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Bio-Production of Pigments from Some Local Fungal Isolates by Solid State Fermentation using some Agro- Industrial Wastes

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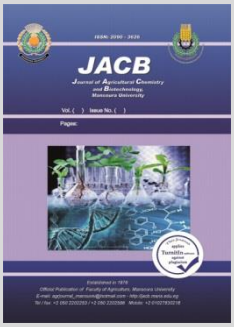

ABSTRACT

Four local fungal isolates were used in this study to produce pigments using some agro- industrial wastes via solid state fermentation. The maximum production of pigments by *Talaromyces purpureogenus* (MT232241.1) was obtained when broken wheat was used as a substrate, after 9 days of incubation , at 25°C , 60% moisture content, 3ml of spore suspension as inoculum , pH5and under dark light condition. In case of *Fusarium oxysporum* (KU671032.1) the highest level of pigments obtained by using broken rice, after 12days of incubation , at 30°c , 60% moisture content, 3ml of spore suspension as inoculum , pH and under dark light By using 3ml of spore suspension as inoculum of *Aspergillus penicillioides* (MT594382.1) the maximum pigment production was achieved with broken wheat as a substrate after 12days of incubation , at 25°C, 60% moisture content, pH6 and under red light condition. By using the corn cobs as a substrate, the fungal *Trichoderma lixii* (MW805725) showed high pigment production after 12days of incubation, at 30°C, pH6, when the moisture content was 60%, 4ml of spore suspension was used as inoculum, and under dark light condition.

Keywords: Bio-pigments, agro- industrial wastes, solid state fermentation *Talaromyces* .

INTRODUCTION

Because of the high cost of currently used technology of production of pigments on an industrial scale, where is demand for developing process for pigments production which could replace synthetic pigments. To attain this objective, cheaply available agro industrial residues such as rice bran, coconut oil cake wheat bran, sesame oil cake, groundnut oil cake, palm kernel cake, cassava powder, spent brewing grain, and jackfruit seed powder were used (Babitha et al., 2007). Velmurugan et al., (2011) used corn cobs for pigment production from Monascus purpureus through solid state fermentation they mentioned that corn cobs contains large amounts of polysaccharides (such as cellulose and hemicelluloses), that promote growth of fungi and thereby increase yield of pigment. SSF presents more adequate habitat for highly low cost pigments production from fungi by using agro – industrial residues as substrates (Pandy et al., 2000,2001). Solid state fermentation process results in higher pigment yield than cultivation in shake culture because pigments in solid state are released into grains but it accumulated in the mycelium through submerged cultivation Gunasekaran & Poorniammal (2008). Application of agro-industrial residues in bioprocess on one hand provides alternative substrates and helps in solving pollution problems, which their disposal may otherwise cause pollution (Singhania et al., 2008). In recent years , search for pigment producing microorganisms as their production is advantageous being of environmental conditions and can be grown on cheaper medium (Joshi ,2006). Fungi are mentioned as potent pigments production which can be used as dye or as a food colorant (Babitha et al., 2006).

The main objective of this work was to select some local pigmented fungal isolates and study factors affecting pigments production using some agro-industrial wastes via solid state fermentation.

MATERIALS AND METHODS

Fungal isolates:

Isolates of pigmented fungi were isolated from rhizosphere region of some plants in Aga region. The isolates were purified, sub cultured every three weeks and maintained on PDA medium at 4°c after incubation at 30°c for 7days.

Raw materials

Broken wheat, broken rice, wheat bran and corn cob were collected from the local market and agricultural fields around Mansoura and used as substrate for pigment production from isolated isolates through solid state fermentation. Cobs were washed thoroughly, dried in sun light and grounded to 2mm particle size using a sterile blender. Raw materials were analyzed by Lab of Soil Fertility Tests And Fertilizers Quality Control- faculty of agriculture- Mansoura University and the results are shown in Table (1).

Table 1. Chemical composition and C/N ratio of the four agricultural wastes used in SSF.

Agro- waste	%N	%C	%moisture	%P	%H	%S	C/N
Broken rice	2.05	48.14	12.10	0.08	8.19	0.00	23.507
Wheat bran	2.58	40.36	13.59	0.73	6.79	0.00	15.634
Corn cob	0.78	41.50	10.15	0.07	5.80	0.00	53.393
Broken wheat	2.75	41.48	11.43	0.41	6.79	0.13	15.247

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Media used

Potato Dextrose Agar (PDA) medium was used for isolation of pigmented fungi from soil, sub culturing and maintaining fungal isolates.

Methods

Isolation of pigmented fungal strains

Fungal strains was isolated by serial dilution method. Serial dilutions of soil samples were done in (0.9%Nacl) saline solution and plated on PDA medium plates. After incubation at 30°C for 7days, pigments fungal colonies were picked up and used for pigment production.

Preparation of inoculum

After incubation at 30°C for 7days,to each slant isolate, 2ml of sterilized distilled water were added to each slant isolate, the growth of 5 slants of each isolate was crushed to 250ml conical flask contains 100 ml of (0.9%Nacl) saline solution, . Each 1ml of inoculum contains ($1*10^5$) spores.

Preparation of the used materials

After collecting the raw materials from local market, they were dried completely at 80°c for 48hrs and grinded, the resulted powders were used as substrate for pigments production through solid state fermentation.

Factors affecting pigments production by isolated fungi

Effect of time course and raw materials on pigment production

Five gram of raw material were taken into 250ml Erlenmeyer flask and tap water was added to reach 50% moisture content .Flasks were mixed well and autoclaved at 121°c for 20min. After inoculation with 1ml spore suspension, flasks were incubated at 28°c for 6,9,12 and 15days. Samples were withdraw after each period and pigment production was measured.

Effect of salt solution addition

Two ml of salt solution containing (g/l) KH_2PO_4 2g, NH_4NO_3 5g, NaCL 1g,$MgSO_4.7H_2O$ 1g were added to each flask contains 5g of raw material. The moisture content (50%) was adjusted by tap water. Flasks were autoclaved at 121°C for 20min. After inoculation with 1ml of spore suspension, flasks were incubated at 28°c. Samples were withdrawn after 6, 9,12 and 15 days of incubation and pigment was determined.

Effect of moisture level

The effect of moisture content (50%, 55%, 60%, and 65%) on pigment production by each fungi was tested at 28°C. The best raw material and the optimum incubation period were used.

Effect of incubation temperature

By using the best previous factors for each isolate, four incubation temperatures (20, 25, 30 and 35°c) were studied .

Effect of inoculum size

The effect of five inoculum sizes (1, 2, 3, 4 and 5ml) on pigment production were examined under the optimum conditions for each isolate.

Effect of initial pH

Six degrees of pH (4, 5, 6, 7, 8 and 9) were used to study the effect of initial pH on pigment production by each isolate. The optimum previous factors for each isolate were used.

Effect of the light on pigment production:

This experiment was carried out using the optimum conditions for each isolate, the inoculated flasks were covered with colored papers of red, blue, green, black and white. After incubation time for each isolate, the production of pigment was measured.

Pigment extraction and estimation

According to Babitha *et al*,(2007) the cultures were dried at 60°C for 24hrs. Pigments were extracted with 5ml of 90% methanol per gram of dry fermented substrate (gd/s).The mixture was placed on a rotary shaker at 200 rpm for 1hour. After stand for 15min, the mixture was centrifuged at 4000 rpm for 10 min and filtered through whatman filter paper No.1 . According to the method of Tseng *et al* (2000), pigments were quantified by measuring OD at 412 and 500nm.,reprsending yellow and red pigment production ,respectively. Pigment yield was expressed as od/gdfs. Pigment yield was expressed as OD at its max per gram dry fermented matter (Johns and Stuart, 1991).

RESULTS AND DISCUSSION

Data in Table (2) shows that maximum production of pigments by *Talaromyces purpureogenus* (MT232241.1) and *Aspergillus penicillioides* (MT594382.1) was observed when used broken wheat, while in case of *Fusarium oxysporum* (KU671032.1) the highest level of pigments obtained by using broken rice. Kaur *et al*., (2017) used broken wheat and broken rice for pigment production from *Penicillium* sp. through solid state fermentation.

On the other hand, corn cobs proved to be the best waste for pigments production by *Trichoderma lixii* (MW805725) Velmurugan *et al*., (2011) proved that corn cobs are a highly economical substrate for SSF, for pigment production. Corn cob contains considerable amounts of polysaccharides (such as cellulose and hemicelluloses), which promote fungal growth and thereby increase pigment yield. (Babitha *et al*., 2006) used agro-industrial wastes such as rice bran, wheat bran, coconut oil cake, sesame oil cake, palm kernel cake, cassava powder, spent brewing grain, for pigment production.

As for incubation time the effect on pigments production by the selected fungal isolates, data revealed that the maximum yield of pigments by *Talaromyces purpureogenus* (MT232241.1) was obtained after 9 days of incubation using broken wheat as a substrate ,but the highest amounts of pigments were obtained after 12 days of incubation by *Fusarium oxysporum* (KU671032.1), *Aspergillus penicillioides* (MT594382.1) and *Trichoderma lixii* (MW805725) when broken rice, broken wheat and corn cobs were used as substrate, respectively. The obtained data showed that the amount of pigment varied with time of incubation, fungal isolate and agro industrial waste. Kaur *et al*., (2017) found that the maximum yield of yellow pigments (137.8u/g) obtained from *Pencillium* sp. via solid state cultivation using broken wheat after 12 days of incubation, while when broken rice is used the yield was 62.2 u/g. Babitha *et al*.,(2007) obtained the maximum yield of pigment from *Monascus purpureus* LPB 97 using jack fruit seed via SSF, after 7days of incubation. On the other hand Soto-cruz *et al*.,(2008) obtained the maximum yield of pigment from *Talaromyces* after 24 days of incubation.

Also, Sethi *et al*., (2016) revealed that maximum red pigment production by *penicillium purpurogenum* was obtained at eighteenth day of incubation. Velmurugan *et al*., (2011) reported that maximum yellow and red pigment production was obtained by *Monascus purpureus* KACC 42430 at 7 days of incubation. (Pandiyarajan *et al*., 2018) reported that the maximum yield of pigments from *Aspergillus* sp. was obtained after 7 days of incubation.

Data in Table (3) and Fig. (1) show that salt solution increase pigment production with all isolates. The increases varied from waste to another. It may be due to nutrients in salt solution that promote growth of fungi and thereby increase yield of pigments

Table 2. Effect of agricultural waste type on pigment production by the selected isolates after 6, 9, 12 and15 days of incubation .

Waste type	Fungal isolate	Incubation time od/gdfs			
		6 days	9 days	12 days	15 days
Broken wheat	*Talaromyces purpureogenus* (MT232241.1)	2.002	4.406	2.314	1.860
Broken rice		0.281	1.326	1.881	0.641
Corn cobs		0.12	1.023	2.101	0.931
Wheat bran		0.834	1.043	2.901	1.104
Broken wheat	*Fusarium oxysporum* (KU671032.1)	0.466	0.44	3.095	1.451
Broken rice		0.343	0.337	4.463	1.484
Corn cobs		0.239	0.249	2.799	1.01
Wheat bran		0.426	0.568	3.623	1.31
Broken wheat	*Aspergillus penicillioides* (MT594382.1)	3.405	4.327	11.23	8.41
Broken rice		1.291	3.246	6.895	4.52
Corn cobs		1.088	2.145	3.797	2.84
Wheat bran		3.336	4.314	8.479	6.41
Broken wheat	*Trichoderma lixii* (MW805725)	0.263	1.191	1.334	0.75
Broken rice		1.162	1.229	1.428	0.985
Corn cobs		1.129	2.094	3.351	1.989
Wheat bran		1.337	1.64	1.964	0.097

Optical Density was measured for *Talaromyces purpureogenus* at 500, for *Fusarium oxysporum* and *Aspergillus penicillioides* at 450 nm, and for *Trichoderma lixii* at 400 nm. Incubation was done at28 °c, initial pH 6.2 and1ml inoculum.

Table 3. Effect of adding salt solution on pigment production by the selected isolates

	od/gdfs											
Waste type	**BW**			**BR**			**CC**			**WB**		
Fungal isolate	**Without s.s**	**With s.s**	**%**	**Without s.s**	**With s.s**	**%**	**Without s.s**	**With s.s**	**%**	**Without s.s**	**With s.s**	**%**
Talaromyces purpureogenus (MT232241.1)	4980	5538	1120	1250	1779	4232	0989	3057	20910	0990	2217	12393
Fusarium oxysporum (KU671032.1)	2900	333	1482	4102	51	2432	101	1764	7465	230	2476	7652
Aspergillus penicillioides (MT594382.1)	101	1191	1792	6401	7337	1462	2165	541	14988	581	6421	1051
Trichoderma lixii (MW805725)	1201	2004	6686	1207	1588	3156	2981	3802	2754	0871	274	21458

Incubation was done at28 °c, initial pH 6.2 and1ml inoculum.

Optical Density was measured for *Talaromyces purpureogenus* at 500 *Fusarium oxysporum* and *Aspergillus penicillioides* at 450 nm, and *Trichoderma lixii* at 400 nm.

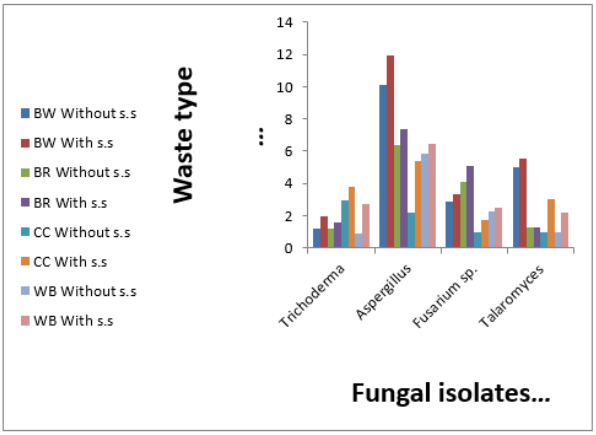

Fig. 1. Effect of salt solution on pigment production by the selected isolates.

Data in Table (4) and illustrated in Fig. (2) revealed that, the maximum yield of pigments was obtained at 60% moisture content with all fungal isolates and the production decreased above or below the optimum moisture content. Similar results were obtained by Johns and Stuart (1991) who stated that initial substrate moisture content less than 40% gave less pigmentation ,but that of 50-56% could give the highest pigmentation by *Monascus purpureus* cultivated using SSF. Babitha *et al*.,(2007) reported that, maximum pigment production by *Monascus purpureus* LPB 97, grown on jackfruit seeds through SSF, was observed at 50% initial moisture content. Also they reported that ,a decrease in pigment yield was observed when the moisture content was higher or lower than the optimum. (Velmurugan *et al*., 2011) reported that maximum yield of pigments produced by *Monascus purpureus* KACC 42430 was obtained at 60% moisture content and pigment yield decreased above or below 60% moisture.

Table 4. Effect of moisture level on pigment production by the selected isolates.

	od/gdfs			
Moisture level Fungal isolate	**50%**	**55%**	**60%**	**65%**
Talaromyces purpureogenus (MT232241.1)	5.553	16.546	23.7	10.99
Fusarium oxysporum (KU671032.1)	3.356	8.594	12.747	6.833
Aspergillus penicillioides (MT594382.1)	10.9	12.03	16.01	10.21
Trichoderma lixii (MW805725)	3.808	4.931	8.348	5.134

After 9days of incubation for *Talaromyces purpureogenus*, and 12days for *Fusarium oxysporum*, *Aspergillus penicillioides* and *Trichoderma lixii*, at 28°c, pH 6.2,1ml inoculum, optical density 500 for *Talaromyces purpureogenus* ,400 for *Trichoderma lixii* and 450 for *Fusarium oxysporum* and *Aspergillus penicillioides*.

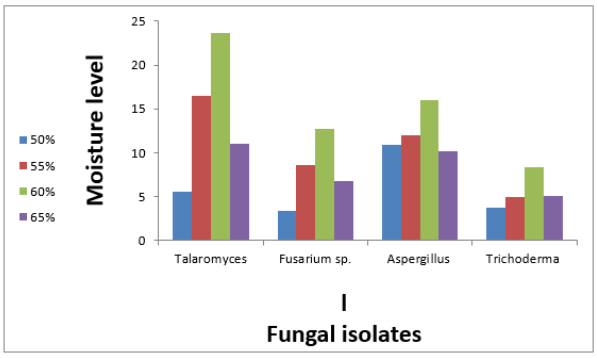

Fig. 2. Effect of moisture level on pigment production by the selected isolates.

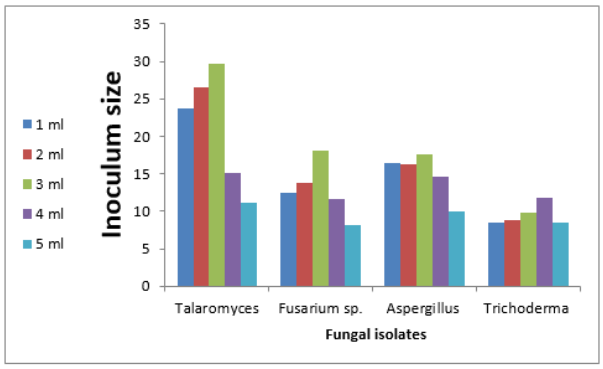

Fig. 3. Effect of inoculum size on pigment production by the selected isolates.

Incubation was done at 28°c ,9 days for *Talaromyces purpureogenus*, and 12days for *Fusarium oxysporum*, *Aspergillus penicillioides* and *Trichoderma lixii*, pH 6.2, 1ml inoculum, 60% moisture content. optical density 500 for *Talaromyces purpureogenus*,400 for *Trichoderma lixii* and 450 for *Fusarium oxysporum* and *Aspergillus penicillioides.*

Data in Table (5) and illustrated in Fig. (3) showed that the best inoculum size of *Talaromyces purpureogenus* (MT232241.1), *Fusarium oxysporum* (KU671032.1) and *Aspergillus penicillioides* (MT594382.1) for pigment production was 3ml of spore suspension but the best inoculum size of *Trichoderma lixii* (MW805725) was 4 ml. The pigment production was decreased at low levels of inoculum sizes, it is due to sufficient biomass and smaller amounts of pigment. Whereas too much inoculum produced excessive biomass and depleted the nutrients required for pigment production (Pandy *et al*., 2000). (Babitha *et al*., 2007) stated that pigment production from *Monascus purpureus* LPB 97,grown on jackfruit seed through SSF, significantly increased to 25.45OD units/gds for an inoculum size of 3ml spore suspension (9 *10^4 spores/ gram dry substrate). Velmurugan *et al*., (2010a) reported that spore inoculum concentration of 4 ml containing 6×10^5 spores/ml was the best for inoculation of 5 g of substrate for solid state fermentation by *Monascus purpureus*, . General *et al*., (2014) reported optimum inoculum volume of 1.8×10^6 spores per gram solid substrate during pigment production by *Talaromyces amestolkiae* using macroalgal biomass as the substrate.

Table 5. Effect of inoculum size on pigment production by the selected isolates.

	od/gdfs				
Inoculum size **Fungal isolate**	**1 ml**	**2 ml**	**3 ml**	**4 ml**	**5 ml**
Talaromyces purpureogenus (MT232241.1)	23.7	26.59	29.61	15.09	11.12
Fusarium oxysporum (KU671032.1)	12.47	13.87	18.07	11.68	8.08
Aspergillus penicillioides (MT594382.1)	16.44	16.32	17.63	14.67	10.01
Trichoderma lixii (MW805725)	8.547	8.864	9.758	11.73	8.531

Data in Table (6) and illustrated in Fig.(4) show that the higher pigment production by *Talaromyces purpureogenus* (MT232241.1) and *Fusarium oxysporum* (KU671032.1) was noticed at pH5.0 while the optimum pH for pigments produced by *Aspergillus penicillioides* (MT594382.1) and *Trichoderma lixii* (MW805725) was obtained at pH 6.0. Similar results on pH effect were reported by many researchers. (Babitha *et al*., 2009) obtained the maximum pigment yield by *Monascus purpureus* at pH 5.0 followed by pH 6.0, using jackfruit seed through SSF. Sethi *et al*., (2016) found that maximum production of the red pigment from *penicillium purpurogenum* BK59 was obtained at pH 6.0 and decrease thereafter . The optimum pH for pigment production by *Talaromyces verruculosus* was found to be 7.0; which is close to reported one (7-7.5) (Soto-Cruz *et al*., 2008). (Babitha *et al*., 2009) found that maximum yield production by *Monascus purpureus* was at pH 4.5-7.5. Akilandeswari and Pradeep (2017) reported that maximum biomass and pigment yield were achieved at 28 °C and pH 5.0 by *Aspergillus sp*. Geweely (2011) reported that high biomass and pigmentation were accomplished at pH 7 and 30 °C for *A. nidulans*.

Table 6. Effect of initial pH on pigment production by the selected isolates.

	pH	od/gdfs				
Fungal isolate	**4**	**5**	**6**	**7**	**8**	**9**
Talaromyces purpureogenus (MT232241.1)	32.16	44.31	32.29	29.76	25.34	20.3
Fusarium oxysporum (KU671032.1)	17.95	19.43	18.48	18.09	16.77	15.32
Aspergillus penicillioides (MT594382.1)	11.12	13.3	24.18	15.99	14.88	7.923
Trichoderma lixii (MW805725)	5.877	9.065	10.61	9.094	8.052	5.548

Incubation was done at 28°c ,9 days for *Talaromyces purpureogenus*, and 12days for *Fusarium oxysporum*, *Aspergillus penicillioides* and *Trichoderma lixii*, pH 6.2 , 60% moisture content, 3ml inoculum for *Talaromyces purpureogenus*, *Fusarium oxysporum* , *Aspergillus penicillioides* , 4ml for *Trichoderma lixii*, Optical density 500 for *Talaromyces purpureogenus*, 400 for *Trichoderma lixii* and 450 for *Fusarium oxysporum* and *Aspergillus penicillioides*.

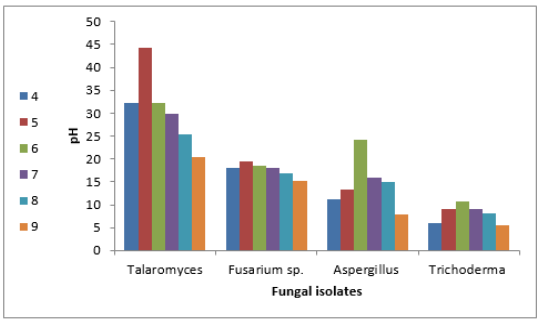

Fig. 4. Effect of pH on pigment production by the selected isolates.

Data in Table (7) and illustrated in Fig.(5) revealed that the optimum temperature for pigment produced by *Talaromyces purpureogenus* (MT232241.1) and *Aspergillus penicillioides* (MT594382.1) was 25°C while it was 30°C in case of *Fusarium oxysporum* (KU671032.1) and *Trichoderma lixii* (MW805725). It could be noticed that at below and above the optimum temperature ,the production of pigments decrease . The optimum temperature for pigment production in solid state culture in Petri dish by *T. purpurogenus* was 30°C. This was in agreement with the results of pigment production by *M. ruber* (Said *et al*., 2010), *M. purpureus* CMU001 (Nimnoi and Lumyong, 2011)), and *Penicillium aculeatum* ATCC 10409 (Afshari *et al*., 2015). With all these species, the optimum temperature was reported to be 30°C. When the newly isolated *T. purpurogenus* was cultivated at 35°C there was good growth but pigment production was very low. Geweely(2011) reported that high biomass and pigmentation were accomplished at pH 7 and 30 °C for *A. nidulans*. Nevertheless, 28 °C with pH 5.5 was selected as the optimum condition for biomass and pigment production by the MBYP1 strain.

Table 7. Effect of Incubation temperature on pigment production by the selected isolates.

Incubation Temp.Fungal isolate	20	25	30	35
Talaromyces purpureogenus (MT232241.1)	5.503	17	13	9.627
Fusarium oxysporum (KU671032.1)	1.891	7.578	11.55	2.808
Aspergillus penicillioides (MT594382.1)	2.399	17.28	11.14	3.143
Trichoderma lixii (MW805725)	1.623	5.461	6.565	1.584

Incubation was done at 28°c ,9 days for *Talaromyces purpureogenus*, and 12days for *Fusarium oxysporum, Aspergillus* and *Trichoderma lixii*, 60% moisture content, 3ml inoculum for *Talaromyces purpureogenus, Fusarium oxysporum, Aspergillus penicillioides* , 4ml for *Trichoderma lixii*. Initial pH 5 for *Talaromyces purpureogenus* and *Fusarium oxysporum*, pH 6 for *Aspergillus penicillioides* and *Trichoderma lixii*.

Optical density 500 for *Talaromyces purpureogenus*, 400 for *Trichoderma lixii* and 450 for *Fusarium oxysporum* and *Aspergillus penicillioides*.

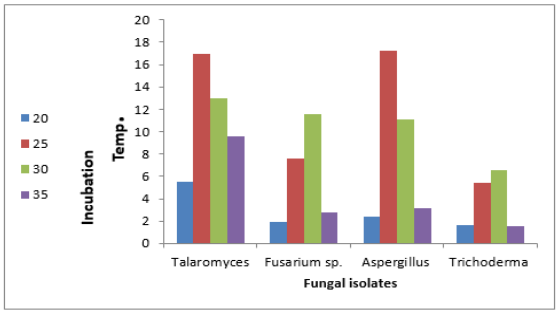

Fig. 5. Effect of incubation temperature on pigment production by the selected isolates.

The effect of light on pigment production by fungi was studied by many researchers. Light can regulate the growth, and pigmentation production of fungi also it regulate asexual and sexual reproduction. Data illustrated in Table (8) and Fig. (6) show the production of used fungal isolate exposed to lights of various wave- lengths. Data revealed that the highest values of production obtained under darkness with *Talaromyces purpureogenus* (MT232241.1), *Fusarium oxysporum* (KU671032.1), and *Trichoderma lixii* (MW805725) Similar results were obtained by (Babitha *et al*., 2009) who found that total darkness increased pigment production (about 2-fold) by *Monascus purpureus* LPB 97 in SSF with jack fruit seeds. Also Velmurugan *et al*., (2010b) noted that pigment production by *M. purpureus, Emericella nidulans, Fusarium verticillioides, Isaria farinosa*, and *P. purpurogenum* were higher under dark condition than when exposed to lights of various wavelengths. *Talaromyces purpureogenus* (MT232241.1) produced (100%)of production under total darkness but under red, green, blue and white lights the production decreased to 90.31%, 41.1, 51.98 and 70.77% respectively. As for *Fusarium oxysporum* (KU671032.1) (100%) of production was obtained under total darkness but under red, green, blue, and white lights the production decrease to 73.69, 70.43, 70.15, and 78.53% respectively. The highest value of pigment (100%) produced by *Trichoderma lixii* (MW805725) was obtained under total darkness and it decreased to 95.94, 69.8, 71.07 and 64.8% under red, green, blue and white lights. Results are in agreement with the previous results of (Ogbonna *et al*.,2017) who reported that pigment production was favored more by incubating in a dark place than under light. On the other hand, *Aspergillus penicillioides* (MT594382.1) noted the highest production value (100%) under red light but production decreased to 79.87, 79.97, 89.99 and 66.42%under total darkness, green, blue and white lights .

Table 8. Effect of light on pigment production by the selected isolates.

light	Black		Red		Green		Blue		White	
Fungal isolate	%pro.	%dec.	%pro.	%dec.	%pro.	%dec.	%pro.	%dec.	%pro.	%dec.
Talaromyces purpureogenus (MT232241.1)	100	-	90.31	9.69	41.91	58.09	51.98	48.02	70.77	29.23
Fusarium oxysporum (KU671032.1)	100	-	73.69	26.31	70.43	29.57	70.15	29.85	78.53	21.47
Aspergillus penicillioides (MT594382.1)	79.87	20.13	100	-	79.97	29.03	89.99	10.11	66.42	33.58
Trichoderma lixii (MW805725)	100	-	95.94	4.06	69.98	30.02	71.07	28.93	64.80	35.20

Incubation was done at 25°c for *Talaromyces purpureogenus*, after 9 days, 25°c for *Aspergillus penicillioides*, 30°c for *Fusarium oxysporum* and *Trichoderma lixii*, after 12days , 60% moisture content.

3ml inoculum for *Talaromyces purpureogenus, Fusarium oxysporum, Aspergillus penicillioides*, 4ml for *Trichoderma lixii*.

Initial pH 5 for *Talaromyces purpureogenus* and *Fusarium oxysporum*, pH 6 for *Aspergillus penicillioides* and *Trichoderma lixii*,

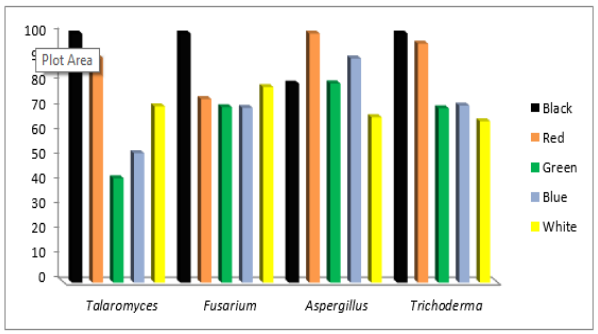

Fig. 6. Effect of the light on pigment production by the selected isolates.

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الإنتاج الحيوي للصبغات بواسطة بعض العزلات الفطرية المحلية باستخدام بعض المخلفات الزراعية عن طريق التخمر الصلب

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الملخص

(في هذه الدراسة تم استخدام 4عزلات فطرية محلية لإنتاج الصبغات باستخدام كسر القمح وكسر الأرز وقوالح الذرة ونخالة القمح عن طريق تخمر الحالة الصلبة) وتم دراسة العوامل المؤثرة على الإنتاج وكانت النتائج كالتالي :بالنسبة لفطر *Talaromyces purpureogenus* (MT232241.1) تم الحصول على أعلى انتاج من الصبغة بعد 9 أيام من التحضين على مخلف كسر القمح عند25 °م ومحتوى رطوبة 60% وحجم لقاح3ملل من معلق الجراثيم ودرجة حموضة 5 وتحضين في الظلام التام .بينما فطر *Fusarium oxysporum* (KU671032.1)بعد 12 يوم من التحضين على 30°م باستخدام مخلف كسر الأرز ومحتوى رطوبة 60% وحجم لقاح3ملل من معلق الجراثيم ودرجة حموضة 5 وتحضين في الظلام التام وفطر *Aspergillus penicillioides* (MT594382.1) بعد 12 يوم من التحضين على 25°م باستخدام مخلف كسر القمح ومحتوى رطوبة 60% وحجم لقاح3ملل من معلق الجراثيم ودرجة حموضة 6 وتحضين في الضوء الأحمر بينما فطر *Trichoderma lixii* (MW805725) بعد 12 يوم من التحضين على 30°م باستخدام مخلف قوالح الذرة ومحتوى رطوبة 60% وحجم لقاح 4ملل من معلق الجراثيم ودرجة حموضة 6 وتحضين في الظلام التام.