

UPGRADING OF THE PROTEIN CONTENT OF BANANA AND ORANGE PEELS BY USING *ASPERGILLUS NIGER*, *TRICHODERMA REESEI* AND *PENICILLIUM SPP*

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INTRODUCTION

The expression "Single cell protein" was first coined at the Massachusetts Institute of Technology around 1966 to depict idea of micro-organisms as food sources. Although Single cell protein is a misnomer in that protein are not only food constituents represented by microbial cells, it obviates the need to refer to each product generically as in fungal protein, bacterial protein and so on. Most of the micro-organisms are rich in protein. The often quoted comparison that a 0.5 tone bullock synthesise less than 0.5 kg of protein every 24 hours but 0.5 tone of soybean produces the equivalent of 40 kg protein every 24 hours and 0.5 tone of yeast produce 50 tone in that time !

Filamentous fungi have been tried extensively for the production of Single cell protein. such fungi hydrolyse Starch, Cellulose, Lignin elaborating the appropriate extra-Cellular enzymes and grow well at low pH (around 3.5) which inhibits potential contaminants. Filaments fungi are able to utilise a variety of carbohydrates but the growth rates will vary considerably depending on the substrate. Cellulose is more difficult to hydrolyse than starch. Most of the work on Single Cell Protein is therefore concentrated on readily assailable carbohydrate such as starch, sucrose and lactose. Anderson et.al. 1975 had successfully grown *Fusarium graminearum* in a continuous culture with low residual carbohydrates at growth rate up to 0.18/hrs on a 25 degree sugar. Gregory 1977 has given a detail account of the fermentation conditions and also degree sugar. Gregory 1977 has given a detail account of the fermentation conditions and also the safety considerations for Single cell protein using filamentous fungi with special emphasis on the conversion of carbohydrates like cassava. Flordeliz et.al. 1983 produced Single cell protein from pineapple wastes and mango peels by using *Aspergillus niger* and *Candida utilis*. They observed that the rise in the production of crude protein Value by *A.Niger* alone (10.21-16.79%) and by *A. Niger* and *C.utilis* combined (9.66-27.53%) were observed in mango peels. Similarly in pineapple waste *A.niger* showed peak production of crude protein (28.8%). In combination with *C.utilis* the highest crude protein value obtained was 36.27%. Laukevics et.al. 1984 carried out fermentation of wheat straw to fungal protein, Steam treated wheat straw at a 70% w/w moisture level was subjected to solid state fermentation with *Trichoderma reesei* and *Endomycopsis fibuligera*. The best protein productivity, they obtained in stationary layer fermentation with a product containing 13%

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protein. similarly, Baldensperger et.al. 1986 carried out solid state fermentation of banana waste using a strain of *A. niger* and found that the protein content of banana

peels was raised from 6 to 18% during fermentation. Besides fruit waste filamentous fungi have been used to produce Single cell protein from other starchy and cellulosic materials. Kahlon et.al. 1986 screened six fungi, which could grow on potato peels. Among them *Pleurotus ostreatus* showed maximum utilization of carbohydrates (38.2%) and produced highest crude and true protein 14.9 and 12.0% respectively; closely followed by *A. niger* 14.6 and 11.5% crude and true protein respectively. Orue et.al. 1985 showed that coffee waste can be used as the substrate for Single cell protein production by using selected fungi *Paecilomyces elegans*, *A oryzae* and *Furasium oxysporum*.

It was observed that *Furasium oxysporum* produced significantly higher protein level than three other fungi.

In Kathmandu about 400 metric tone of such fruit wastes released everyday. These fruit peels like the peels of Citrus, Banana and Pineapple are causing the environmental pollution in city area, because of their unmanaged disposal. These fruit peels are very rich sources of cellulose, hemicellulose, pectin and starch, Production of microbial protein from such starchy materials has the potential for reducing the deficit in protein production from conventional sources. The use of such protein has already become familiar in livestock and poultry feed components and can possibly be a source for human consumption's this work will present some useful data for the production of microbial protein from orange and banana peels by using different strains of fungi. It is thus believed that in some extent this work will help researches, industrials, and policy makers to cope with the present protein deficit problems.

METHODOLOGY

COLLECTION OF THE SUBSTRATE

Banana and orange peels were collected from Kalimati fruit market. The peels were sun dried for 10 days in order to reduce to moisture content to the required level.

SOURCE OF INOCULUM

The fermentation was carried out by using three fungi: Among them *Aspergillus niger* and *Penicillium spp.* Was screened from the rotten orange by their enzymatic activities and the strain of *Aspergillus niger* and *Penicillium spp* which gave the best cellulase, α -amylase and pectinase activities were used as inoculum. The inoculum for the fermentation was prepared by maintaining the organism in Potato Dextrose Agar slant till it was perfectly sporulated. Where as the known strains of *Trichoderma reesei* was obtained from Indian Institute of Technology (IIT, New Delhi).

MAINTENANCE OF CULTURE

The fungus culture of the inocula was maintained in potato dextrose agar (PDA). The preparation of spores for inoculum was carried out by 1 week old Potato Dextrose Agar slant culture of each strain. The spore suspension was prepared by pouring 5 ml of sterile distilled water in the MacCarnthy bottle where there was 1 week old sporulated slant culture of fungi.

PROFITIATION OF SUBSTRATE

- (a) **Orange peel:** The dried orange peels were grinded to a fine-grained meal. To 250 gm of the meal 2 gm of KH_2PO_4 and 3.7 gm of $(\text{NH}_4)_2\text{SO}_4$ was added. The meal was properly mixed and equally divided into three parts.
- (b) **Banana peel:** One kg of dried banana peels were grained to a fine meal than 12 ml of H_3PO_4 solution, 33 gm of $(\text{NH}_4)_2\text{SO}_4$ and 35 gm of urea in 350 ml of distilled water was added and the meal was mixed well. Then whole the meal was equally divided into three parts.

FERMENTATION PROPER

The orange and banana meal was taken in 250 ml Erlenmeyer flasks. Then the flasks were inoculated with 10 ml of respective inoculum as were labelled previously. Then the solid state formation was carried out in water bath shakers at 27° for 72 hours.

PREPARATION OF FERMENTED MEAL FOR PROTEIN DETERMINATION

Ten grams of the fermented samples in each 18 hours were sampled from the flasks and then heated at 75° for 10 mins. Then these samples were packed in sterile plastic pocket and stored in refrigerator until the protein determination.

PROTEIN DETERMINATION

Protein determination of the fermented substrate was carried out according to AOAC by the Micro Kjeldahl method.

RESULTS AND DISCUSSION

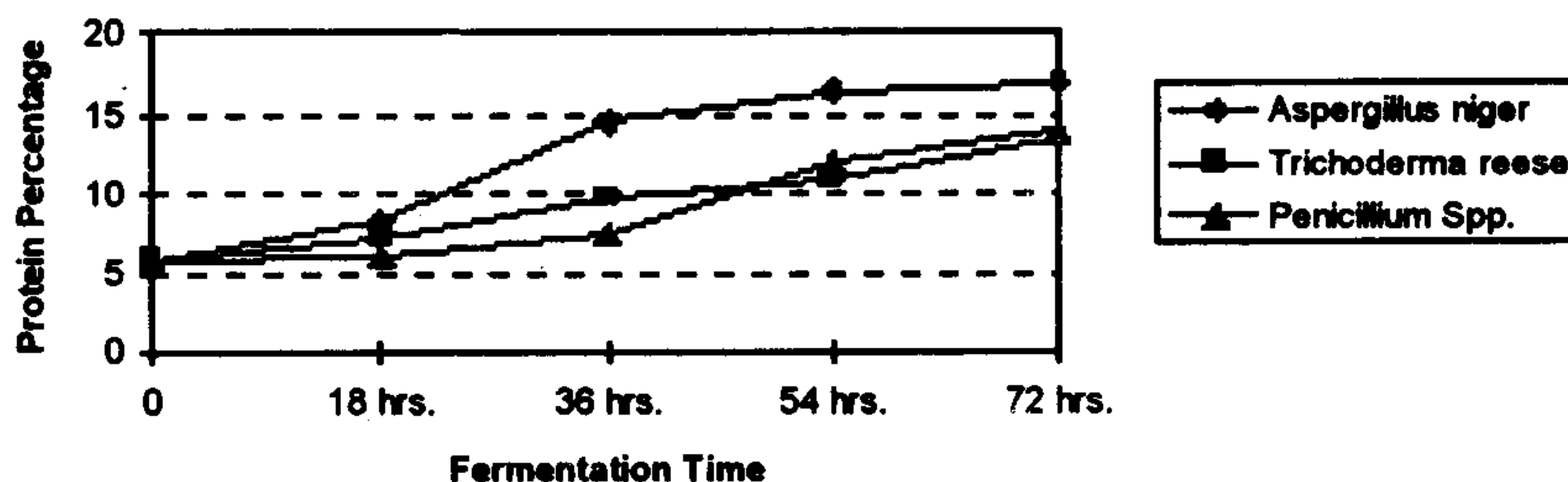
Table 1 shows the change in protein content of banana peels during the formation by different fungi. The protein content of the banana peels is found to increase gradually. The increase in protein content with the fermentation days and types of fungi is found to be significant ($p > .01$). Application of DMRT on the types of fungi shows the significant different in mean protein change by *Aniger* and *T.reesei* but protein change by *T. reesei* and *Penicillium spp.* are statistically insignificant. These results are quite similar to the findings by Baldnesperger et.al. 1986. He carried out solid state fermentation of banana waste using a strain of *A. niger* and found that the protein content of banana peels was raised from 6 to 18% during fermentation. The gradual increase in the protein content with fermentation hours in shown in fig. 1.

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Table-1: Change in (%) protein content during the solid state fermentation of banana peels by different fungi.

Fungi	Change in protein (%) with fermentation days				
	0	18 hrs	36 hrs	54 hrs	72 hrs
<i>Aspergillus niger</i>	5.8	8.4	14.5	16.5	17
<i>Trichoderma reesei</i>	5.8	7.3	9.8	11.0	13.5
<i>Penicillium Spp.</i>	5.8	5.9	7.5	12	14

Figure-1: Protein Upgrading of Banana Peels during Fermentation by Different Fungi

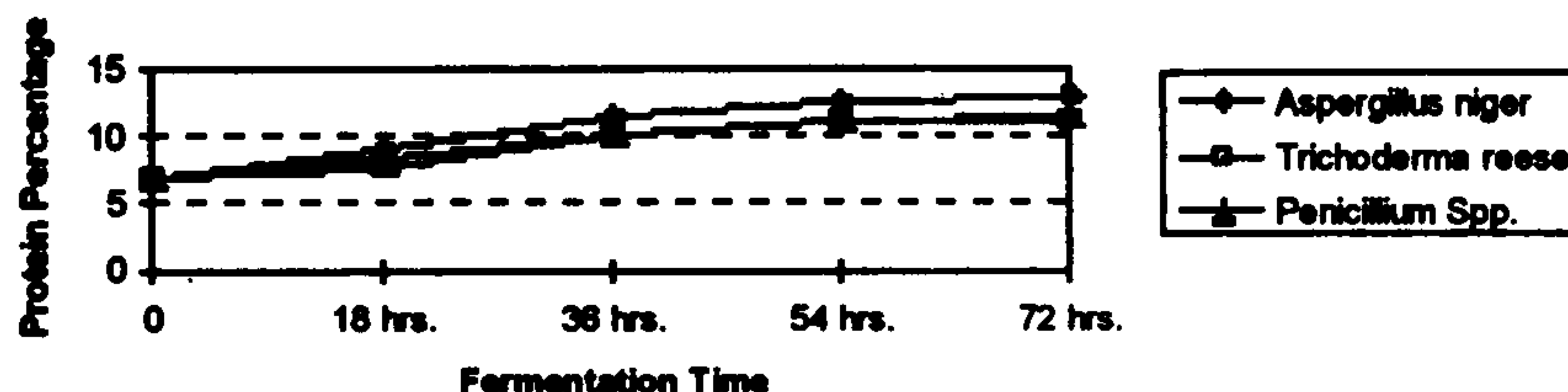


Similarly, Table, 2 shows the protein increment of orange peels during solid state fermentation by different type of fungi. The value increases along the fermentation days. The ANOVA analysis shows the change in protein content of orange peels during solid state fermentation was significant ($P > .01$) among the three different fungi. The DMRT shows that the protein increment by the three different fungi differed significantly, the change in protein content during the fermentation days is also statistically significant. Fig .2. shows the gradual increase in the protein content with fermentation hours.

Table-2: Change in (%) protein content during the solid state fermentation of orange peels by different fungi

Fungi	Change in protein (%) with fermentation days				
	0	18 hrs	36 hrs	54 hrs	72 hrs
<i>Aspergillus niger</i>	7.0	9.1	11.5	12.5	13.0
<i>Trichoderma reesei</i>	7.0	7.8	10.2	11.2	11.2
<i>Penicillium Spp.</i>	7.0	8.1	10.1	11.3	11.5

Figure 2: Protein Upgrading of Orange Peels during Fermentation by Different Fungi



WORKS CITED

Anderson, C. (1975), *The Growth of Microfungi on Carbohydrates*. Single Cell Protein. pp. 314-329, USA: MIT Press.

Baldensperger, J. Lemer, J.L. Hannibal and Quinto, P.T. (1986), *Solid State Fermentation of the Banana Waste*.

Gregory, K.F. and S.J. Maclean (1977), *Further Thermotolerant Fungi for the Conversion of Cassava Starach to Protein*, *Anim. Feed Sci. and Technol.* 2,7-19.

Kahlon, S.S. and M. Arora. (1986), "Utilization of Potato Peels by Fungi for Protein Production." *J. of Food Science and Technology*, 23, pp. 264-266.

Kihlberg, R. (1972), "The Microbe as a Source of Food." *Ann. Rev. Microbial.* 26:427-466.

Laukevics, J.J., A.F. Apsite, V.E. Viestures, (1984), *Solid Substrate Fermentation of Wheat Straw to Fungal Protein*. *Biotéchnology and Bioengineering XXXVI*, pp. 1464-1474.

Orue, C. and S. Bahour (1985), "Utilization of Solid Coffee Waste as a Substrate for Microbial Protein Production." *J. of Food Science and Techno.*, 22, pp. 10-16.