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A STUDY ON THE YIELD AND SOME AGRONOMICAL CHARACTERISTICS OF THE GAMMA INDUCED OYSTER MUSHROOM (*PLEUROTUS OSTERATUS*)

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Abstract

This research deals with the study on the effect of gamma irradiation on yield and quality of oyster mushroom in each generation. The spawn of mushrooms sample (Ngwe-Hnin-Mho) was collected from Kaung-Ei Mushroom Nursery, South-Okkalapa Township,Yangon Region. The sample of mushrooms was treated with different doses (0.25, 0.5, 0.75 and 1 kGy) of gamma radiation. After irradiation, these spawn were successively cultivated to third generation. The yield and some agronomical characteristics of different generations were determined. To be safe for consumption, the induced activity of each mutant sample (OMG 0.25, OMG 0.5, OMG 0.75, OMG 1) was monitored by using NaI(Tl) Scintillation Gamma Counter at Nuclear Laboratory, Department of Chemistry. It was found that there were no induced activity in these samples. Thus, they are safe for human consumption. Agronomical characteristics such as average diameter of mushroom, yields, fruiting period, shelf-life of mutants oyster mushrooms were determined. And then, study of SEM and FT IR measurement was done. All doses of irradiation provide the higher yield of mushroom than those of control for every generation. The shelf-life of each mutant oyster mushroom increase than that of control. It was found that the fruiting periods of OMG 0.75 and OMG 1 always provided 1 day to 5 day shorter fruiting period than that of others. Thus, it is to reduce the time of producing oyster mushroom. The study of SEM was done for morphology of irradiated oyster mushroom. From this study, one evident fact is that there is no similar pattern between non-irradiated and irradiated oyster mushroom in all generation. From the FT IR spectra, it was found that effect of gamma irradiation did not vary the functional groups in the oyster mushroom up to third generation.

Keywords *:* oyster mushroom, gamma , induced activity, nutritional value, OMG

Introduction

In general, edible mushrooms are low in fat and calories, rich in vitamins B, D, K and sometimes vitamins A and C. They contain more protein than any other food of plant origin and are also a good source of mineral nutrients. Malnutrition is a problem in developing third world countries. Mushrooms with their flavor, texture, nutritional values and high productivity per unit area have been identified as an excellent food source to alleviate malnutrition in developing countries. In a world of rising food prices, cultivation of mushrooms is a very reliable and profitable option. Oyster mushroom cultivation can play an important role in managing organic wastes whose disposal has become a problem (Chang and Hayes, 2011). These wastes can be recycled into food and environment may be less endangered by pollution. Furthermore, the use of these residues in bioprocesses may be one of the solutions to bioconversion of inedible biomass residues into nutritious protein rich food in the form of edible mushrooms. Apart from food value, its medicinal value for diabetics and in cancer therapy has been emphasized. Many of mushrooms pose a range of metabolites of intense interest to pharmaceutical e.g., antitumour, antigenotoxic, antioxidant, anti-inflammatory, anti-hypertensive and food industries (Chikelu Mba, 2013).

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Gamma rays are emitted in the process of the decay of the radioisotopes cobalt-60 (^{60}Co), cesium-137 (^{137}Cs) and to a less extent, plutonium-239 (^{239}Pu). Gamma sources containing one of these radio isotopes are typically installed as gamma cell irradiators. A gamma cell is used mostly for acute irradiation (i.e., for short periods) (Dung *et al.*, 2012).The exposure of plants to irradiation for extended periods of times, irradiators are installed in specially designed gamma rooms (or chambers), greenhouses or fields. Gamma radiation has been used to useful mutations in rice, wheat, cotton, sweet paper, tomato and sesame and in maize. Induced mutations, exploitable in crop breeding, have been achieved by transporting plant propagules, mostly botanical seeds, in recoverable space orbiting satellites (Longvah and Deosthale, 1998). In this research work, the applying gamma irradiated oyster mushroom showed that a good benefit for their improve of yield percent and agronomical characteristics of oyster mushroom.

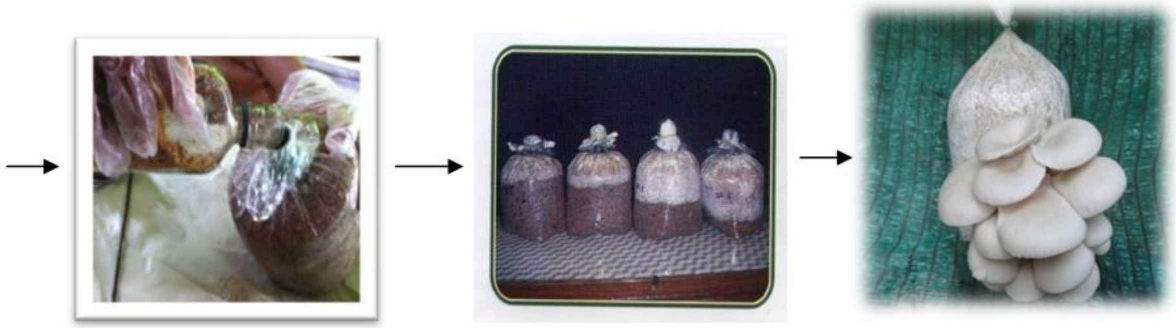
Materials and Methods

The spawn of mushrooms sample was collected from Kaung-Ei Mushroom Nursery, South Okkalapa Township, Yangon Region. The spawn of mushrooms was transported to the Department of Atomic Energy, Ministry of Science and Technology for irradiation. The spawn of oyster mushroom was cultivated as shown in Figure 1 in different doses of radiation (0.25, 0.5, 0.75, 1 kGy) up to third generation. Oyster mushrooms were firstly cultivated on rubber tree logs and were commonly grown on sawdust. Cultivation merely involved placing the sterilized and inoculated substrate in plastic bags, keeping them in the cool and dark. The mycelium has grown throughout the substrate, openings are cut through the bag to allow fruiting bodies (fruiting mushroom) to develop.

For study on safety consumption of mutant of first generation (0.25, 0.5, 0.75,1 kGy), the induced activity was monitored by NaI (Tl) Scintillation Gamma Counter at Nuclear Chemistry Laboratory, Yangon.

The study on investigation of agronomical characteristics of mutant oyster mushroom from first generation to third generation was done. The cultivated non-irradiated and mutant oyster mushrooms were characterized by using SEM and FT IR analyses.

Spawn of oyster mushroom   Substrate Preparation   Bagging   Pasteurization



Putting spawn into bags Sealed bags Fruiting mushroom

Figure 1 Cultivation procedure of oyster mushroom

Results and Discussion

Measurement of Induced Radioactivity of Mutants Oyster Mushroom

The induced activity of each mutant oyster mushroom sample (OMG 0.25, OMG 0.5, OMG 0.75, OMG 1) was monitored by using NaI(Tl) Scintillation Gamma Counter at Nuclear Laboratory, Department of Chemistry. The results are reported in Table 1. Since the induced radioactivity of each irradiated sample was monitored for safety consumption. It can be observed that there is no activity on the background for both before and after cultivation of M_1first generations. It is clear that counts for these sample were not exceed to that of background activity. Therefore, there was no induced activity in these samples. Hence, gamma irradiation mutant samples of oyster mushroom in each generation can be handled and stored, and they are safe for consumption.

Table 1 Monitoring of Induced Radioactivity in Mutant of Oyster Mushroom in First and Second Generation (after harvested)

No.	Samples	Induced activity relative to background (±%) (cp 300s)	
		M_1 generation	M_2 generation
1	OMG 0.25	1.50	1.20
2	OMG 0.5	0.55	0.25
3	OMG 0.75	0.97	0.41
4	OMG 1	1.11	0.64

± = due to fluctuation Note: activity no distinct above background

M_1 = First Generation, M_2 = Second Generation

OMG 0.25 = Gamma 0.25 kGy irradiated Oyster Mushroom

OMG 0.5 = Gamma 0.5 kGy irradiated Oyster Mushroom

OMG 0.75 = Gamma 0.75kGy irradiated Oyster Mushroom

OMG 1 = Gamma 1 kGy irradiated Oyster Mushroom

Study on Agronomical Characteristics of Mutants Oyster Mushroom Samples

The agronomical characteristics of each mutant oyster mushroom were studied to investigate some important characters (average diameter of mushroom, actual yield, yield increase, fruiting period and shelf-life of mushroom).The results of each mutant in different generations are reported in Tables 2, 3, 4, 5 and Figure 2. From basic on actual yield, percentage of yield increase were calculated. In first generation, percentage yield improvement of OMG 0.25, OMG 0.5, OMG 0.75 and OMG 1 were found to be 7.60 %, 11.50 %, 29.20 %, 17.60 % . In second generation, percentage yield improvement of OMG 0.25, OMG 0.5, OMG 0.75, OMG 1 and control were found to be 5.71 %, 9.28 %, 11.42 % and 10.00 % respectively. In third generation, percentage yield improvement of OMG 0.25, OMG 0.5, OMG 0.75 and OMG 1 were found to be 6.90 %, 30.00 %, 46.32 % and 21.64 % respectively.

The mutants 0.25 kGy, 0.5 kGy, 0.7 kGy and 1 kGy doses of gamma radiation on oyster mushroom were found to be effective in morphology, yield, fruiting period and shelf-life. Among them, OMG 0.75 sample provide the highest yield with shorter fruiting period in every generation. Therefore, the effect of gamma irradiation was found on the shelf-life, yield and fruiting period of oyster mushroom.

Table 2 Agronomical Characteristics of Mutant Oyster Mushroom Samples in First Generation (M_1)

No.	Characteristics of Oyster Mushroom	Samples				
		OMC	OMG 0.25	OMG0.5	OMG 0.75	OMG 1
1	Average diameter of mushroom (cm)	9.20	10.23	10.41	10.06	9.20
2	Actual Yield (g/ bag)	223.33 ± 20.67	233.33 ± 8.17	241.67 ± 9.57	291.67 ± 20.34	251.67 ± 24.83
3	Relative Yield	100	107.60	111.50	129.20	117.60
4	Yield Increase (%)	-	7.60	11.50	29.20	17.60
5	Fruiting Period (days)	34	34	34	31	33
6	Shelf-life (h)	18	23	24	24	24

Table 3 Agronomical Characteristics of Mutant Oyster Mushroom Samples in Second Generation (M_2)

No.	Characteristics of Oyster Mushroom	Samples				
		OMC	**OMG 0.25**	**OMG 0.5**	**OMG 0.75**	**OMG 1**
1	Average diameter of mushroom (cm)	9.00	9.50	9.70	9.40	10.40
2	Actual Yield (g/ bag)	233.00 ± 17.28	247.00 ± 11.78	255.00 ± 13.78	260.00 ± 12.64	257.00 ± 12.12
3	Relative Yield	100	105.71	109.28	111.42	110.00
4	Yield Increase (%)	-	5.71	9.28	11.42	10.00
5	Fruiting Period (days)	33	33	33	32	32
6	Shelf-life (h)	17	20	21	21	20

Table 4 Agronomical Characteristics of Different Mutants Oyster Mushroom in Third Generation (M_3)

No	Characteristics of Oyster Mushroom	Samples				
		OMC	**OMG 0.25**	**0MG0.5**	**OMG 0.75**	**OMG1**
1	Average diameter of mushroom (cm)	6.03	8.33	8.32	7.09	8.29
2	Actual Yield (g/ bag)	385.00 ± 25.88	411.66 ± 28.58	501.66 ± 22.29	563.33 ± 24.20	468.33 ± 27.21
3	Relative Yield	100	106.90	130.30	146.32	121.64
4	Yield Increase (%)	-	6.90	30.30	46.32	21.64
5	Fruiting Period (days)	33	32	29	28	28
6	Shelf-life (h)	19	24	27	27	24

Table 5 The Yield Comparison of Different Mutant Oyster Mushrooms from First to Third Generation

Generation	Samples	Actual Yield (g/bag)	Relative Yield	Yield Increase (%)
M_1	OMC	223.33	100	-
	OMG 0.25	233.33	107.60	7.60
	OMG 0.5	241.67	111.50	11.50
	OMG 0.75	291.67	129.20	29.20
	OMG 1	251.67	117.30	17.60
M_2	OMC	233.00	100	-
	OMG 0.25	247.00	105.71	5.71
	OMG 0.5	255.00	109.28	9.28
	OMG 0.75	260.00	111.42	11.42
	OMG 1	257.00	110.00	10.00
M_3	OMC	385.00	100	-
	OMG 0.25	411.66	106.90	6.90
	OMG 0.5	501.66	130.30	30.30
	OMG 0.75	563.33	146.32	46.32
	OMG 1	486.33	121.64	21.64

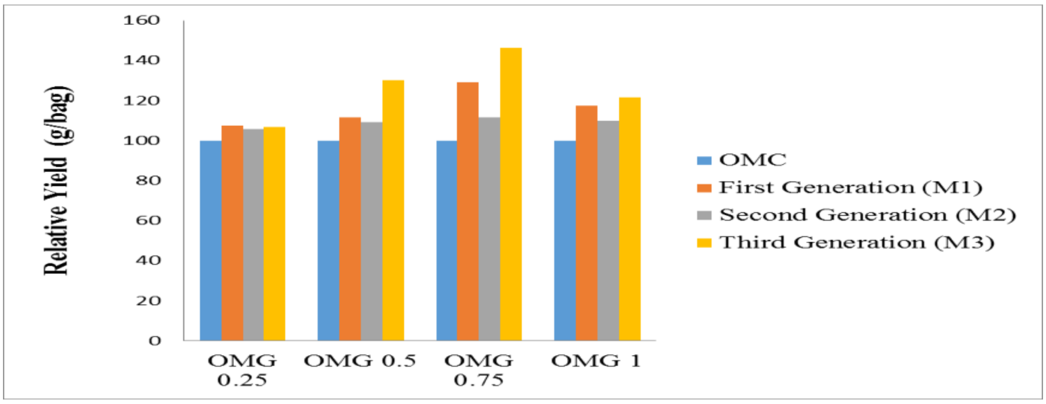
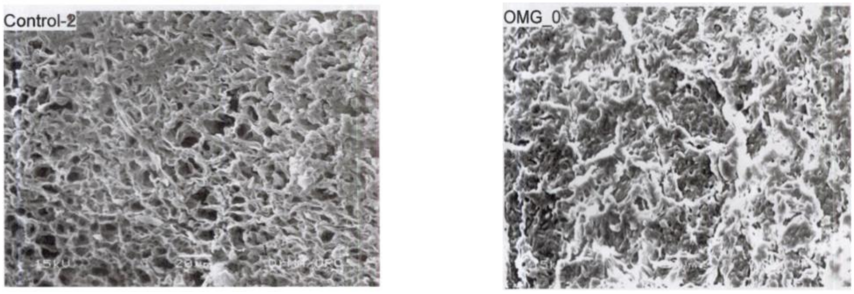


Figure 2 Bar graph of relative yield of different mutants oyster mushroom for three generations

OMC	=	Oyster Mushroom Control
OMG 0.25	=	Gamma 0.25 kGy irradiated Oyster Mushroom
OMG 0.5	=	Gamma 0.5 kGy irradiated Oyster Mushroom
OMG 0.75	=	Gamma 0.75 kGy irradiated Oyster Mushroom
OMG 1	=	Gamma 1 kGy irradiated Oyster Mushroom

Studies on Surface Morphology of Mutant Oyster Mushrooms up to Third Generation

In this work, the irradiated mutant oyster mushrooms had been studied by SEM. The obtained SEM photomicrographs for non-irradiated and irradiated oyster mushroom are shown in Figure 3. It can be seen that the surface morphology of before and after irradiated oyster mushroom was different. The more fine state particles are observed in irradiated spawn of mushroom. It can be said that gamma irradiation can affect surface texture of oyster mushroom. From these figures, one evident fact is that there is no similar pattern was observed. Moreover, it was found that all of surface morphology of these gamma exposed mutant oyster mushrooms were different from non-irradiated and irradiated oyster mushroom.



(a) (b)

Figure 3 SEM photomicrograps of (a) cultivated non-irradiated oyster mushroom (OMC)
(b) cultivated mutant oyster mushroom (OMG 0.75)

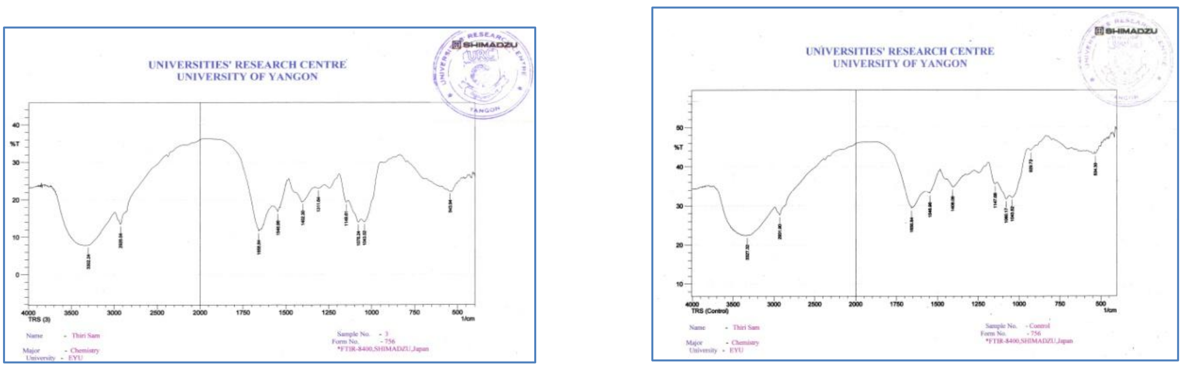
FT IR Analysis of Non-irradiated and Irradiated Oyster Mushroom

From this study, the functional group of compounds present in non-irradiated and irradiated oyster mushroom (OMG 0.75) were studied by FT TR spectrometer. The FT IR spectra of cultivated non-irradiated and irradiated oyster mushroom are shown in Figure 4. The position of absorption bands of non-irradiated and irradiated are shown in Table 6. It was found that, there is no change in functional group for both samples. Hence, it can be said that there were no effect of gamma irradiation on the functional groups of control.

Table 6 FT IR Spectra Data of the Non-Irradiated and Irradiated Oyster Mushroom

Wavenumber (cm^{-1})		**Band Assignment***
Non irradiated	**Irradiated**	
3327	3392	OH and NH stretching vibration
2931	2928,2924	C-H asymmetric and symmetric stretching vibration
1658	1658	C=O stretching vibration
1546, 1408	1548,1408	C=C stretching vibration
1147	1147,1149	Symmetric stretching for C-O-C
1080, 1043	1080,1043	C-O band in –C-O-H

* Silverstein *et al*., 2005



(a) (b)

Figure 4 FT IR spectra of the (a) cultivated non-irradiated oyster mushroom (OMC)
(b) cultivated of mutant oyster mushroom (OMG 0.75)

Conclusion

From results, all irradiated oyster mushroom have no induced activity. Therefore, it is safe for consumption, handle and storage. Oyster mushrooms were irradiated with different doses (0.25 kGy, 0.5 kGy, 0.75 kGy and 1 kGy) of gamma irradiation and cultivated from first and third generation. The quality, yields and agronomical characteristics of mutants oyster mushroom up to third generation were studied. All dose of irradiation provide the highest yield of mushroom than those of control for every generation. From study on the long term, 0.75 kGy of gamma radiation gives the highest yield in first to third generation (29.20 %, 11.42 % and 46.32 %) respectively. The gamma irradiation has the effect on the fruiting period of oyster mushroom from first to third generation. 0.75 kGy and 1 kGy provide one day to 5 days shorter fruiting period than other irradiation doses. The shelf-life of each mutant oyster mushroom from first to third generation was increased from 4 to 6 than the control. It can be concluded that all doses of gamma radiation were found to be effective on the morphology, yield, fruiting period and shelf-life of oyster mushroom.

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