OCESS OPTIMIZATION OF BIOETHANOL PRODUCTION FROM PEELS CASSAVA CULTIVARS USING DIFFERENT MICROBIAL INNOCULANTS

by

n Edak Aniedi[1], Obianwa Chibuzor Uchenna[1] and Igile Godwin[2]

partment of Genetics & Biotechnology[1] and Department of Biochemis

UNIVERSITY OF CALABAR,

NIGERIA

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CASSAVA IS CULTIVATED EXTENSIVELY AS OOD CROP IN NIGERIA AND OTHER TROPIC REGIONS

ROCESSED INTO TAPIOCA, GARRI, FUFU A CASSAVA FLOUR

3RD LARGEST SOURCE OF CARBOHYDRATE HE WORLD

THERE'S A GROWING INTEREST IN T CONVERSION OF ORGANIC WASTES L CASSAVA PEELS INTO USEFUL END-PRODUC

TTRACTIVE FEATURES OF CASSAVA:

- nigh yielding
- able to grow on marginal soils
- requires minimal labour and mangt costs
- Thus, good candidate for bioethanol prod

M OF STUDY - TO OPTIMIZE THE PRODUCTION OF

OETHANOL USING DIFFERENT MICROBIAL INOCULANTS

R THE SIMULTANEOUS SACCHARIFICATION AND

RMENTATION OF CASSAVA PEELS IN 3 CASSAVA

RIETIES .

INNOCULANTS USED

- *Aspergillus niger + Saccharomyces cerevisiae*
- *Aspergillus niger + Saccharomyces cerevisiae + Rhizopus nigricans*
- *Spirogyra africana + Saccharomyces cerevisiae + Rhizopus nigricans*
- *Aspergillus niger + Saccharomyces cerevisiae + Spirogyra africana*
- *Rhizopus nigricans + Saccharomyces cerevisiae*

METHODOLOGY :

Peels from 3 cassava cultivars TME 0505, TME 41 and TME 4779, were washed, dried in an oven at 120^{o}C for 3hours, ground into a fine texture using locally made milling machine & sieved with 1.5µ nylon sieve.

Cultured under anaerobic condition at different n small bioreactors using the five inoculants separately.

- **Optical Density (microbial growth) was measured using a spectrophotometer every 3 days.**
- **Trial fermentation was done to find out the optimal parameters required for high ethanol yields**
- **Amount of Ethanol produced was recorded at 7, 14 & 21 days using optimal parameters**

TABLE 1

ptical densities (indicating microbial growth) for different inoculum a
540nm and the observed pH (in brackets) in cassava cultivar TME 050

Inoculum	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18
Rhizopus/yeast	1.131 (5)	1.22 (4)	1.339 (4)	**1.485 (5)**	1.33 (5)	1.22 (5)	1.064 (5)
Aspergillus/yeast	0.915 (6)	1.272 (6)	**1.535 (5)**	1.383 (5)	1.262 (5)	1.255 (5)	1.011 (5)
Aspergillus/ Rhizopus/yeast	1.12 (5)	1.34 (5)	1.401 (5)	**1.471 (5)**	1.125 (5)	0.95 (6)	1.001 (6)
Rhizopus/Spirogyra/yeast	0.804 (5)	0.914 (5)	1.42 (5)	1.608 (5)	**1.632 (5)**	1.35 (6)	1.226 (6)
Aspergillus/ Spirogyra/ yeast	0.929 (5)	1.056 (5)	**1.614 (5)**	1.61 (5)	1.456 (5)	1.232 (6)	1.325 (6)

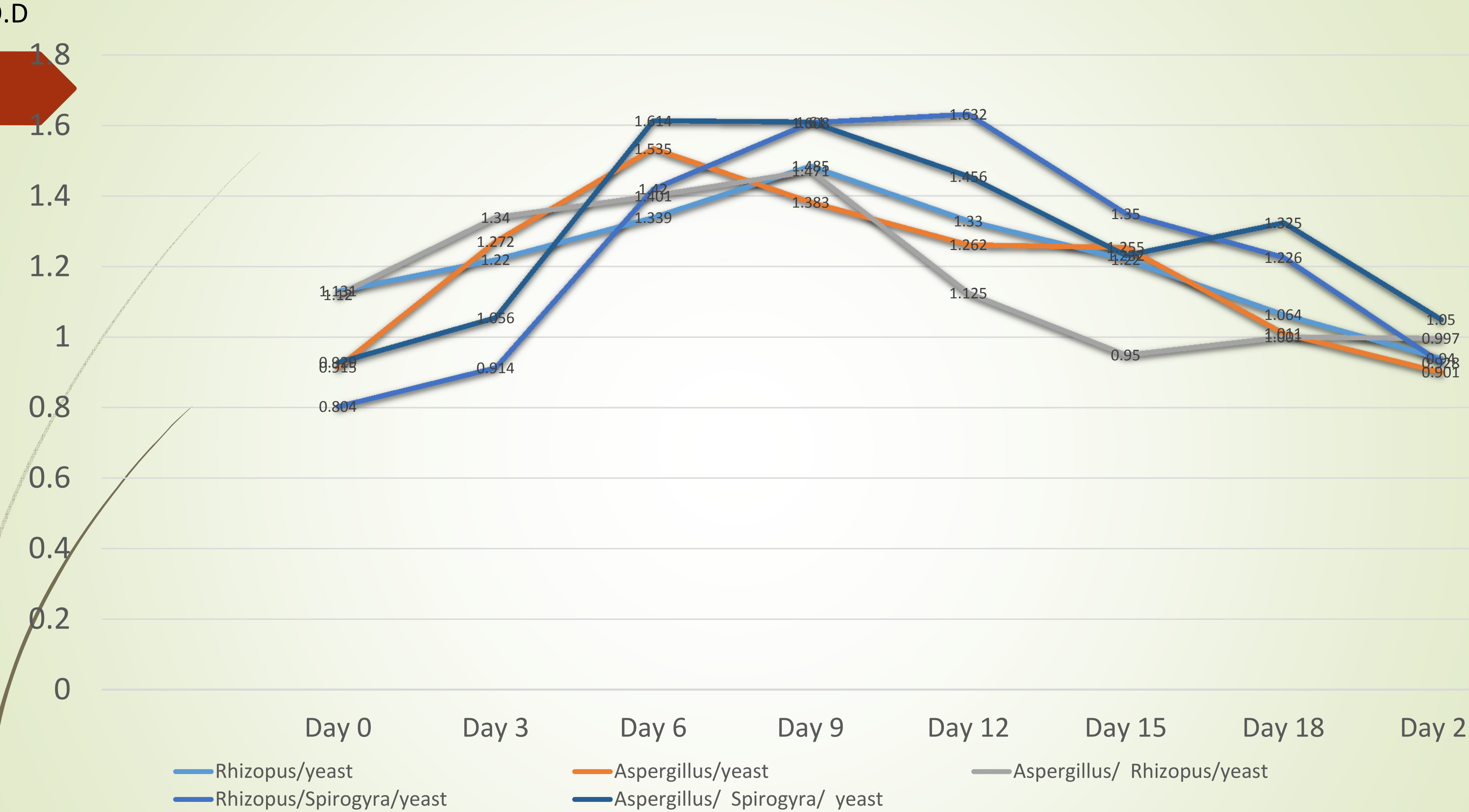


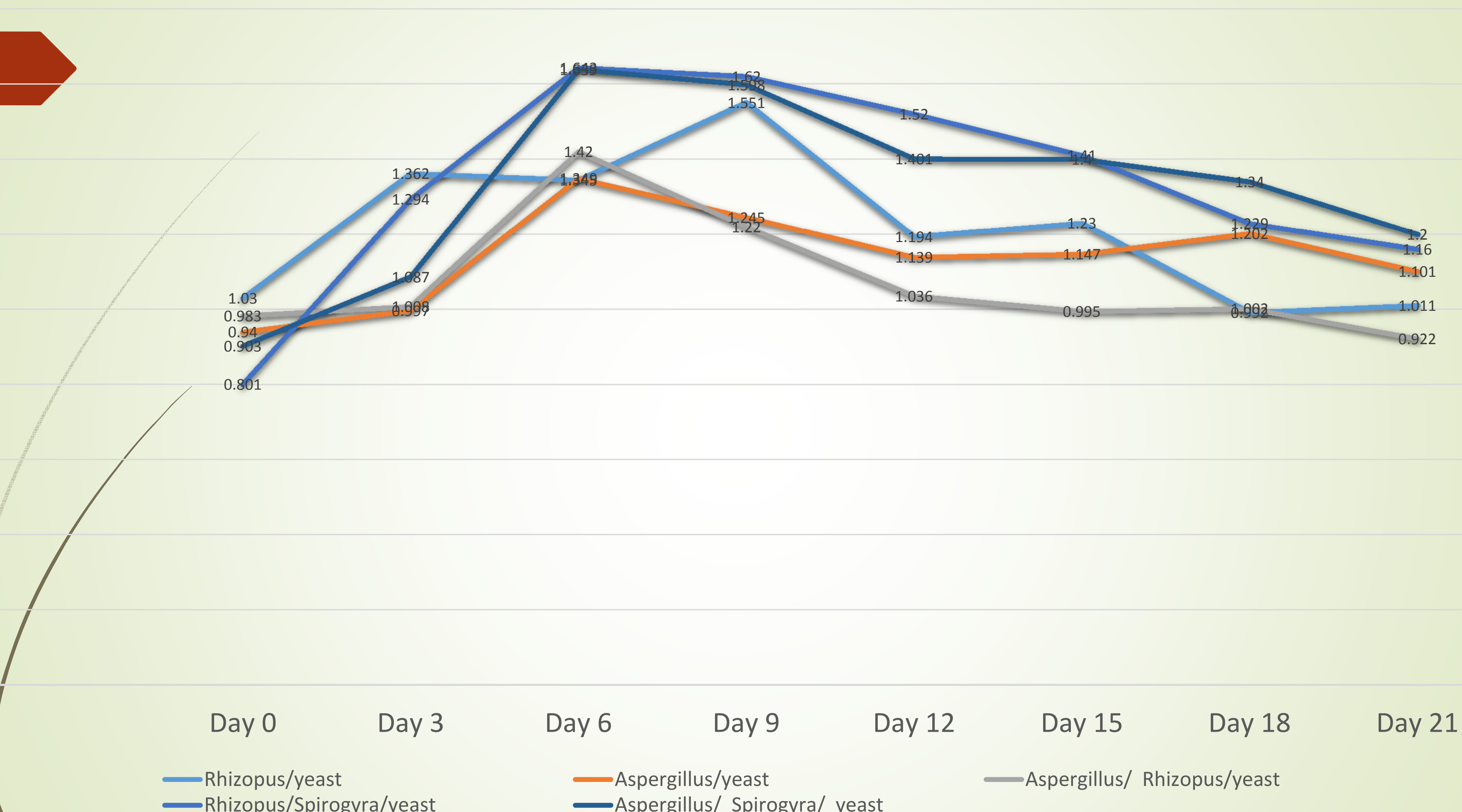
FIG. 1: Growth curve obtained from treating cassava cultivar TME 0505 with different innocula

TABLE 2

crobial growth from different inoculants at optical density of 540nm and the observed pH, in cultivar TME 419

TME 419

Inoculum	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 2
hizopus/yeast	1.03 (5)	1.362 (4)	1.345 (5)	**1.551 (5)**	1.194 (5)	1.23 (6)	0.992 (6)	1.011 (
spergillus/yeast	0.94 (5)	0.997 (4)	**1.349 (5)**	1.245 (5)	1.139 (5)	1.147 (5)	1.202 (6)	1.101
Aspergillus/ hizopus/yeast	0.983 (5)	1.008 (5)	**1.42 (5)**	1.22 (5)	1.036 (5)	0.995 (6)	1.002 (6)	0.922 (
us/Spirogyra/yeast	0.801 (6)	1.294 (5)	**1.643 (5)**	**1.62 (5)**	1.52 (6)	1.41 (6)	1.229 (6)	1.16 (
rgillus/ Spirogyra/ yeast	0.903 (5)	1.087 (5)	**1.639 (5)**	1.598 (5)	1.401 (6)	1.4 (6)	1.34 (6)	1.2 (

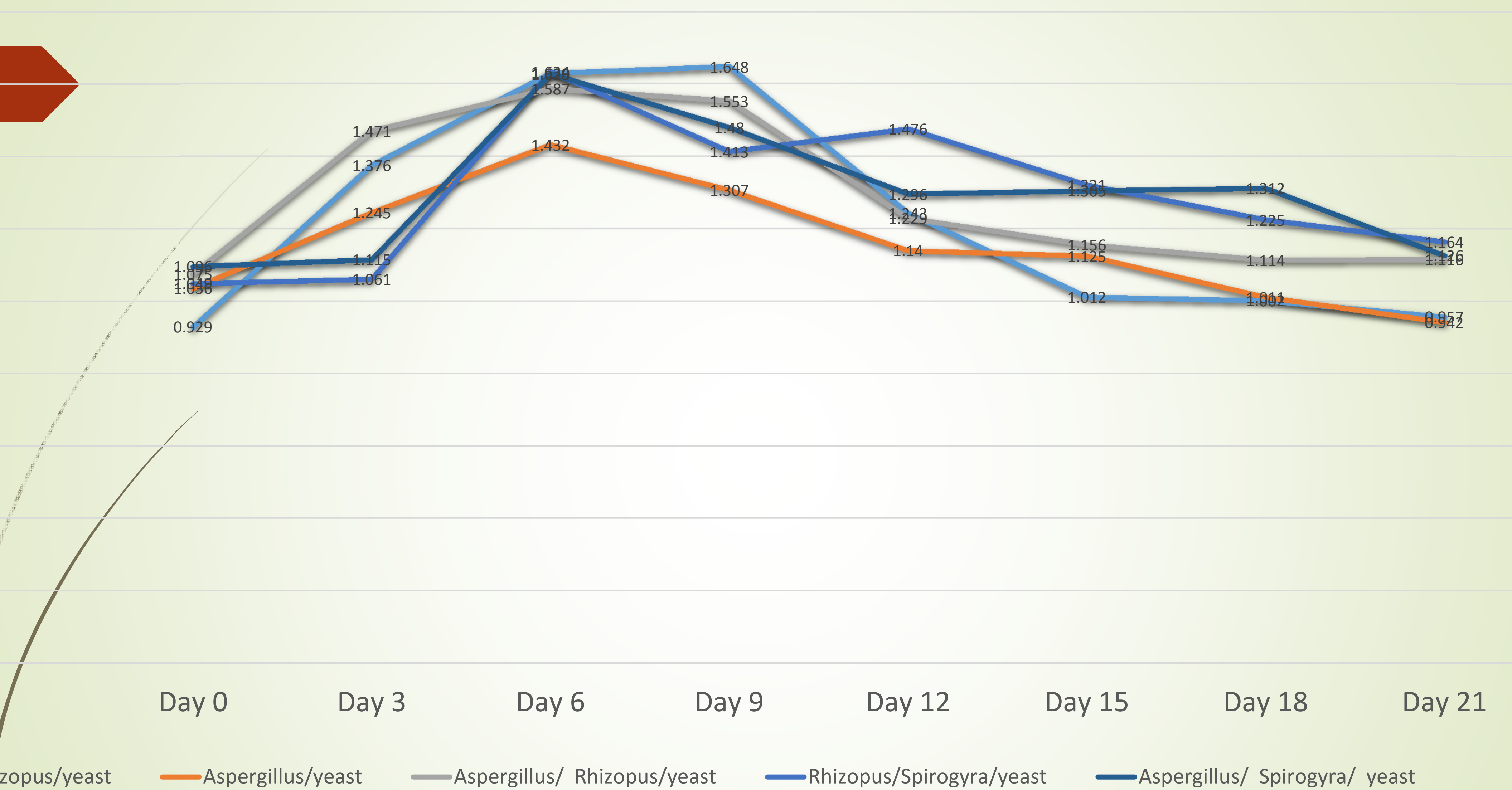


IG. 2: Growth curve obtained from treating cassava cultivar TME 419 with different inoculants

TABLE 3

icrobial growth for different inoculum at optical density of 540nm and the obser pH, on cassava cultivar TME 4779

	TME 4779							
Inoculum	**Day 0**	**Day 3**	**Day 6**	**Day 9**	**Day 12**	**Day 15**	**Day 18**	**Day 2**
hizopus/yeast	0.929 (4)	1.376 (5)	1.629 (5)	**1.648 (5)**	1.243 (5)	1.012 (5)	1.002 (5)	0.957
spergillus/yeast	1.036 (5)	1.245 (5)	**1.432 (5)**	1.307 (4)	1.14 (5)	1.125 (5)	1.011 (6)	0.942
Aspergillus/ hizopus/yeast	1.075 (5)	1.471 (5)	**1.587 (5)**	1.553 (5)	1.229 (5)	1.156 (6)	1.114 (6)	1.116
us/Spirogyra/yeast	1.049 (5)	1.061 (5)	**1.634 (5)**	1.413 (5)	1.476 (6)	1.321 (6)	1.225 (6)	1.164
rgillus/ Spirogyra/ yeast	1.096 (5)	1.115 (5)	**1.628 (5)**	1.48 (6)	1.296 (6)	1.305 (6)	1.312 (6)	1.126



3: Growth curve obtained from treating cassava cultivar TME 4779 with different inoculants

SULTS OF FERMENTATION AT OPTIMIZED PARAMETERS

pH 5.0, temperature 28^{O}C, increase surface area of substrate, substrat concentration and inoculant cultur concentration on Days 7, 14 and 21 ar shown in tables 5, 6 and 7.

TABLE 5

Ethanol yield obtained on the 7th day from three cassava cultivars treated with the different inoculants

	TME 0505		TME 419		TME 4779	
ulum	vol (ml)	mass (g/cm)	vol (ml)	mass (g/cm)	vol (ml)	mass (g/
A	13.33^{b} ± 1.33	10.71^{b} ± 1.07	13.33^{b} ± 0.88	10.71^{b} ± 0.71	17.33^{b} ± 2.94	13.92^{b} ±
B	13^{b} ± 0.58	10.44^{b} ± 0.47	15.33^{b} ± 0.34	12.32^{b} ± 0.27	16.00^{b} ± 1.00	12.86^{b} ±
C	13.33^{b} ± 0.34	10.71^{b} ± 0.27	14.66^{b} ± 0.88	11.78^{b} ± 0.71	16.00^{b} ± 0.00	12.85^{b}
D	18^{a} ± 1.00	14.46^{a} ± 0.80	18.33^{a} ± 2.03	14.73^{a} ± 1.63	23.67^{a} ± 0.67	19.01^{a} ±
E	17.33^{a} ± 0.88	13.92^{a} ± 0.71	18^{a} ± 0.58	14.46^{a} ± 0.47	21.33^{a} ± 0.33	17.14^{a} ±
trol	8.67^{c} ± 1.20	6.96^{c} ± 0.97	8.67^{c} ± 1.46	6.96^{c} ± 1.17	11^{c} ± 1.00	8.84^{c} ±

TABLE 6

anol yield obtained on the 14th day from three cassava cultiv treated with different inoculants

	TME 0505		TME 419		TME 4779	
ulum	vol (ml)	mass (g/cm)	vol (ml)	mass (g/cm)	vol (ml)	mass (g/c
A	$12.33^{b} \pm 0.88$	$9.91^{b} \pm 0.70$	$13.67^{b} \pm 0.88$	$10.98^{b} \pm 0.71$	$17^{b} \pm 3.22$	$13.66^{b} \pm$ 2
B	$17.67^{b} \pm 1.20$	$14.19^{b} \pm 0.97$	$17^{b} \pm 1.53$	$13.67^{b} \pm 1.23$	$16^{b} \pm 1.00$	$12.86^{b} \pm$ 0
C	$13.67^{b} \pm 1.20$	$10.97^{b} \pm 0.97$	$12.67^{b} \pm 0.34$	$10.17^{b} \pm 0.27$	$14^{b} \pm 2.33$	$11.24^{b} \pm$ 1
D	$15.67^{b} \pm 1.86$	$12.49^{b} \pm 1.46$	$14.46^{b} \pm 1.77$	$11.78^{b} \pm 1.42$	$21.33^{b} \pm 0.88$	$17.14^{b} \pm$ 1
E	$19.57^{a} \pm 1.33$	$15.8^{a} \pm 1.07$	$19^{a} \pm 1.16$	$15.26^{a} \pm 0.93$	$22.33^{a} \pm 0.88$	$17.94^{a} \pm$ 0
trol	$6.67^{c} \pm 0.88$	$5.89^{c} \pm 0.97$	$7^{c} \pm 0.58$	$5.62^{c} \pm 0.81$	$9.33^{c} \pm 2.60$	$9.34^{c} \pm$ 1.

TABLE 7

Ethanol yield obtained on the 21st day from three cassava cultivars treated with different inoculants

	TME 0505		TME 419		TME 4779	
culum	vol (ml)	mass (g/cm)	vol (ml)	mass (g/cm)	vol (ml)	mass (g/c
A	$10.66^{b} \pm 0.34$	$8.57^{b} \pm 0.27$	$11.67^{b} \pm 1.20$	$9.37^{b} \pm 0.96$	$15.33^{b} \pm 2.33$	$12.32^{b} \pm 1$
B	$14^{b} \pm 0.58$	$11.25^{b} \pm 0.47$	$15.33^{b} \pm 1.86$	$12.31^{b} \pm 1.49$	$13^{b} \pm 1.00$	$10.45^{b} \pm 0$
C	$11^{b} \pm 0.58$	$8.84^{b} \pm 0.47$	$11.33^{b} \pm 0.33$	$9.11^{b} \pm 0.27$	$11^{b} \pm 0.58$	$9.37^{b} \pm 0.$
D	$17^{a} \pm 1.53$	$13.66^{a} \pm 1.22$	$15.67^{a} \pm 1.67$	$12.59^{a} \pm 1.34$	$22^{a} \pm 1.73$	$17.67^{a} \pm 1$
E	$21^{a} \pm 1.53$	$16.87^{a} \pm 1.22$	$21.33^{a} \pm 0.66$	$17.14^{a} \pm 0.53$	$21.33^{a} \pm 0.34$	$17.14^{a} \pm 0$
ntrol	$9.67^{c} \pm 0.67$	$7.77^{c} \pm 0.54$	$7.67^{c} \pm 0.88$	$6.16^{c} \pm 0.71$	$10^{c} \pm 1.00$	$8.03^{c} \pm 0.$

TABLE 8

Proximate Analysis of Cassava Cultivars

Parameter Tested	TME 4779	TME 419	TME 0505
Moisture Content (%)	62.19	63.59	64.15
Dry Matter (%)	**34.92**	30.72	25.77
Starch (%)	**72.19**	70.44	69.85
Fibre (%)	3.42	3.22	**3.12**
Ash (%)	0.45	0.47	**0.28**
Protein (%)	2.25	1.15	1.26
Fat (%)	0.61	0.72	0.78
Carbon Nitrogen Phosphorus(ppm)	**12.27**	6.29	8.56

DISCUSSION

The yield reported in this study competes favorably with (and sometimes better than) those reported from cassava peels using other inoculants, potato peels and spoilt mangoes by other workers.

Growth curves obtained using the five treatmen differed slightly, reflecting differences in the enzyma composition of these microorganisms and in t composition of peels of the three cassava varieties.

An optimum pH of 5.0 obtained in this study is
pH at which each curve showed maximum activit

Cassava cultivar 4779 when treated with *Rhizop*
nigricans, Spirogyra africana and *Saccharomy*
cereviceae gave the highest yield of 19.01g/c
and percentage concentration yield of 22% on
7th day.

This may be attributed to the presence
Spirogyra as an additional carbon source for
microorganisms

Spirogyra generally is known to b
autotrophic and its carbohydrat
composition can also lead to increase i
the release of sugars for fermentation. Thi
result is in line with the work of Sulfahri e
al., (2011) but gave a higher yield in th
presence of cassava peel substrate an
good pH conditions.

hanol yield obtained in the present study uch lower than the 67.7% and 63.8% reported veleke and Jubril 2009 when *Aspergillus nig* d *Zymomonas mobilis* were us multaneously on guinea corn husk and mil sk respectively.

n line with reports that *Saccharomyces cerevisiae* is a non- amylolytic microorganism nable to hydrolyse strarch (Jumai et al., 2006) ow concentrations of ethanol were obtained in his study.

TME 4779 has the highest % starch omposition of 72.19, Carbon-Nitrogen-Phosphorus (ppm) of 12.27 and dry matter o 34.92%; this may have contributed to the higher ethanol yield from it. Also the low fibr and ash content of cassava cultivar TME 0505 made it susceptible to quick microbial breakdown.

CONCLUSION

he process of bioethanol production can ptimized for increased ethanol yield at a reduc eriod of fermentation by improving the vario arameters affecting the medium (pH, substr urface area and concentration).

ioethanol production from *Spirogyra* holds gnificant potential due to their low percentage gnin and hemicellulose content compared her ligno-cellulosic plants.

Spirogyra can be cultivated and prolifera
nore, as a major feedstock for biof
roduction.

Cassava cultivars can be developed w
igher starch content and lower fibre valu
o that the wastes generated can have hig
ioethanol potential.

There is need to invest in large-sc otechnology plants for conversion of bioma gricultural wastes) to useful products as this ovide wealth and employment.

The use of agricultural wastes instead of sta ods for biofuel production will not infringe ailable food supply. It will in addition redu ollution arising from improper management ese wastes.

THANKS FOR YOUR ATTENTION