AJLS

Asean Journal of Life Sciences, Vol 1(2), 2021 (Special Issue), pp 56-59
Symposium on Final Year Project 2021
18 & 19 August 2021@Faculty of Engineering and Life Sciences, UNISEL

Accepted date: 30 October 2021
Publish date: 31 December 2021

Enhanced Production of Total Phenolic Content and Antioxidant Property of Agricultural Wastes Through Solid-state Fermentation

Nur Fazleen Diana Abdul Rahim and Norakma Mohd Nor*

Department of Science and Biotechnology, Faculty of Engineering and Life Sciences, Universiti Selangor, Jalan Timur Tambahan, 45600 Bestari Jaya, Selangor
*norakma@unisel.edu.my

Abstract

The considerable amount of agricultural wastes generated yearly is creating disposal concerns to the environment. As a result of the abundance of bioactive molecules in agricultural wastes, numerous ways are applied to utilise them as substrates in fermentation. Using agricultural wastes as substrates can save production costs while also reducing pollution. Solid-state fermentation (SSF) has been devised as a technique for the synthesis and improvement of phenolic compounds because of their cost-effectiveness and environmental benefits. During fermentation, phenolic compounds are either separated from the substrates by enzymatic actions or newly synthesized by the microorganisms. The present review aims to investigate the effect of SSF on the enhancement of total phenolic content (TPC) and antioxidant property of agricultural wastes. The involvement of enzymatic activities from different microbes in the changes of TPC and antioxidant activity during fermentation were discussed. Through all the findings, rice bran is the most common agricultural wastes used by researchers along with *Aspergillus* strains as the majorly used microbes for the enhancement of TPC and antioxidant properties during SSF. It is concluded that SSF has great potential in enhancing the TPC and antioxidant property of agricultural wastes along with a variety of microorganisms utilised during the process

Keyword: agricultural wastes; solid-state fermentation; total phenolic contents; phenolic compounds; antioxidant property

INTRODUCTION

Agricultural wastes are residues produced from various agriculture activities. If these wastes are emitted into the atmosphere without properly treated, they can have a destructive impact on the environment and also jeopardizes public health. Despite causing risk to the environment, some of these agricultural wastes consist of high nutritional content, high contents of protein, minerals, and sugars, as well as possible sources of phenolics and antioxidant property. As most phenolic compounds exist in insoluble bound form, it must be separated against cell-wall to allow the determination of phenolic contents [1], thus few methods and strategies were utilised for the separation of bound phenolic

compounds. Solid-State Fermentation (SSF) can be implemented to increase the efficiency in extracting bioactive compounds can contribute to solving environmental problems while also adding economic value to these products. SSF is defined as a bioprocess that allow microbial growth on a solid moist substrate with low content of free water [2].

As the disposal of agricultural wastes is creating concern of management issue, thus alternatives are developed to solve the problems. With biotechnologies, agricultural residues can be transformed into valuable products through fermentation. SSF serves as an attractive alternative for the separation of phenolic compounds from agricultural wastes. The extracts obtained from SSF is expected to contain enhance total phenolic contents (TPC) and potential natural antioxidants which might be valuable to be utilised as biomaterials in various industry such as food, cosmetic, and pharmaceuticals industry. The present review aims to investigate the effect of SSF on enhancement of total phenolic contents and antioxidant property of agricultural wastes. Also, the involvement of enzymatic activities from different microbes in the changes of phenolic content and antioxidant activity during fermentation were discussed.

LITERATURE REVIEW

Phenolics exist as secondary metabolites and amongst the most diverse chemical group found in the plant kingdom with one or more aromatic rings coupled to a single or more hydroxyl group. Phenolics work as powerful antioxidants, protecting cells from oxidative stress. Antioxidants play a major part by reducing the amount of reactive oxygen species (ROS) produced within the human body, thereby keeping the oxidants-antioxidants balance in check. Antioxidants prevent damage of biological materials in three main mechanisms: (i) by preventing the generation of new radicals, (ii) by trapping free radicals and preventing chain reactions, and (iii) by repairing the impairment caused by free radicals [3]. The consumption of antioxidant-rich foods has a part in prohibiting and controlling the excess level of ROS in the human body.

RESULT AND DISCUSSION

Enzymatic Actions of Fermenting Microbes

Enzymes are synthesised by microbes and simultaneously utilised throughout the fermentation process to mobilise bound phenolics from the substrate while also producing new phenolics [4]. Razak et al. [4] mentioned that the increased TPC is due to the fungal hydrolytic enzymes, which take action on the substrate to enhance the presence of free hydroxyl groups on phenolic structure, thereby improving the antioxidant property of the fermented sample. The hydrolytic enzymes secreted by microbes are capable of modifying the level of bioactive compounds during fermentation resulting in an increased level of phenolic content [2].

A complex collection of enzymes known as the cellulase complex enzyme (endoglucanase, exoglucanase, and β-glucosidase) catalyses the hydrolysis of cell wall polysaccharides and the breakdown of β-1,4-glycosidic linkages in cellulose [5]. The hydrolysis of glycosidic bonds, hydrolysis of ester linkages, and cleavage of glycosidic bonds are catalysed by the hemicellulose enzymes that are classified into glycosides hydrolases, polysaccharide lyases, and carbohydrate esterases [5]. As mentioned by Rashid et al. [1], the enhancement of TPC is due to the action of the β-glucosidase enzyme secreted by *A. oryzae* during fermentation. Throughout fermentation, β-glucosidase catalysed the biotransformation of bound forms phenolic compounds to phenolic aglycone, contributing to a rise in phenolic content [2].

Effect of SSF in Enhancing TPC and Antioxidant Activity of Agricultural Wastes

Based on recent studies, Table 1 shows the main result of SSF in enhancing the TPC and antioxidant property of agricultural wastes.

Table 1: Main result of SSF in enhancing TPC and antioxidant property of agricultural wastes.

Samples	Methods	Effects	Refs
Rice bran	SSF by using *A. oryzae*	Improved extractable TPC up to 3.8-fold. Five types of phenolic acids (sinapic acids, p-coumaric, caffeic, protocatechuic and ferulic) were detected.	[1]
Rice bran	SSF by using *R. oligosporus* and *M. purpureus*	Increased TPC and antioxidant activity. Increased in 4-hydroxybenzoic acids, ferulic, syringic, vanillic and caffeic.	[4]
Coconut testa and rice bran	SSF by using *M. purpureus*	TPC and antioxidant potential were increased by threefold. There are changes in free phenolic acids contents.	[2]

Based on Table 1, it can be seen the most researchers have chosen rice bran (RB) as the substrates for the enhancement of TPC and antioxidant property during SSF. Furthermore, most studies show significant increases of TPC by utilising RB as the substrate along with different microorganisms. In relation to that, the most significant studies can be observed by both Rashid et al. [1] and Razak et al. [4] as their studies mentioned the increased significant TPC of fermented RB compared to unfermented RB. In particular, filamentous fungi are seen to be the most suitable microbes to be used during SSF. Based on Table 1, *Aspergillus* strains, especially *A. oryzae* can be seen as the majorly used microbes during SSF. *A. oryzae* is known to secrete various extracellular enzymes like α-amylase, cellulase, protease and β-glucosidase [1]. This may be the reasons why most researchers utilise *Aspergillus* strain as the microbes. Nevertheless, there are many more microbes which can be utilised during SSF and are proven in successful liberation of the bound phenolic compounds. Examples of such microbes includes *Monascus purpureus, Saccharomyces cerevisiae, Rhizopus oligosporus*, *Formitopsis pinicola*, and *Bacillus clausii.*

CONCLUSION

It has been proven that SSF has great potential for the production and extraction of phenolic compounds along with enhancement of antioxidant property of agricultural wastes. Using agricultural wastes as raw materials can assist in a lower production price while also contributing to waste recycling thus creating a more environmentally friendly environment. The enhanced level of TPC observed in fermented samples is mainly due to the enzymatic actions of the microorganisms used during the fermentation.

ACKNOWLEDGEMENT

This study was supported by SEMESTA-MBI Research Grant (I/SEM-MBI/ST/2020/12).

REFERENCES

[1] N. Y. A. Rashid *et al.*, "Quantification of phenolic compounds changes by Aspergillus oryzae on rice bran fermentation," *Food Res.*, vol. 3, no. 2, pp. 133-137, 2019, doi:

10.26656/fr.2017.3(2).122.

[2] A. Jamaluddin *et al.*, "Effects of solid state fermentation by Monascus purpureus on phenolic content and biological activities of coconut testa and rice bran," *J. Teknol.*, vol. 78, no. 11–2, pp. 23–28, 2016, doi: 10.11113/jt.v78.9939.

[3] F. Rodríguez-Serrano, N. Mut-Salud, P. J. Álvarez, A. Aránega, J. M. Garrido, and E. Carrasco, "Antioxidant Intake and Antitumor therapy: toward nutritional recommendations for optimal results," *Oxid. Med. Cell. Longev.*, vol. 2016, pp. 1–19, 2016.

[4] D. L. Abd Razak, N. Y. Abd Rashid, A. Jamaluddin, S. A. Sharifudin, and K. Long, "Enhancement of phenolic acid content and antioxidant activity of rice bran fermented with Rhizopus oligosporus and Monascus purpureus," *Biocatal. Agric. Biotechnol.*, vol. 4, no. 1, pp. 33–38, 2015, doi: 10.1016/j.bcab.2014.11.003.

[5] S. H. Toushik, K. T. Lee, J. S. Lee, and K. S. Kim, "Functional Applications of Lignocellulolytic Enzymes in the Fruit and Vegetable Processing Industries," *J. Food Sci.*, vol. 82, no. 3, pp. 585–593, 2017, doi: 10.1111/1750-3841.13636.