13

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Effect of Rice Straw Application on Water Quality and Microalgal Flora in Fish Ponds

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THE PRESENT experiment was conducted to assess the effects of decomposing rice straw on algal flora as well as physical, chemical, and biological-parameters of 9 earthen fish ponds of 2100m^3 for each with one-meter average depth. It was conducted for 6 months using three treatments. Each pond was stocked with 6000 fish fries of Nile tilapia (*Oreochromis niloticus*). Results showed that water quality decreased with increased loading rates of rice straw. Most of water quality parameters including EC, TDS, total alkalinity, total phosphorus, NO_3, NO_2, chlorophyll *a*, and pH were significantly lower in rice straw treatments than control. Total ammonia, Secchi disc visibility and orthophosphate were significantly higher with increase rice straw loading than control.

Cyanophyceae constituted the dominant algal group at the initial phase at all examined ponds. This dominance remained stable in control ponds by the end of experiment. In contrast, in the final stage of the experiment *Chlorophyceae* and *Bacillariophyceae* dominate in T2 and T3 treatments compared with control. The results of this work illustrated that the decrease of algal count was related to action of allelochemicals discharged from rice straw aqueous extract leading to suppress growth of some algal species. Hence, this technique is a way to reduce the cost and reduce the use of herbicides, by providing natural compounds that can be obtained from agricultural waste.

Keywords: Rice straw, Water quality, Microalgae flora, Fish pond.

Introduction

Fish aquaculture systems have been created basically to serve nourishment security for the people in developing nations. To fulfill these requests, aquaculture has been experiencing enhancement of cultured species and heightened of culture systems (Shahabuddin et al., 2012). Improvement of low-cost technologies and their application to current cultivating methods would aid in improving aquaculture production. For long time fish farmers have increased their production by fertilizing their fish ponds through utilizing inorganic fertilizers which leads to eutrophication. Numerous technologies have been applied to avoid eutrophication of water bodies, like ultrasonic treatment, adjusted biochar, chemical algicides and invasive aquatic plant (Broekman et al., 2010; Jancula & Marsalek, 2011 and Chen & Pan, 2012). Although these strategies are valuable, they are related with high costs and secondary pollution.

Rice produces huge amounts of residues. In Egypt, with increasing the demand on rice grains to meet the rapidly growing population leaving large amount of rice straw, which from the standpoint of health and environmental pollution is considered one of the most agricultural critical problems in rice producing countries (FAO, 1982). Recently, several studies have been carried out on the allelopathic phenomenon of rice and some encouraging results have been achieved (Carmichael & Boyer, 2016). It was found that covering fish ponds by biodegradable materials like rice straw other than being cost-effective, it diminishes the clay turbidity (Lin et al., 2000 and Yi et al., 2003) and favor the development

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of microbes (Van Dam et al., 2002 and Mridula et al., 2003, 2005) that upgrade the fish culture. Rice straw has a potential effectiveness toward treating wastewaters driving to improve their water characteristics for using in different purposes, particularly aquaculture (Shahabuddin et al., 2012 and Al nagaawy et al., 2013). In this way, use of rice straw must be one of the leading alternative choices for water quality improvement and microbial generation. Increased loading of rice straw can cause oxygen exhaustion and may lead to fish's death (Keshavanath et al., 2001 and Van Dam et al., 2002).

Allelopathic impacts of aquatic macrophytes has acquired expanding consideration as eco-friendly and promising choices for controlling harmful algae blooms (Zak & Kosakowska, 2016). The inhibitory impact of macrophytes on algal species of diverse phyla have been examined, most of these studies detailed that cyanobacteria are more delicate to macrophyte allelochemicals compared to other algal groups (Mohamed, 2017). Numerous allelochemicals, compounds such as phenolic acids, aromatics, terpenes, and flavonoids, have been distinguished in rice straw watery extract (Huang et al., 2008). Most of the allelochemicals recognized in rice straw are phenolic compounds as coumaric, vanillic, ferulic, hydroxy benzoic, salicylic, syringic and benzoic-acids (Inderjit et al., 1995 and Chung et al., 2001). The discharge of these phenolic compounds into the water from decay of rice straw plays a significant part in the limitation of phytoplankton growth (Pillinger et al., 1994; Inderjit et al., 1995 and Ridge & Pillinger, 1996). Park et al. (2006) mentioned that rice straw extract ranged from 0.01 to 10mg/L appeared allopathic action to *Microcystis aeruginosa*. They also mentioned that the suppressive action was related to the synergistic impacts of different phenolic compounds in rice straw. The growth inhibition of *M. aeruginosa* utilizing rice straw may have suggested it as a potential biomaterial to control of algae in eutrophic water.

Barley straw was confirmed to control algal growth (Spencer & Lembi, 2007 and Wu et al., 2016). But few researches have been done to investigate the potential of utilizing rice straw to enhance water quality, algal control and improve fish generation. It has huge potential to be used for controlling water quality, phytoplankton generation. Regardless, little investigate has been conducted to check the physical, chemical, and natural changes caused by rice straw in fish ponds. Hence, we considered the effective role of barley straw in control of algal growth to test the allelopathy of rice straw on algae. The present study aimed to evaluate the effect of rice straw on water quality profile, phytoplankton abundance, community structure and to optimize the loading of rice straw to fertilized fish ponds.

Materials and Methods

Field application of rice straw

An experiment was conducted from April to October 2015 in 9 earthen fish ponds of 2100m^3 per one with one-meter average depth at Aquaculture Research Central Lab., Agricultural Research Center, Abbassa, Abo Hammad, Sharkia, Egypt. In three replicates, treatment include control free of rice straw (T1), 100kg rice straw/faddan (T2) and 150kg rice straw/faddan (T3), each pond was stocked with 6000 fish fries of Nile tilapia (*Oreochromis niloticus*). Just before application of the straw, all ponds were evaluated for phytoplankton biomass as initial. Monthly, water samples were collecting from five spots in each pond between 8.00 and 9.00am at a depth of 20cm below the water surface and mixed together in a plastic container according to Boyd (1990). Water parameters in concern pH, temperature, electrical conductivity, total ammonia, and Secchi disc visibility, were *in situ* measured. Other water samples were taken to the laboratory for further analysis for total alkalinity, total hardness, total phosphorus, NO_3, NO_2, dissolved orthophosphate and chlorophyll *a* content were determined spectrophotometrically according to Boyd (1990). 500ml of water samples were collected from the different sampling sites and taken to the laboratory in polyethylene bottles. The samples were preserved according to APHA (1985) for phytoplankton flora examination (identification and counting). Cell numbers was counted by a hemocytometer under a light microscope. All colonial, filamentous and unicellular organisms were counted as one unit according to Prescott (1962, 1978).

Statistical analysis

Data were statistically analyzed by one-way analysis of variance (ANOVA) and regression using SPSS statistical software. Tukey multiple comparison test was used to find the difference. Differences were considered significant at an alpha level of 0.05 ($P< 0.05$). All means were given with ±1 standard error (SE).

Results and Discussion

Effects of rice straw on water quality

Water quality of experimental treatments are presented in Table 1. Water temperature plays an important role in the distribution and productivity of phytoplankton. It is one of the most effective environmental factors affecting both the metabolism and growth of fish and phytoplankton (Weatherley & Gill, 1983 and Herzing & Winkler, 1986). The results showed that there is no significant difference between temperature degrees during the experiment time in all treatments, it was reached about 27.5°C. Water temperature of the present study was in favorable range for growth of phytoplankton according to Alabaster & Lioyd (1982). In fish ponds, plankton is usually the major source of turbidity, so, Secchi disk visibility has often been used to estimate plankton density (Almazan & Boyd, 1978). Average values of Secchi disk was 17.52cm in T2, 17.6cm in T3 and 12.57cm in T1. There were significant differences between T1 and T2, T3, which may be attributed to the increased algal density. Similar findings were speculated by Elnady et al. (2010 b). Water pH depends on some factors such as atmospheric carbon dioxide, events or disturbances in the watershed, and human activities (DWAF, 1996 a). In the present study, pH values of all treatments were at the alkaline side, the highest pH value (8.99) was in control ponds. This can be attributed to the increase in primary productivity of algal population, which leads to increase of photosynthesis that involves the uptake of free carbon dioxide from water and precipitation of calcium carbonate, which agree with (El-Wakeel & Wahby, 1970 and Boyd, 1990). When phytoplankton community grows well, carbon dioxide is used in huge amounts in photosynthesis, leading to elevation of water pH (Boyd & Scarsbrook, 1974 and Arce & Boyd, 1975). Electric conductivity was slightly differed from treatment to other during treatment period the same trend was observed in total dissolved solids. The highest values of these parameters were in control ponds (T1). The observed result showed that the lowest total alkalinity values were in rice straw treated ponds (T2 and T3) this may be due to the consumption of bicarbonate ions by heterotrophic bacteria (Krishnani et al., 2006), while increase of total alkalinity values in control ponds may be attributing to increase in photosynthetic activity of algal population (Raina et al., 2013). Total phosphorus values in Table 1 revealed that there was a significant difference between T1 and (T2, T3), where T1 has the highest value (0.47mg/L), this may be attributed to the increase of phytoplankton community. The obtained results indicated that there is a close correlation between total phosphorus and phytoplankton growth. Similar results were previously reported by Dassenakis et al. (1997), Saker et al. (1999), Saeed (2000) and Elhagry (2012). The nutrient levels increased due to the release of stored nitrogen and phosphorus contents during algal decay and this result agrees with Padmavathi & Durgaprasad (2007). On the contrary, in T1 (0.01mg/L) orthophosphates was the lowest significant value and in T3 and T2 (0.03 and 0.02mg/L, respectively) were the highest significant value, this may be attributed to the decrease in phytoplankton community in treated ponds than in control ponds. Nitrate content of water is an index of the productive capacity of water. Fayed & Shehata (1980) and Kobbia (1982) revealed that in absence or deficiency of nitrate, phytoplankton population growth decreased. The obtained nitrate concentrations results were in the recommended range by the DWAF (1996 b), which stated to be below 300mg/L. Nitrite is the medium form between ammonia and nitrate and remains only in medium with very little oxygen because they tend to oxidize to nitrates in oxygenated water (Arrignon, 1999). Since aquatic vegetation generates large amounts of oxygen, the medium is favorable for a rapid transformation of this salt to nitrate the most stable form of dissolved nitrogen in water. These results are consistent with the previous results of Elnady et al. (2010 a). Nitrite concentrations of all ponds were in safe site according to Meade (1989) who mentioned that NO_2 concentrations lower than 0.1mg/L is considered safe concentration for soft water species. DWAF (1996 b) which recommended 0-0.05mg/L as a safe range for NO_2. Ammonia has the second rank after oxygen in importance in water quality assessment. This is because ammonia is toxic to fish if it accumulates and its toxicity increases as temperature and pH of the water increase. Planktonic algae uptake and assimilate ammonia thereby reducing the amount of ammonia, so the problem of ammonia toxicity to fish is more prevalent in absence of phytoplankton flora (Mustapha & Akinshola, 2016). The present results in Table 1, showed that total ammonia (0.49mg/L) increased in ponds treated with rice straw accompanied with reduction of phytoplankton community which may be ascribed to ferment of dead cells in agreement with (Brown & Gratzek, 1980), but these values in secure side. The harmful levels for unionized ammonia ordinarily lie between 0.6 and 2.0mg/L for fish ponds (Robinette, 1976).

TABLE 1. Effect of different treatments on water parameters during the experiment.

	T1 (control)	T2	T3
Temperature (ºC)	27.53^{a}±0.5	27.49^{a}±0.8	27.48^{a}±1
Secchi disk visibility (cm)	12.57^{b}±1	17.52^{a}±3	17.6^{a}±2
pH	8.99^{a}±0.3	8.46^{b}±0.3	8.49^{b}±0.3
Electric conductivity (EC)	438.57^{a}±17	428.1^{ab}±10	424.05^{b}±12
Total dissolved solids (TDS)	313.38^{a}±15	302.71^{b}±8	299.71^{b}±5
Total alkalinity (mg/L)	226.43^{a}±13	219.05^{b}±6	218.33^{b}±3
Total phosphorus (mg/L)	0.47^{a}±0.009	0.24^{b}±0.009	0.24^{b}±0.009
Orthophosphate (mg/L)	0.01^{b}±0.001	0.02^{a}±0.001	0.03^{a}±0.001
Chlorophyll *a* (µg/L)	375.46^{a}±19	180.57^{b}±10	170.14^{b}±7
NO_3 (mg/L)	0.3^{a}±0.005	0.2^{b}±0.005	0.2^{b}±0.005
NO_2 (mg/L)	0.02^{a}±0.001	0.02^{a}±0.001	0.02^{a}±0.001
Total ammonia (mg/L)	0.21^{b}±0.4	0.49^{a}±0.6	0.49^{a}±0.5

Values are mean±SE, mean values with different superscript letters in the same row were significantly different ($P< 0.05$).

Chlorophyll *a* content in Fig. 1, was higher in control ponds 375.46µg/L than T2 (180.57) and T3 (170.14), this mean that there was a positive correlation between chlorophyll *a* content and algal density and inverse correlation with Secchi disk readings in the examined ponds. This agrees with Abdel-Mageed (1997) and Ibrahim (1997).

In this study, as revealed in Fig. 2 phytoplankton density of all the treatments was generally low at the initial phase of the culture period. T1 (control) had the highest phytoplankton number and gradually increased through time increasing over the experimental period.

Effects of rice straw on microalgal flora

It is well-known that the change in physicochemical characteristics of water body leads to concomitant quantitative changes in phytoplankton abundance (Abel, 1998). Phytoplankton identified during this study composed of four divisions with 21 genera, which are: 16 of *Chlorophyta*, 5 of *Cyanophyta*, 8 of *Bacillariophyta*, and 2 of *Euglenophyta* (Table 2 and Fig. 3). At the initial culture phase of experimental study, *Cyanophyceae* had the highest value with 59.6% of the total algal population, followed by 28.94% *Bacillariophyceae*, 7.68% *Chlorophyceae*, and 3.75% *Euglinophyceae* in control pond. Towards the end of the experiment, *Cyanophyceae* was more dominated with 88% of total algae, followed by 7.74% *Chlorophyceae*, 3.06% *Euglinophyceae* and 1.18% *Bacillariophyceae* (Fig. 3). Consistent with Lancaster & Drenner (1990) results, our study in control ponds (T1), without the allelochemicals compounds distinguished in rice straw watery extract, recorded increase in the species composition and relative abundances of *Cyanophyta*, as well as decreases in *Bacillariophyta*. Cyanobacteria more delicate to macrophyte allelochemicals compared to other algal groups (Mohamed, 2017).

On the other hand, at the beginning of the study, microalgal population percentage of rice straw treated ponds (T2 and T3) revealed that *Cyanophyceae* had the highest algal density (57.27% and 55.07%, respectively) followed by *Chlorophyceae* (19.48% and 18.51%, respectively), *Bacillariophyceae* (20% and 23.48%, respectively) and *Euglinophyceae* (3.19% and 2.91%, respectively) respectively. While, at the end of the experiment, *Chlorophyceae* was noticeably dominate and formed (43.27% and 54.07%, respectively) of total algal composition, whereas *Cyanophyceae*, *Bacillariophyceae* and *Euglinophyceae* were constitutive of (19.69%, 20.53% and 29.08%, 17.88% and 7.94% and 7.49%, respectively) of algal composition for T2 and T3 (Fig. 3). *Cyanophyceae* constituted the dominant algal group at the initial phase of the culture period. This dominance remained stable in control ponds (T1) by the end of experiment. In contrast, algal dominance in both rice straw treatments (T2 and T3) changed to *Chlorophyceae* towards the end of the experiment. Paerl & Tucker (1995) defined that *Cyanophyceae* are organisms that have slow growth rates, thus, their sensitivity to the rice straws could probably be more than the other classes of algae. Nevertheless, this nature cannot generalize to all species of Cyanobacteria. Houman

(2010) on laboratory bioassay showed resistance of *Oscillatoria* to the barley and rise straw extracts. There is an increase in *Bacillarophyceae* in rice straw treatments (T2 and T3) over the control during July to the end of the experiment. This result agrees with Ridge et al. (1995) which expressed diatoms as a group of algae may not be inhibited by barley straw also may be attributed to presence rice straw which contain silica where the silica is considered the limited growth factor for diatoms (Chakraverty & Kaleemullah, 1991).

Cyanobacterial blooms have increased in most freshwater systems because of increasing freshwaters eutrophication (Van Ginkel et al., 2000 and Xie & Liu, 2001). The shift in algal composition of treated ponds from Cyanobacteria to green algae might be useful in control of toxic Cyanobacterial species such as *M. aeruginosa* (Geng et al., 2006 and Wu et al., 2007), *Anabaena flos–aquae* (Spoof et al., 2006 and Osswald et al., 2007) and *Aphanizomenonflos–aquae* (Yamamoto & Nakahara, 2005 and Preussel et al., 2006). Thus, it provides important information that rice straw could be used as a management strategy for improvement of water quality in water bodies with history of Cyanobacterial blooms.

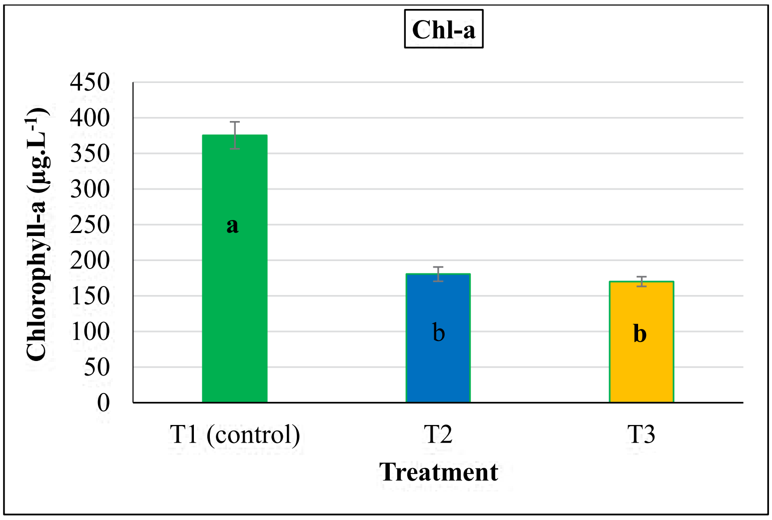

Fig. 1. Effect of rice straw on chlorophyl *a* content of microalgal flora in different treated fish ponds at the end of experiment period [Values are mean±SE, n= 3, P< 0.05. The Labeling different letters indicate significant differences].

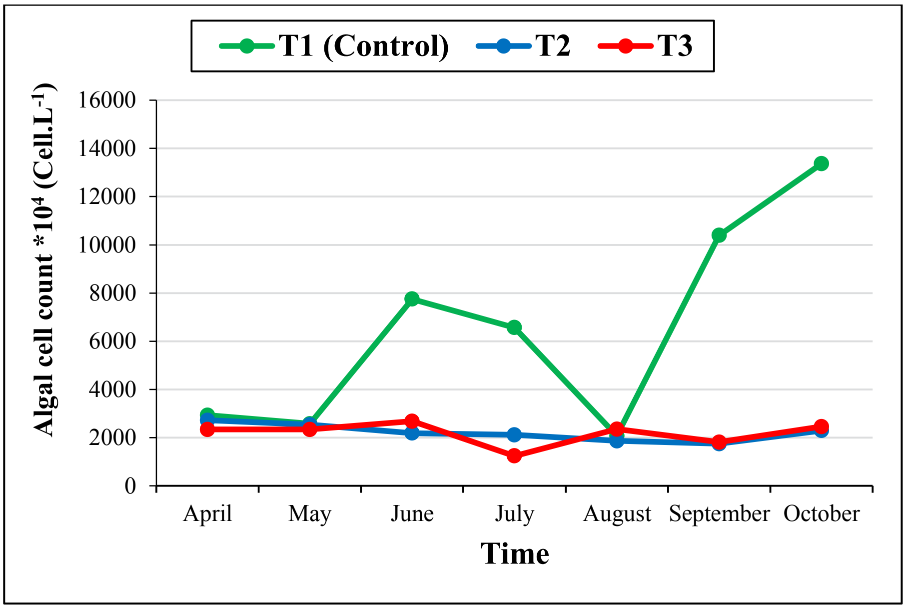

Fig. 2. Effect of rice straw on total count (organism/L) of microalgal flora in different treated fish ponds during the study period.

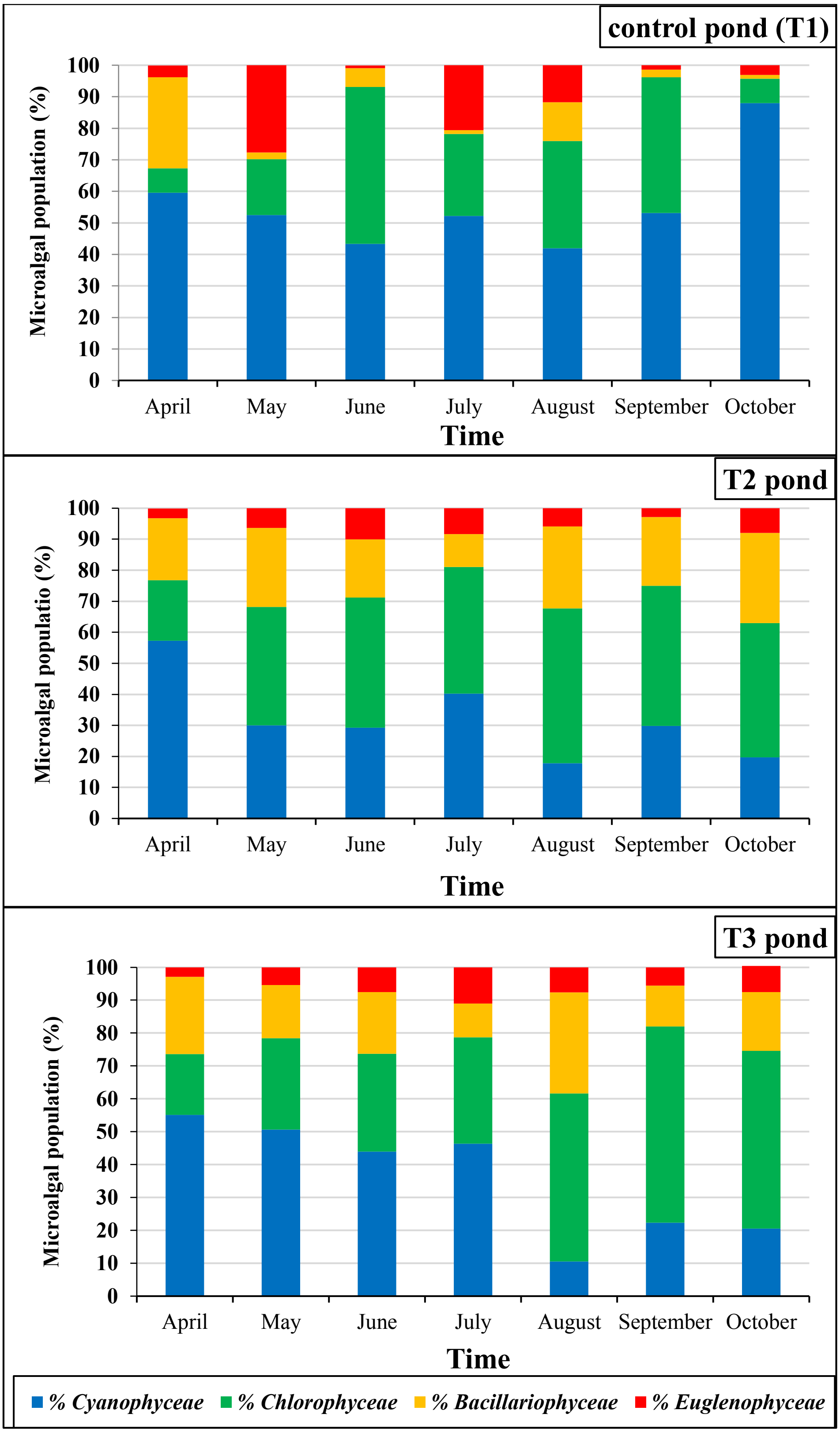

Fig. 3. Effect of rice straw on percentage composition of microalgal flora in fish ponds (T1, T2, T3) during the study period.

TABLE 2. Impact of rice straw on algal flora distribution in aquaculture fish ponds (cell/L*10^4).

	T1							T2							T3						
	April	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**April**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**April**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**
Cyanophyceae																					
Anabaena	1286	1136	2196	49	27	43	11	987	327	125	11	47	33	-	1171	769	654	53	36	29	-
Mersmopedia	252	22	55	66	-	25	-	100	141	57	121	36	34	-	114	-	38	-	38	10	19
Microcyists	-	45	105	2124	555	4281	11223	167	20	177	120	138	231	326	-	172	47	160	149	308	207
Gomphosphearia	-	149	975	974	204	1172	-	304	271	268	493	99	199	103	-	241	438	320	12	57	267
Pleurocapsa	206	-	-	66	82	-	3	-	-	-	51	-	-	-	-	-	-	25	-	-	-
Chrococcus	-	-	30	149	-	-	526	-	-	13	54	12	24	22	-	-	-	14	13	-	11
%	**59.6**	**52.5**	**43.4**	**52.2**	**41.9**	**53.1**	**88**	**57.3**	**30**	**29.3**	**40.3**	**17.8**	**29.9**	**19.7**	**55.1**	**50.6**	**43.9**	**46.3**	**10.5**	**22.3**	**20.5**
Chlorophyceae																					
Chlorella	22	22	793	199	22	356	45	263	238	229	274	191	437	330	22	149	212	11	342	622	340
Cloesterium	22	68	81	-	-	482	-	22	-	-	-	-	-	-	-	57	12	-	-	9	-
Cosmarium	-	45	739	158	32	400	-	20	-	24	-	-	54	11	137	57	88	53	-	101	-
Kirchneriella	69	-	-	-	-	22	-	67	22	24	51	36	46	-	-	-	27	-	-	20	-
Monoraphidium	-	-	-	15	22	101	-	13	-	58	18	35	ND	11	22	57	25	20	49	19	77
Scenedesmus	45	114	379	25	57	46	1	56	74	156	166	122	111	25	160	57	140	67	85	82	45
Tetradron	45	22	400	212	68	568	75	56	-	82	82	84	76	34	91	11	115	39	-	62	22
Cruciginia	-	-	-	-	-	26	-	33	-	14	15	12	22	-	-	-	-	8	41	68	11
Pediastrium	22	-	-	-	11	453	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-
Dictyosphaerium	-	183	1387	788	259	856	903	-	539	200	59	-	-	271	-	252	83	148	255	76	511
Palmellococcus	-	-	-	-	-	400	-	-	45	86	-	-	-	-	-	-	-	-	-	-	-
Trochiscia	-	-	27	30	96	68	11	-	47	30	30	61	-	75	-	-	65	-	24	11	11
Sturastrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-
Tetrastrum	-	-	47	-	-	-	-	-	-	14	-	-	-	-	-	-	31	-	-	11	-
Protococcus	-	-	-	279	137	644	-	-	-	-	166	386	41	234	-	-	-	54	395	-	310
%	**7.7**	**17.6**	**49.7**	**26**	**34**	**43.1**	**7.7**	**19.5**	**38.1**	**41.9**	**40.8**	**49.8**	**45.1**	**43.3**	**18.5**	**27.9**	**29.8**	**32.4**	**51.1**	**59.7**	**54.1**
Bacillariophyceae																					
Syndra	367	-	-	-	-	-	-	181	-	-	-	-	-	-	229	-	-	-	-	-	-
Navicula	68	-	34	-	11	-	17	123	16	29	76	-	-	11	91	11	22	-	12	-	22
Nitzishia	45	-	14	-	-	-	-	221	134	-	-	99	22	-	45	80	-	8	-	-	-

TABLE 2. Cont.

	T1							T2							T3						
	April	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**April**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**April**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**
Tabillaria	-	-	-	-	-	-	-	20	-	-	-	12	-	-	-	-	-	-	-	-	-
Biddulphia	367	57	415	-	149	178	142	-	480	380	59	80	238	551	183	287	424	69	153	76	330
Cyclotella	-	-	-	9	84	-	-	-	15	-	75	279	101	82	-	-	46	36	521	99	65
Cymatopleuria	-	-	-	71	11	69	-	-	-	-	-	-	13	-	-	-	12	14	11	11	-
Melosria	-	-	-	-	-	-	-	-	-	-	14	22	13	22	-	-	-	-	24	39	22
%	**28.9**	**2.2**	**6**	**1.2**	**12.3**	**2.4**	**1.2**	**20**	**25.5**	**18.7**	**10.6**	**26.5**	**22.2**	**29.1**	**23.5**	**16.2**	**18.8**	**10.3**	**30.7**	**12.4**	**17.9**
Euglenophyceae																					
Euglena	91	45	71	1199	243	108	356	87	146	139	135	109	49	160	68	22	22	114	169	101	111
Phacus	19	666	-	149	-	39	53	-	15	81	41	-	-	22	-	103	179	22	11	-	73
%	**3.8**	**27.6**	**0.9**	**20.5**	**11.7**	**1.4**	**3.1**	**3.2**	**6.4**	**10.1**	**8.3**	**5.9**	**2.8**	**7.9**	**2.9**	**5.4**	**7.5**	**11.0**	**7.7**	**5.6**	**7.9**

Treatments were (T1) control free of rice straw, (T2)100kg rice straw/faddan and (T3) 150kg rice straw/faddan

In the present study, there is a decrease in the count of *Microcystis* sp. cells in treated ponds over the control one during the period from July to the end of the experiment (Table 2). This result agrees with Wang et al. (2016) who reported a decrease in cell volume or slow growth of *M. aeruginosa* exposed to *Dracontomelon duperreanum* extract. Park et al. (2006) and Hua et al. (2018) reported that the growth of *M. aeruginosa* was limited by rice straw extract observantly suppressed the growth of algal cells in a concentration-dependent way. These results confirmed that rice straw aqueous extract may act as an algistatic agent. This action was due to the synergistic impacts of different phenolic compounds within the rice straw comparable result was proved by Wen et al. (2014). There is an increase in *Scenedesmus* sp. cells count in treated ponds over the control one during the period from July to the end of the experiment, this result agrees with Martin & Ridge (1999). They observed significant growth stimulation of *Scenedesmus subspicatus* by the compound released during aerobically decomposition of barley straw extract. Dominance of *Synedra* sp. in all ponds during April may be due to low inorganic nitrogen concentrations. Lampert & Sommer (1997) found that the *Synedra* sp. at a low concentration of nitrogen it became a more productive species. While, appearance of *Melosira* sp. in treated ponds (T2 and T3) during August, September, and October (autumn) agrees with Mansour (2009) and this may be attributed to water turbulence where the diatoms dominate (Messyasz, 2002). The data obtained by Train & Rodrigues (1998) confirmed the greatest variety and abundance of diatoms in the spring and autumn seasons, but dominance of *Cyclotella* sp. during August in treated ponds may be related to high ammonia concentration and high nutrients salts (Abdalla et al., 1991 and Affan et al., 2005).

Some species as *Pleurocapsa, Chrococcus, Kirchneriella, Monoraphidium, Cruciginia, Pediastrium, Palmellococcus, Sturastrum Tetrastrum, Protococcus, Navicula, Cyclotella,* and *Cymatopleuria* were disappeared at certain periods and reappeared later (Table 2). These results are identical to those found in earlier studies of El-Abbassa fish ponds (El-Ayouty et al., 1994, 1999 and Ahmed et al., 2001). Generally, phytoplankton fluctuation may be temperature dependent (Goldman & Horne, 1983; Reynolds, 1984 and Boyd, 1990) and water chemistry (Lathrop, 1988 and Boyd, 1990). The dominance and the absence of some species may be controlled by nutrient and light competition (Tilman et al., 1982 and Kilham, 1984), sinking (Tilman & Kilham, 1976), and fish grazing (Lazzaro, 1987; Northcote, 1988 and Drenner et al., 1990). Fish impact on phytoplankton depends on both fish feeding and algal growth rates as well as the predatory pressure of fish on plankton density. The great diversity in the phytoplankton biomass and structure might be related to predation by zooplankton (Verity, 1986).

The antialgal compounds discharged by the straw are more forcing in avoiding algal growth than in algal death (Greenfield et al., 2004). It can prevent the new growth but cannot kill algae and Cyanobacteria already present in water. The straw does not bring immediate effects; however, it may give long-term impact (Drabkova, 2007). Previous researches have indicated the following four major mechanisms for inhibition of *M. aeruginosa* growth, including destruction of the internal structure of algae cells, antagonistic impacts on photosynthesis of algae, respiration of algae and enzymatic activities (Nakai et al., 2000; Leu et al., 2002 and Li & Hu, 2005).

Conclusion

The results of this work demonstrated that the decrease of algal density was directly related to activity of allelochemicals secreted from rice straw aqueous extract reacting with algal cells, suspending algal growth and causing cellular death. Therefore, this approach of utilizing rice straw to suppress algal blooms may be a way to diminish financial costs through decrease the use of harmful herbicides and offer an alternative sustainable technology for use feasible material from agricultural waste.

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تأثير تطبيق قش الأرز على جودة المياه والفلورة الطحلبية في أحواض استزراع الأسماك

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أجريت تجربة لتقييم آثار التحلل المائي لقش الأرز على الفلوره الطحلبية والقياسات الفيزيائية والكيميائية والبيولوجية لتسعة أحواض سمكية ترابية. وقد أجريت التجربة لفترة ستة أشهر باستخدام ثلاث معاملات (كنترول بدون قش الأرز ومعاملتان مختلفتان من قش الأرز) في أحواض استزراع البلطي النيلي (*Oreochromis niloticus*). وقد أوضحت النتائج أن جودة المياه قد تحسنت مع زيادة معدلات تحميل قش الأرز. معظم قيم قياسات جودة المياه مثل التوصيل الكهربي، الأملاح الكلية الذائبة، الفوسفور الكلي، القلوية الكلية، النترات، النيتريت، الكلوروفيل (أ)، ودرجة الحموضة كانت أقل في معاملات قش الأرز من الكنترول. وكان إجمالي الأمونيا، ودرجة العكارة، والأورثوفوسفات أعلى بشكل ملحوظ مع زيادة تحميل قش الأرز من الكنترول.

سادت الطحالب الخضراء المزرقة في بداية التجربة في جميع الأحواض الأستزراع السمكي بالتجربة واستمرت هذه السيادة في أحواض الكنترول فقط حتى نهاية التجربة. في المقابل، في المرحلة النهائية من التجربة، سادت الطحالب الخضراء والعصوية في معاملات T_2 وT_3. كما سجلت نتائج التجربة انخفاض عدد الطحالب والمرتبط بالتأثير الفسيولوجي المضاد للمواد الكيميائية المتحررة كمستخلص مائي لقش الأرز والتي تؤدي إلى تثبيط نمو الطحالب. وبالتالي، فإن هذه التقنية هي طريقة للحد من التكلفة والحد من استخدام مبيدات الأعشاب، من خلال توفير المركبات الطبيعية التي يمكن الحصول عليها من النفايات الزراعية.