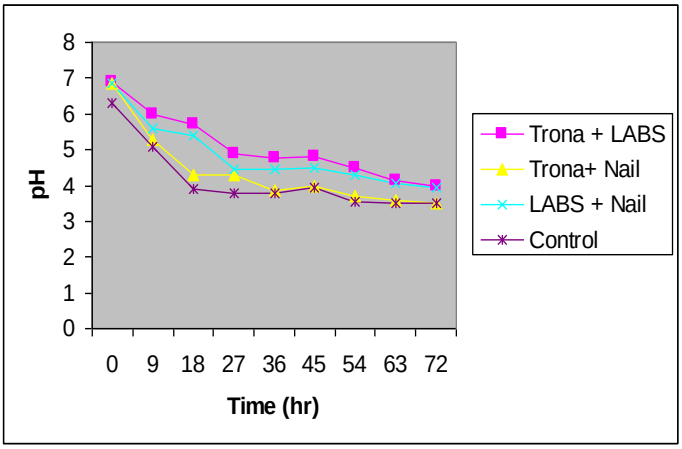

Fig. 4: pH of Sample Solution against time for Set B

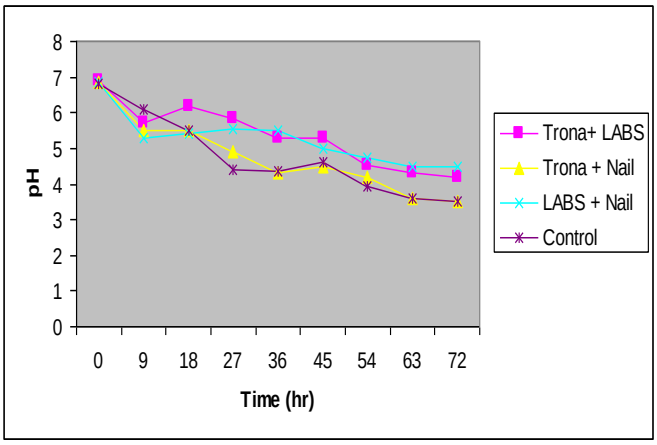

Fig. 5: pH of Decanted Homogenate Solution against Time for Set B

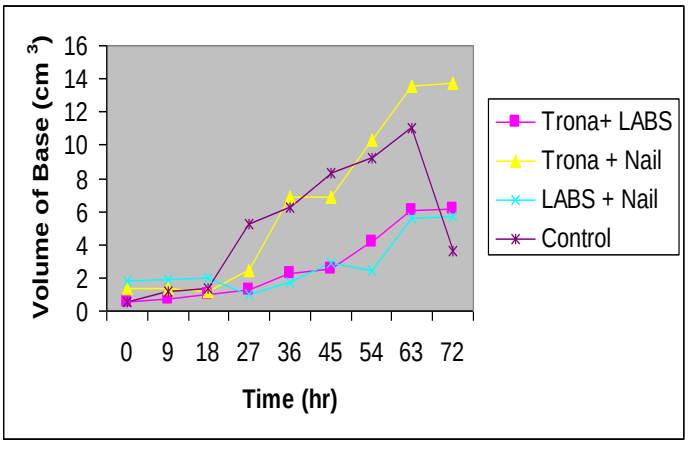

Fig. 6: Total Titratable Acidity against Time for Set B

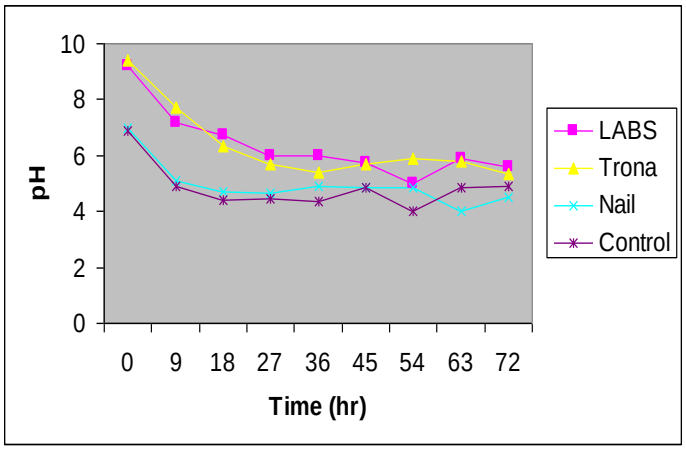

Fig 7: pH of Sample Solution against Time for Set C

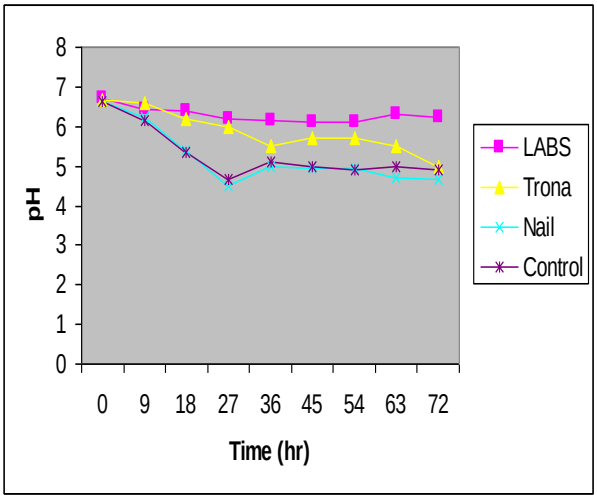

Fig 8: pH of decanted Homogenate Solution against Time for Set C

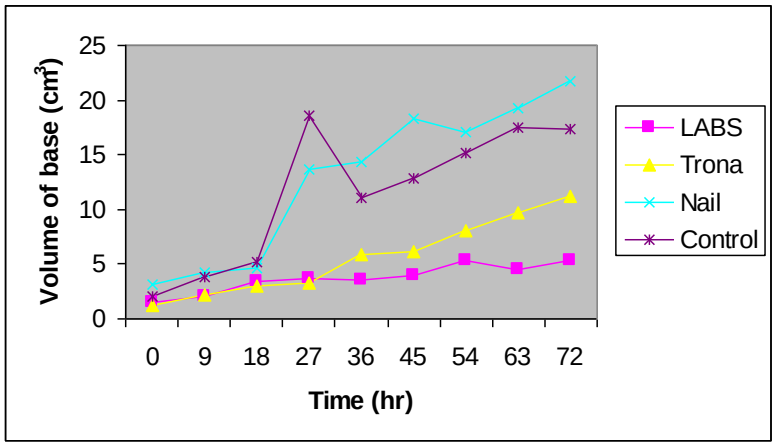

Fig 9: Total Titratable Acidity against Time for Set C

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