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PRODUCTION OF SINGLE CELL PROTEIN FROM PINEAPPLE PEEL WASTE USING PALMYRAHTODDY YEAST

Thiviya. P[1], Kapilan. R[2] & Madhujith. T[3]
[1]*Department of Food Science & Technology, University of Peradeniya,*
[2]*Department of Botany, University of Jaffna.*

Abstract

The disposal of fruit waste into environment poses health hazard for living beings. And also protein deficiency is becoming a major problem with the fast growing world population. The bioconversion of fruit wastes into single cell protein production is an innovative and alternative way to this direction. Therefore, this study was aimed to produce single cell proteins from pineapple peel using palmyrah (*Borassus flabellifer*) toddy yeast under liquid state fermentation system. Pineapple peel was collected, cleaned, washed and blended and physiochemical properties such as Total Soluble Solid (TSS), pH, moisture content, protein, fat and ash content were determined in dry weight basis. The extract of pineapple peel was filtered and diluted to 10% and autoclaved. The sterilized pineapple peel extract kept in sterilized conical flask in triplicates and inoculated with natural palmyrah toddy yeast and allowed for fermentation at 100 rpm for 48 hrs. The sediment was collected by centrifugation and oven dried and the dry weight was measured and the protein content was determined by using Kjeldahl method. The protein content of peel was 6.9%±0.06, the TSS, pH, moisture, fat and ash content of pineapple peel were 10.8%, 3.69, 84.68%±0.85, 0.86%±0.088 and 4.50%±0.30 respectively. The mean cell bio mass was 0.940±0.053 gram cell mass per 100 mL substrate and the crude protein content was significantly increased to 49.7% from 6.9% (7.2 times, dry weight basis). Therefore, locally available pineapple peel waste could be a good source for the production of protein-rich cell biomass using fermentation by natural toddy yeast of palmyrah**.**

Keywords: Liquid state fermentation, Palmyrah toddy yeast, Pineapple peel, Single cell protein

Introduction

The disposal of fruit waste from fruit processing industry into environment can pose serious environmental pollution. Fruit waste might have a potential for recycling to get raw material or for bio conversion into useful product such as organic acid, methane, ethanol, SCP and enzyme. On the other hand increasing world deficiency of protein is becoming a major problem with the fast growing world population. It is important to focus on new, alternate and unconventional protein production in order to produce enough food and feed to meet the nutritional requirement. The single cell protein derived from the waste organic products has become more popular technology in recent days. Single cell protein (SCP) refers to the dead, dried microbial cell or total protein extracted from pure microbial cell culture (algae, bacteria, filamentous fungi, yeast) which grown on different carbon sources. Besides high protein content (about 60-82% of dry cell weight), SCP also contains fats, carbohydrates, nucleic acids, vitamins and minerals. SCP is rich in certain essential amino acids like lysine and methionine which are limiting in most plant and animal foods (1). Fruits which have a huge market potential, 30-40% of the harvest is lost at the postharvest stage due to improper

supply chain and value chain activities(2). In general the nonedible portion of fruits and vegetables such as peels, pods, seeds, skins, etc., are discarded during processing and it accounts for about 10–60% of the total weight of the fresh produce. Mainly pineapple are brought from other district into Jaffna Peninsula market (3) and the cultivation of pineapple has been initiated in chavakachcheri, Kaithady and Urumpirai(4). The increasing production of pineapple processed item in Sri Lanka, results in massive waste generation.

Microorganism utilizes the cheap and abundant agro waste to produce SCP thus, it can help to minimize the effect of organic waste disposal into the environment (5). Moreover, bioconversion of these waste materials to protein-rich food can reduce the cost of SCP production significantly (6).Various microorganisms are used for the production of SCP are bacteria (*Cellulomonas, Alcaligenes*, etc.), algae (*Spirulina, Chlorella*, etc.), molds (*Trichoderma, Fusarium, Rhizopus*, etc.) and yeast (*Candida, Saccharomyces*, etc.)(7). Yeast is suitable for SCP production because of its superior nutritional quality, high lysine content, larger size making them easier to harvest, low nucleic acid content and ability to grow on low pH (7). Moreover yeast and fungi are the most accepted and utilized microorganism for SCP production because of the long history of using in traditional fermentation (8).

The objective of this study was to determine the possibilities to produce SCP from the cheap and abundant pineapple peel waste using natural yeast from the palmyrah toddy**.** There have been very few literatures addressing the possibility of exploring different cost effective fruit wastes for SCP production. This study will focus on SCP production from cheap and abundant local pineapple peel waste, using natural yeast from the palmyrah toddy under Liquid State Fermentation (LSF) system.

Methodology

Collection of materials

Non-infected pineapple fruit wastes were collected from the local markets and processing industries located in Jaffna town, Sri Lanka. Palmyrah toddy was collected from the collection point of mature palm using sterile vessels in-order to use as the source of natural yeast, *Saccharomyces cerevisiae.*

Proximate analysis of pineapple peel

Cleaned and washed pineapple peel was weighed and the moisture, protein/ nitrogen content, fat, ash content were determined by AOAC (2006) methods.

Preparation of pineapple peel and produce SCP

The collected mass of pineapple peel was cleaned and washed using water. Then the cleaned peel was macerated using the blender into a slurry and filtered through the Whatman filter paper. The solid content and the pH of the extract were determined by using a refractometer (Abbe Refractometer) and the pH meter respectively (5). The extract was diluted to 10% using distilled water and sterilized in autoclave at 121ºC for 15 psi and 15 min. The 50 mL of sterilized peel substrate was transferred into pre-sterilized conical flask in triplicates under sterile condition. The sterilized media were inoculated with 5 mL of fresh palmyrah toddy sample ($(1.63\pm0.15)\times10^6$cells/mL) and allowed for fermentation under Liquid State

Fermentation (LSF) system at 100 rpm for 48 hr at 28^{o}C. After 48 hrs, sediment was centrifuged (4000 rpm for 20 min) and oven dried (50^{o}C for 16 hr) and the dry weight was measured. Protein content was determined on the basis of total nitrogen content (N×6.25) by using Kjeldahl method as per the protocol explained in AOAC, 2006 (9).

Results and Discussion

The mean pH and the total soluble solid values of the pineapple peel extract was 3.69 and 10.8% respectively. The result of the proximate analysis of the pineapple peel extract is presented in Table 1.

Table 1: Proximate analysis (dry weight basis) of pineapple peel waste.

Proximate composition	Amount w/w% (Mean ± SD)
Moisture %	84.68±0.85
Fat%	0.86± 0.09
Protein%	6.9± 0.1
Ash%	4.50± 0.30

The results of the chemical composition of peel established that it is a good nutrient source for yeast cell mass formation with the 6.9% protein content (10) and higher mineral content(11).

Yeast biomass produced after fermentation (Table 02) revealed that the mean cell bio mass was 0.940±0.053 gram cell mass per 100 mL pineapple peel substrate and the crude protein content was significantly increased to 49.7% from 6.9% (7.2 times, dry weight basis).

Table 2: Yeast biomass produced after fermentation from pineapple peel extract.

	Value (Mean ± SD)
Weight of Single cell colony (g)	0.047 ± 0.003
Per 100mL substrate (g)	0.940 ± 0.053
Crude protein (%)	49.7 ± 1.3

Previous studies used inorganic supplements (nitrogen, carbon and glucose sources) for the biomass production on waste materials(11). No such supplements were used to grow yeast culture on pineapple peel waste in this present study and therefore this process of SCP production extremely becomes cheaper. The above result established that pineapple peel extract and palmyah toddy yeast sample can be used to produce SCP. Additionally, it plays a vital role in waste management as waste materials (pineapple peel) are used as substrate (1). Studies on the possibilities of single cell protein production from various fruit peel waste as substrate using fresh palmyrah toddy yeast sample are under way.

Conclusion

Locally available pineapple peel waste can be a good source for the production of protein-rich cell biomass using fermentation by natural palmyrah toddy yeast and this biomass could be recommended as a food or feed after appropriate food quality testing. The crude protein content of the pineapple peel waste extract was significantly increased by 7.2 times after the fermentation by natural palmyrah toddy yeast.

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