International Journal of Life Sciences. Vol. 7 No. 1. 2017. Pp. 63-65

Full Length Research Paper

Production of Single Cell Protein using Fungi in Soybean Milk Residue

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Article history
Received: 02-12-2017
Revised: 10-12-2017
Accepted: 12-12-2017

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Abstract
The soymilk residue is produced in large amount during soymilk production. Okara is a waste product for soymilk industries, so they face a big problem for it disposal. However, it's nutritive composition; make it suitable for producing fermentable edible products, like single cell protein for human food and feed. Soybean milk residue is produced in huge quantities in soymilk industries. Okara is the residue obtained from ground soybean after removing the water-extractable fraction used to produce tofu or soymilk. The combinations were inoculated with two fungal species viz. Aspergillus oryzae, Bacillus subtilis. In the present investigation keeping into consideration the above evidences on the utility of okara and soybean milk residue for the production of single cell protein is tried and results are reported in this paper.

Key words: *Curd residue, Okara, Single cell protein, Soybean meal, Soymilk, Yeast*

Introduction

The cells of algae, bacteria, yeast and fungi grown for the protein contents (Schrimshaw, 1975). Due to the increasing population and shortage of proteins, the world's attention has been drawn to microbial sources of proteins. (Hedenskog *et al*., 1973) described some methods of processing the single cell protein. (Huang, 1974) utilized acid brine for the production of food yeast. (Chen and Peppler, 1977) highlighted the application of single cell protein in food. (Dimmling, 1978) examined the raw materials for the production of SCP. (Kharatyan, 1978) explored the microbes used as foods for humans. Suitability of single cell protein as a feed for human beings has been studied by (Kacmpfel *et al*., 1995). (Schuegerl and Rosen, 1997) have investigated the use of agricultural by products for fungal protein production.In the present investigation, soybean has been reported to be the oldest legume food known to mankind. The botanical name of soybean is *"Glycine max"*.

The white soybean was for the first time introduced in India as early as 1960. It was during this period when Nutri-nuggets were introduced in the India market. A large amount of okara is generated during soymilk production. About 1.1 kg wet okara is obtained from each kg of soybean processed for producing soymilk. Soybean mik and tofu have maintained wide popularity as food sources for thousands of years, and large quantities of their byproducts are generated during the manufacturing processes. In Asian countries, soybean is made into various food such as tofu, soymilk, soymilk powder, bean powder, sprouts, dried tofu, soysouce, soyflour and tempeh soybean oil, soybean crude residues, namely, Okara in Japanese is the main surpluse material of soybean product, and it is often regarded as waste. About 1.1kg of fresh SCR is produced from every kilogram of soybean processed into soymilk of tofu. According to (Shurtleff and Aoyagi, 1979) the high moisture content of okara acts as a barrier in utilizing it for preparing different fermentable edible products. (Yousufi *et al*., 2003) successfully produced single cell protein using okara, by varying its moisture content. Nutritionally okara is rich in proteins, fats, carbohydrates and starch. It also contains minerals like calcium, iron, copper, and zinc.

In the year 2012, Yousufi investigated on inoculum size, incubation temperature and nucleic acid concentration of SCP produced by using soymilk residue (okara). (Dimmling and Seipenbusch, 1978) studied the raw material for the production of SCP. In vivo antioxidant activity of okara Kogi, a fermented okara, by *Aspergillus oryzae* was determined by (Matsuo, 1997). (Miyamura *et al*., 1988) detected fibrinolytic activity of okara fermented by *Bacillus subtilis*. (Hedenskog and Mogren, 1973) studied some methods of processing for single cell protein. Okara, a by-product of soymilk industry was used as the substrate. Okara is produced in large quantities in soymilk industries. Raw okara, also called soy pulp, is a white or yellowish insoluble material from soybean seeds, which remains in the filter sack when pure soybeans are filtered for the production of soymilk. It's a by product of tofu, soymilk or soy protein manufacturing and is treated as industrial waste with little market value because of its short shelf life (Van der Riet *et al*., 1989; O'Toole, 1999; Prestamo *et al*., 2007; Redondo-Cuenca *et al*., 2008). The nutritional quality and antioxidant of soybean meal was improved by solid state fermentation using *Aspergillus oryzae* and *Bacillus subtilis* (Da Teng *et al*., 2012). The potential use of okara and to improve the health beneficial properties of soybean waste manufacture product (okara) which, produced by solid state fermentation.

Production of soymilk

The method of production of soymilk is shown in chart below:

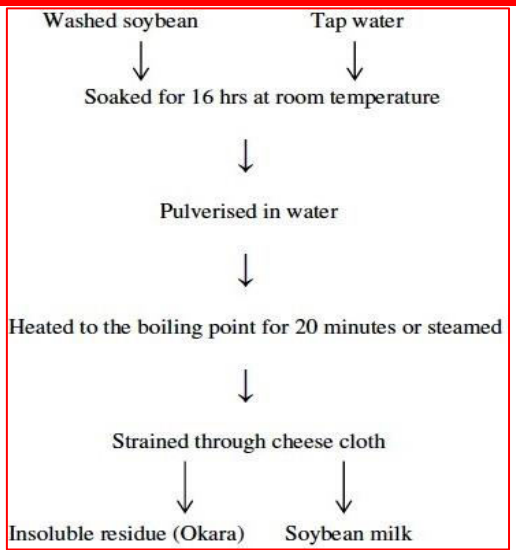

Fig. 1. Production of Soymilk.

Production of SCP from soybean oil and waste soybean

Feasibility on the production of single cell protein from soybean oil and waste soybean oil was studied. Three strains, *Candida rugosa* IFO 0591, *Candida utilis* IFO 0639 and *Candida lipolytica* ATCC 8661, which were not pathogenic, were used. The cultivation of three strains were carried out using a liquid medium containing 0.5% of oil, 0.67% of yeast nitrogen base and 0.05% of surfactant. When soybean oil was used as a sole source of carbon, *Candida rugosa* IFO 0591 was superior in cell mass and *Candida lipolytica* ATCC 8661 in the yield of protein to other strains. On waste soybean oil, both of the cell mass and the yield of protein of *Candida lipolytica* ATCC 8661 was superior, however the yield of them decreased a little compared with on soybean oil. It was concluded that this strain had ability to assimilate waste soybean oil sufficiently.

Importance of soybean (milk) curd residue

Soybean curd residue:

Soymilk and tofu have maintained wide popularity as food sources for thousands of years, and large quantities of their by-products are generated during the manufacturing process.

- *In Asian countries, soybean is made into various foods such as tofu, soymilk, soymilk powder, bean sprouts, dried tofu, soy sauce, soy flour, and soybean oil. Soybean curd residue namely, okara in Japanese, is the main surplus material of soybean products, and it is often regarded as waste. About 1.1 kg of fresh soybean curd residue is produced from every kilogram of soybean processed into soymilk or tofu.*
- *Currently, soybean curd residue is used as stock feed and fertilizer or dumped in landfill. Particularly in Japan, most of the soybean curd residue is burnt which will create carbon dioxide.*
- *Soybean curd residue also has high moisture content (70-80%), which makes it difficult to handle and expensive to dry by conventional means.*
- *Soybean curd residue is a relatively inexpensive source of protein that is widely recognized for its high nutritional and excellent functional properties.*

Soymilk taste

Soymilk flavour quality differs according to the cultivar of soybean. Soymilk aroma, smoothness and thickness in the mouth, colour and creamy appearance are considered desirable qualities, with fevered sensory attributes associating with protein content, soluble solids, and oil content. In a study of taste attributes, soymilk flavoured with vanilla or sweet aromatic flavours and higher viscosity was preferred by most subjects, while dislike factors were bean or broth flavours.

Conclusion

It is clear from above discussion and critical review of available literature that high moisture content of soybean milk residue acts as a barrier in utilizing it for preparing different fermentable edible products. Replacement of soybean meal with yeast single cell protein at the level of 10.5g/kg feed improved body weight gain and feed conversion ratio.The aim of this study was to evaluate the potential use of soybean milk residue and to improve the health beneficial properties of soybean waste manufacture product soybean milk residue. In this we found that successfully produced single cell protein using soybean milk residue, by varying its moisture content.

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