PROTEIN ENRICHMENT OF SWEET POTATO BY SOLID STATE FERMENTATION USING FOUR MONO-CULTURE FUNGI

O.A. ABU; G.B. OGUNTIMEIN[1] AND O.O. TEWE
Department of Animal Science, University of Ibadan, Nigeria.
[1]Department of Food Technology, University of Ibadan, Nigeria

ABSTRACT

Washed, sliced and oven-dried whole sweet potato tubers (*Ipomoea batatas*) of the local variety were milled and supplemented with a mineral salts solution containing (g litre^{-1}) glucose, 5; $(NH4)_2SO_4$ 1.5; KH_2PO_4, 1.5; $MgSO_4$ 0.05;Yeast extract, 0.05 and fermented at 30$_o$C for 72 hr by solid state fermentation (SSF) using *Neurospora sitophila, Aspergillus niger, Candida utilis* and *Saccharomyces uvarum*. At the end of the fermentation period *A.niger* gave the highest protein content of 11.8%, DM basis while *S. uvarum* showed the least protein content. However in terms of true protein production *N sitophila* gave the best value of 8.98%. While *S. uvarum* gave the least value under the standard conditions.

Keywords: Sweet potato, amylolytic fungi, fermentation, protein, carbohydrates

INTRODUCTION

The utilization of roots and tubers and their wastes as source of energy for livestock is assuming importance in livestock production systems in Africa. However the efficient utilization of these crops is limited by high post harvest losses (Booth, 1974), and also their inherently low protein content (Woolfe, 1992). The production of single cell protein from starchy substrates have been studied (Raimbault *et al.*, 1935, Noomhorm *et al.*, 1992). Sweet potato is grown throughout the tropics and sub-tropics and it is less competed for as food for humans in most parts of Africa (Tewe, 1994). The purpose of this study is to increase the protein content of sweet potato by solid state fermentation using selected fungi.

MATERIALS AND METHODS

Sweet potato

A local variety of sweet potato was bought at Bodija market, Ibadan, Nigeria. Whole tubers were washed, and cut into slices of about 2-3 mm thick and then oven-dried at 60oC for 24 hr and then milled.

Micro-organisms

Pure cultures of *Neurospora sitophila* ATCC-36935, *Aspergillus niger* NRRL 567, *Saccharomyces uvarum* and *Candida utilis* were to inoculate the sweet potato substrates.

Culture media and conditions

The growth medium contained (g litre^{-1}) glucose, 5;$(NH_4)_2SO_4$, 1.5; KH_2PO_4, 1.5; $MgSO_4$, 0.05 and yeast extract 0.05. The mixture was then autoclave for 15 min. The fungi were first cultivated on potato dextrose agar at 30$_o$C and then inoculated in the sterile medium culture at 30$_o$C providing oscillation of

45 rpm in a Gallenkamp shaker water bath for 12 hr.

Solid state fermentation

5 ml of 3-day old inoculum was transferred aseptically and then mixed with 20g of sterile sweet potato flour contained in a 250 ml conical flask plugged with cotton wool and then incubated at 30°C for 72 hr. No forced aeration was provided. The experiments were done in duplicates.

Determination of chemical and physical changes in the substrates

After 72 hr in incubation period, the fermented substrate was oven-dried at 60°C for 48 hr, milled and protein determination carried out using the Kjeldahl method. The pH was measured using the lab pH meter (EIL Analytical Instrument). The total soluble carbohydrates were determined according to Southgate, (1969) method. The optical density was measured at 490nm using a UV/VIS Spectrophotometer (PYE UNICAM. SP6-550). A standard curve was prepared using D-glucose (0.20, 40, 60, 80 and 100 ug/ml).

RESULTS AND DISCUSSION

In the composition of the culture medium glucose served as source of carbon. Ammonium sulphate and yeast extract as major sources of nitrogen. Potassium hydrogen phosphate as source K^+ and $PO4^{2-}$ ions; Mg SO_4 as source of Mg^+ and SO_4^{2-} ions. These salts were needed to promote the initial growth of the microbial cells. The extent of protein enrichment obtained using selected strains of the fungi (Table 1) showed that *A. niger* had the highest increase in the crude protein content from an initial value of 6.29% to 11.08%. *N. sitophila* had 9.38% while *C.utilis* had 7.04%. *S. uvarum* showed no change when compared with the control. Values of true protein and non protein nitrogen in the final biomass were also analysed as shown in Table 2. The NPN values obtained were 0.4, 1.55, 0.85, 2.88 and 2.14% for *N. sitophila, C. uilis, S, uvarum, A.niger* and uninoculated control respectively. Even though *A. niger* gave the highest protein level, it also gave the highest NPN level. A major limitation in the use of single cell protein as foods and feeds is the prevalence of NPN in the final product. Digestion of NPN has long been known to produce unacceptably high levels of uric acid (Edozien *et al.*, 1970). *N. sitophila* promised to be the best among the strains of fungi tested in this study since it gave a low NPN value and a moderately high protein content when compared with *A. niger*. The carbohydrate fractions of the inoculated substrates are shown in Table 3. A. niger recorded the least starch level after inoculation therefore showing the best amyloltic activity of all the fungi studied.

Table 1 **Protein, moisture content, and pH of whole sweet potato root meal after the growth of fungi solid state fermentation for 72h at 30°C**

	moisture content		pH		crude protein (%,DM)
fungal strain	initial	final	initial	final	
N. sitophila	60.12	68.20	4.10	4.50	9.38
C. utilis	60.50	63.50	5.30	3.70	7.04
S. uvarum	62.30	63.70	5.60	4.30	6.24
A. niger	61.20	65.10	5.30	4.20	11.08
Control	60.0	64.21	5.50	5.30	6.29

Values are the average of two estimations

Table 2 **True and non-protein components (%) Sweet potato root meal inoculated by selected fungi using solid state fermentation method**

fungal strain*	Crude protein (%)	True protein (%)	NPN (%)
N. stiophila	9.38±0.38	8.98±1.44	0.4±0.08
C. utilis	7.04±0.75	5.48±0.15	1.55±0.03
S. uvarum	6.24±0.28	5.39±0.12	0.85±0.002
A. niger	11.08±0.63	8.70±0.30	2.88±0.05
Control	6.29±0.66	4.15±0.25	2.14±0.001

Values are the average of two estimations

Table 3: **Total sugars, non-reducing sugars, reducing sugars and starch content (%) of inoculated by selected fungi using solid state fermentation method**

fungal strain*	Total sugars (%)	Non-reducing sugar (%)	Reducing sugars (%)	Starch (%)
N. stiophila	28.90±0.43	18.35±0.43	10.59±0.86	41.19±0.4
C. utilis	31.58±1.19	18.54±1.35	13.40±0.52	44.59±0.6
S. uvarum	30.91±0.54	17.94±0.41	12.97±0.95	41.10±1.2
A. niger	28.44±0.94	17.93±0.43	10.51±0.46	38.87±0.1
Control	37.89±0.57	21.51±0.68	16.38±1.24	49.68±1.5

Acknowledgements: The authors wish to thank Prof. M.A. Moo-Young, University of Waterloo, Canada, Dr. C.W. Hesseltine, US. Army, Natick Laboratories, Massachusetts, USA and Dr. J. Engasser for supply the fungi used in this study.

REFERENCES

Booth, R.H., (1974). Post-harvest deterioration of tropical root crops. Trop. Sci. 16 (2) 49.

Edozien, J.C. Udo, U.V., Young, V.R. and Scrimshaw, N.S., (1970). Effects of high levels of yeast feeding on uric acid metabolism of young men. Nature, London 228, 180.

Noomhorm, A., Ilangantileke, S. and Bautista, M.B., (1992). Factors in the protein enrichment of cassava by solid state fermentation. J. Sci. Food Agric., 58, 117.

Raimbault, M., Revah, S, Pina, F. and Villalobos, P., (1985). Protein enrichment of cassava by solid substrate fermentation using moulds isolated from traditional foods. J. Ferment. Techno., Vol. 63, no: 4, 395.

Tewe, O.O., (1994). Biochemical characteristics and utilization of sweet potatoes (*Ipomoea batatas*) for livestock feeding. In: Sweet potato situation and priority research in West and Central Africa, eds C. Martin and I. Zandstra being a paper presented at the workshop held in Douala, Cameroon, July 27-29, 1992.

Southgate, D.A.T., (1969). Determination of carbohydrates in foods. I - Available carbohydrate. J. Sci. Fd. Agric.,, Vol.2, 326-330.

Woolfe, J.A., (1992). Sweet potato - an untapped food resource, Cambridge University Press (Published in collaboration with International Potato Centre, Lima, Peru) Cam. UK.