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# Fungal species causing spoilage of marine fishes marketed in Saudi Arabia

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The low cost of fish in comparison to the cost of meat gives it a high advantage. However, the fungal contamination leading to spoilage of fish and causing public health hazard. This study aimed to survey and identify fungal spoilage species of some marine fish which marketed in Saudi Arabia. A total of one 160 samples from 8 types of fishes; Red sea Bream *"Pagrus pagrus"*, Rabbitfish *"Siganus rivulatus"*, Spanish mackerel *"Scomberomorous commerson",* Salmon *"Salmoniformes"*, Red mullet *"Mullus surmuletus",* Whiteleg shrimp *"Litopenaeus vannamei"*, Spangled emperor *"Lethrinus nebulosus"*, and Yellowfin hind *"Cephalopholis hemistiktos"* 20 fish from each fish type. Samples prepared and plated on PDA and SDA, incubated for 3-7 days/ 28±2°C and examined daily. Macroscopic and microscopic identified with lacto phenol cotton blue to detect fungal structures. Result revealed that; 33.1%, 5.1%, 14.5, 7.1%, 6.1%, 3.1%, 7.1%, 1.1.%, 5.1%, 2.1% and 12.5% from; *Aspergillus niger, Aspergillus flavus, Aspergillus carbonius, Aspergillus parasiticus, Aspergillus fumigatus, Aspergillus oryzae, Rhizopus oryzae, Alternaria alternaria, Penicillium* spp., *Candidia* spp. and *Saccharomyces* spp. respectively. 61.3% of the tested fish samples were carrying fungus species, the highest incidence of fungal spoilage were in; Salmon, Solider bream, Rabbitfish, Spanish mackerel, Whiteleg shrimp, Red mullet, Spangled emperor, and Yellowfin hind fish, respectively. More attention in fish rearing facilities, caution should be taken by consumers in preparation and applying perfect cooking in consuming fish and more education and efforts should be developed by fish farmers to avoid fishponds contamination. We recommended to further research should be done on fungal contaminations.

**Keywords: *Aspergillus* spp., *Penicillium* spp., *Saccharomyces* spp., Rabbitfish, Solider bream, Red mullet.**

## INTRODUCTION

The progressive increase in the world population requires a parallel increase in the sources of food, particularly the sources of proteins directed the attention to the search for other sources such as; fish and their by-products which fulfill all the desired requirement of human consumption, where fish has long been regarded as nutritive and highly desirable food due to its high quality of animal protein content, high phosphorus, calcium, and ß- complex vitamins. In addition to its least expensive value of fish as compared to the price of meat offers it a high advantage. The American Heart Association suggested uptake fish dishes not less than twice per week minimally in order to have the daily needed of omega-3 fatty acids. Moreover, its richness of iodine and fluorine that required development of teeth strength and prevent the goiter (El-Moselhy et al. 2014 and Mahmud et al. 2018).

The Red Sea is characterized by its beautiful fish in shape or, and delicious in taste it is impressive in its colors and distinctive forms.

There are many people who enjoy seeing these fish and savoring their taste. The average consumption of fish in Saudi Arabia is low, equivalent to 9 kg per person per year, while the Japanese person consumes 60 kg per year, and now there are awareness campaigns aimed at raising the awareness of the Saudi citizen about the importance of seafood and its reflection on human health and reaching the average global average of 18 kg Grams per capita per year. Saudi Arabia's aquaculture projects produce nearly 70,000 tonnes of fish, and the government is seeking to raise production to 600,000 tonnes by 2030 (Rahman et al. 2017).The continuous growing in population all over the world which increase the need to transport the fish from place to another, food preservation becomes necessary to extend its shelf life with its nutritional value, flavor and texture. Thus, increasing demand in development new techniques of food preservation to avoid microbial spoilage of food and saving the nutritional quality one third of all fruits and vegetables produced worldwide are lost due to spoilage (Ghaly et al. 2010).

Fish fungal contamination leading to spoilage of fish which detected by gradual development changes as; off flavor and unpalatable taste and it may constitute a public health hazard as well as many of economic losses. Moulds and yeasts comprise a large group of microorganisms which are widely distributed in nature and effect on the food supply as a result of their contamination. However, they are responsible for deterioration of a major portion of such food in developing countries (Atef et al. 2011).

*Aspergillus* spp., *Penicillium* spp. and *Saccharomyces* spp. are the most fish spoilage moulds. Aspergillus species consist of; *Aspergillus niger, Aspergillus flavus, Aspergillus carbonius, Aspergillus parasiticus, Aspergillus fumigatus, Aspergillus oryzae* (CODEX Alimentarius, 2009).

The fish spoilage may caused by the fungus growth on fish, rotting, discoloration, changes the textural and flavour quality of fish and leading to decrease the nutrient quality in addition to the big economic loss. Fungal growth mainly influenced by moisture, nutrients, pH, temperature, relative humidity, salt concentration and water activity during storage (Ahvenainen, 2003).

The main demerit of fish is it spoils very rapidly after catching due to the relatively high moisture content and high degree of unsaturated fatty acids in fish accounts for its perishability either during processing or storage and is the suitable medium for increasing in micro-organisms after catching (Ojutiku et al. 2009). According to Da Silva et al. (2008) the water content in fish affects the chemical and microbiological stability, processing, storage and distribution of fish. Almost fish species damaged as a result of digestive enzymes, oxidation and fungal spoilage from surface (AMEC, 2003).

During spoilage, there is a breakdown of various components and formation of new compounds such as; ketone, aldehyde etc, which are responsible for the changes in odour, flavor and texture of the fish meat. This problem leads to short shelf life and economic loss (Ghaly et al. 2010).

There was a surveillance shortage in fish spoilage fungus species in marine fish generally and marketed fish species in Saudi Arabia especially, that encouraging us to perform this study which aimed to survey, isolation and identification fungal spoilage species of some marine fish from Saudi Arabia markets.

## MATERIALS AND METHODS

### 2.1. Study area, collection of samples

A total of 160 samples from eight types of fishes; Rabbitfish ***"****Siganus rivulatus"*, Red sea Bream *"Pagrus pagrus"*, Red mullet *"Mullus surmuletus",* Spangled emperor *"Lethrinus nebulosus"*, Spanish mackerel *"Scomberomorous commerson",* Salmon *"Salmoniformes"*, Whiteleg shrimp *"Litopenaeus vannamei"*, and Yellowfin hind *"Cephalopholis hemistiktos"*, 20 fish from each fish type. samples of different types of marine fish samples collected with aid of fish Saudi Arabia aquaculture authority; about 150g/fish packaged in polyvinyl chloride films and transferred within several minutes after collection to an ice box container; aseptically handled and moved promptly to Faculty of science, University of Jeddah, on one of the postgraduate microbiology laboratory.

### 2.2. Examination of samples

Collected samples were prepared aseptically according to the technique recommended by (USDA, 1999). 25 grams of the sample were transferred into a sterile plastic bag of the stomacher (Seward laboratory services, 400R Auckland) then 225 ml. of sterile 0.1% peptone water were added. The 2 minutes stomached sample was adequately dispersed to provide the homogenate; which represent the dilution of 1:10 ($10^{-1}$) and plated in triplicate over plates containing on different culture media Potato

Dextrose Agar (PDA) medium incubated for 3-7 days/ 28±2°C and examined daily. Macroscopic identification made by observing the colony colour and texture then prepared slides with lacto phenol cotton blue to detect fungal structures covered with a cover slip, identified microscopically according to the morphology of colony and spores.

### 2.3. Statistical analysis

The statistical program, SPSS version 16 for window, was used for determination of means, standard error and analysis of variance (ANOVA) using the one way (mean at significance level of (*P<0.05*). Statistical significance was tested at the 5% level of significance in this study.

## RESULTS

### 3.1. Phenotyping of fungal genera isolated from different fish species samples

Figure (1) declared the macroscopic and microscopic features which detected from different fish *spp*. samples as following: Pictures from 1-6 groups revealed the different *Aspergillus spp.* which were; *Aspergillus niger, Aspergillus flavus, Aspergillus carbonius, Aspergillus parasiticus, Aspergillus fumigatus* and *Aspergillus oryzae; Aspergillus niger* represented on figures in group 1; ($1_a$ & $1_b$) declared the morphological feature in front and the inverted side of the colonies on PDA plate which appeared as compact white basal colonies covered by condense black layer conidial heads which enlarged and roughen with maturity. Meanwhile the microscopic feature of *Aspergillus niger* as single and aggregated colonies declared on ($1_c$ & $1_d$) which appeared as filamentous fungi resembling plant structure. A closer view reveal globose and black dark conidial heads of the fungus with dark spores. Group 2 morphological viewed of *Aspergillus flavus* macroscopically in front and on the inverted side of colonies on PDA plate in ($2_a$ &$2_b$) where colonies were yellow at the beginning and became flat, granular, and bright to dark yellow green with radial grooves by time. ($2_c$ & $2_d$) showed the microscopic *Aspergillus flavus* single and aggregation pale yellowish-green colonies with radiated coarsely roughened wall of conidial heads with loose columns. Morphological feature of *Aspergillus carbonius* represented on group 3; ($3_a$ & $3_b$) which declared the in front and the inverted side of colonies on PDA plate as compact yellow basal colonies covered by powdered black layer conidial heads which radiated and roughen with age. Meanwhile the microscopic feature of *Aspergillus carbonius* as single and aggregated colonies of the plant like filamentous fungi on ($3_c$ & $3_d$) were globose as brownish-black conidial heads with dark spores with rough margin. Group 4 morphological viewed of *Aspergillus parasiticus* macroscopically in front and behind of the colonies on PDA plate in ($4_a$ & $4_b$) where colonies were spherical, rough dark green to brown, thick walls. ($4_c$ & $4_d$) showed the microscopic *Aspergillus parasiticus* single and aggregation dark orange yellow colonies. The morphological feature of *Aspergillus fumigatus* represented in group 5; the front and the inverted side of the colonies on PDA plate on ($5_a$ & $5_b$) many a suede-like, grey, blue-green colonies. The microscopic feature of *Aspergillus fumigatus* showed in ($5_c$ & $5_d$) as long chains Conidia, green color and finely roughened. Group 6 morphological viewed of *Aspergillus oryzae* macroscopically in front and on the inverted side of colonies on PDA plate in ($6_a$ & $6_b$) where rough colonies were blackish-yellow. ($6_c$ & $6_d$) showed the microscopic *Aspergillus oryzae* single and aggregation irregular, pale grey to black colonies with coarsely wall of conidial heads and short column.

Morphological feature of *Rhizopus oryzae* revealed on Figure (1) group 7 which viewed the macroscopic and microscopic features which detected from different fish *spp*. samples as following: Pictures group 7 revealed *Rhizopus oryzae* were; macroscopic in ($7_a$, $7_b$) from front and inverted side of the culture plates on PDA as white cottony which turned to yellowish-brown colonies. ($7_c$ & $7_d$) showed the greyish black smooth-walled, branched or simple stolons. Meanwhile morphological feature of *Alternaria alternaria* described in ($8_a$, $8_b$) as texture wooly to downy, olive brown to pale gray surface. ($8_c$ & $8_d$) showed the microscopic figures of the individually and as aggregation form of *Alternaria alternaria* as; septate, brown, ovoid with an elongated, solitary and/or chains. *Penicillium* spp. declared in group 9 macroscopically in ($9_a$, $9_b$) as; rapid growing woolly, velvety texture colonies. White color firstly turn to pinkish or yellow with white center or olive gray, ($9_c$ & $9_d$) described the microscopic figures of *Penicillium* spp. as; hyaline branched or simple conidia carrying cup-shaped phialides with brush-like clusters at the tips which known as “penicilli”. Group 10 presented *Candidia* spp. macroscopically in ($10_a$, $10_b$) as smooth, pasty, creamy, dull and wrinkled. The microscopic features of *Candida* spp. also appeared in ($10_c$ & $10_d$) as singly or in clusters, elongate or round in

shape. While, group 11-12; declared macroscopic *Saccharomyces* spp. in ($11_a$, $12_a$, $11_b$, $12_b$) from front and behind of culture plates on PDA as; creamy, rapidly growth colonies, moist, smooth, flat colonies. ($11_c$, $12_c$ &$11_d$, $12_d$) declared the microscopic figures of *Saccharomyces* spp. as; spherical or oval cells clusters.

### 3.2. Prevalence of different fungal species in examined fish samples

Figure (2) showed the detection percent of different fungus found in the fish samples as following; 33.1%, 5.1%, 14.5, 7.1%, 6.1%, 3.1%, 7.1%, 1.1.%, 5.1%, 2.1% and 12.5% from; *Aspergillus niger, Aspergillus flavus, Aspergillus carbonius, Aspergillus parasiticus, Aspergillus fumigatus, Aspergillus oryzae, Rhizopus oryzae, Alternaria alternaria, Penicillium* spp., *Candidia* spp. and *Saccharomyces* spp. respectively. The chart declared the highest fungal spoilage in fish were; *Aspergillus niger* followed by; *Aspergillus carbonius, Saccharomyces* spp., *Aspergillus parasiticus, Aspergillus oryzae, Aspergillus fumigatus, Aspergillus flavus, Penicillium* spp., *Rhizopus oryzae,* and *Candidia* spp. respectively while, the lowest detected incidence was in *Alternaria alternaria.*

### 3.3. Incidence of fungal species in different examined fish samples

Distribution of different fungal species detected from different tested fish species tabulated in table (1) as following; according to the numbers of fungal spoilage species, the highest incidence of fungal spoilage types were detected in; Salmon *"Salmoniformes",* Red sea Bream *"Pagrus pagrus"*, Rabbitfish *"Siganus rivulatus"*, Spanish mackerel *"Scomberomorous commerson",* Whiteleg shrimp *"Litopenaeus vannamei"*, Red mullet *"Mullus surmuletus",* Spangled emperor *"Lethrinus nebulosus"*, Yellowfin hind *"Cephalopholis hemistiktos"* respectively as following; Salmon *"Salmoniformes"* which had 10 types of fungal spoilage as following; 4 (20%) *Saccharomyces* spp., 2 (10%) in *Aspergillus fumigatus* & *Candidia* spp. while, 1 (5.0%) in *Aspergillus niger, Aspergillus flavus, Aspergillus carbonius, Aspergillus parasiticus, Aspergillus oryzae, Rhizopus oryzae* & *Alternaria alternaria*. All the examined Salmon *"Salmoniformes"* fish samples were not detected any Candidia spp. Red sea Bream *"Pagrus pagrus"* had 7 types of fungal species as following; 10 (50%) *Aspergillus niger,* 5 (25%) for *Aspergillus carbonius, Penicillium* spp., 3 (15%) *Aspergillus flavus, Saccharomyces* spp. followed by 1 (5.0%) *Aspergillus parasiticus, Rhizopus oryzae.* All the examined Red sea Bream *"Pagrus pagrus"* fish samples were not detected any *Aspergillus fumigatus, Aspergillus oryzae, Alternaria alternaria* and *Candidia* spp. Rabbitfish *"Siganus rivulatus"* fish samples recorded 5 types of fungal species which were; 13 (65%) *Aspergillus niger*, followed by 4 (20%) *Aspergillus carbonius* and 2 (10%) *Aspergillus parasiticus, Aspergillus fumigatus, Aspergillus oryzae.* While, all Rabbitfish samples were free from; *Aspergillus flavus, Rhizopus oryzae, Alternaria alternaria, Penicillium* spp., *Candidia* spp. and *Saccharomyces* spp. also, Spanish mackerel *"Scomberomorous commerson",* Whiteleg shrimp *"Litopenaeus vannamei"*, fish samples recorded 5 fungal species as following; Spanish mackerel had 4 (20%) *Aspergillus niger,* 3 (15%) *Saccharomyces* spp., 2 (10%) *Rhizopus oryzae* and 1 (5.0%) *Aspergillus carbonius* & *Aspergillus fumigatus.* Whiteleg shrimp, detected 5 fungal types as following; 3 (15%) *Saccharomyces* spp., 1 (5.0%) in *Aspergillus niger, Aspergillus carbonius, Aspergillus parasiticus, Aspergillus fumigatus.* Red mullet *"Mullus surmuletus",* Spangled emperor *"Lethrinus nebulosus"*, had 4 fungal spoilage species as following; Red mullet fish samples detected about 5 (25%) *Penicillium* spp. as highest result followed by; 2 (10%) *Aspergillus niger* and 1 (5.0%) *Aspergillus flavus* & *Aspergillus carbonius*. While, all Red mullet samples were not detected other tested fungal species. Spangled emperor detected about; 2 (10%) *Aspergillus parasiticus* & *Rhizopus oryzae* and 1 (5.0%) *Aspergillus niger* & *Aspergillus carbonius*. All Yellowfin hind *"Cephalopholis hemistiktos"* fish samples not detected any fungal species. Inaddition to that table (1) showed that about 61.3% of the total fish tested samples were carrying different types of fungus species, the arrangement of different fungal species detected from different tested fish species as following; the highest fungal species detected was *Aspergillus niger* as 32 (20%) followed by 14 (8.8%) *Aspergillus carbonius,* 13 (8.13%) *Saccharomyces* spp., 10 (6.3%) *Penicillium* spp., 7 (4.4%) *Aspergillus parasiticus,* 6 (3.8%) *Aspergillus fumigatus & Rhizopus oryzae.* 5 (3.1%) *Aspergillus flavus,* 3 (1.9%) *Aspergillus oryzae,* 2 (1.3%) *Candidia* spp. While, *Alternaria alternaria,* were the lowest incidence in the different fish tested samples as 1 (0.6%).

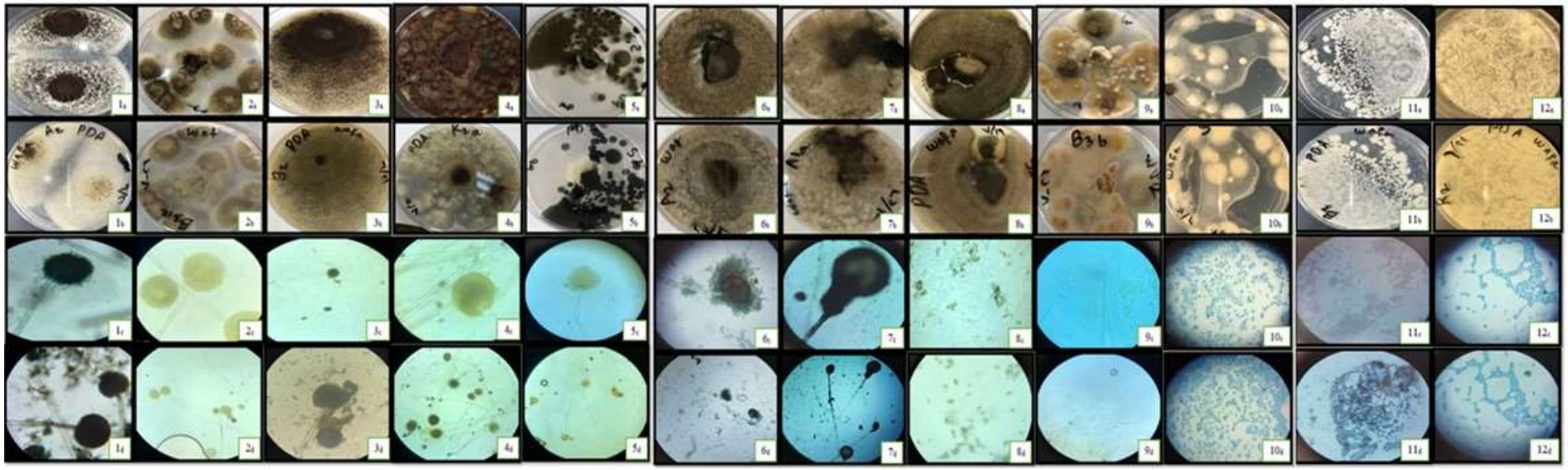

**Figure 1: Phenotyping of fungal genera isolated strains by macroscopic and microscopic features which detected from different fish *spp*. samples as following:**

1-Pictures from 1-6 groups revealed the different *Aspergillus spp.* which were;

*Aspergillus niger, Aspergillus flavus, Aspergillus carbonius, Aspergillus parasiticus, Aspergillus fumigatus* and *Aspergillus oryzae.*

2-Pictures group 7; declared macroscopic *Rhizopus oryzae* in ($7_a$, $7_b$) from front and behind the culture plates on PDA. While, ($7_c$ & $7_d$) declared the microscopic figures of the fungus individually and as aggregation form.

3-Pictures group 8; declared macroscopic *Alternaria alternaria* in ($8_a$, $8_b$) from front and behind the culture plates on PDA. While, ($8_c$ & $8_d$) declared the microscopic figures of the fungus individually and as aggregation form.

4-Pictures group 9; declared macroscopic Penicillium *spp*. in ($9_a$, $9_b$) from front and behind the culture plates on PDA. While, ($9_c$ & $9_d$) declared the microscopic figures of the fungus individually and as aggregation form.

5-Pictures group 10; declared macroscopic Candidia *spp*. in ($10_a$, $10_b$) from front and behind the culture plates on PDA. While, ($10_c$ & $10_d$) declared the microscopic figures of the fungus individually and as aggregation form.

6-Pictures group 11-12; declared macroscopic Saccharomyces *spp*. in ($11_a$, $12_a$, $11_b$, $12_b$) from front and behind the culture plates on PDA. While, ($11_c$, $12_c$ &$11_d$, $12_d$) declared the microscopic figures of the fungus individually and as aggregation form.

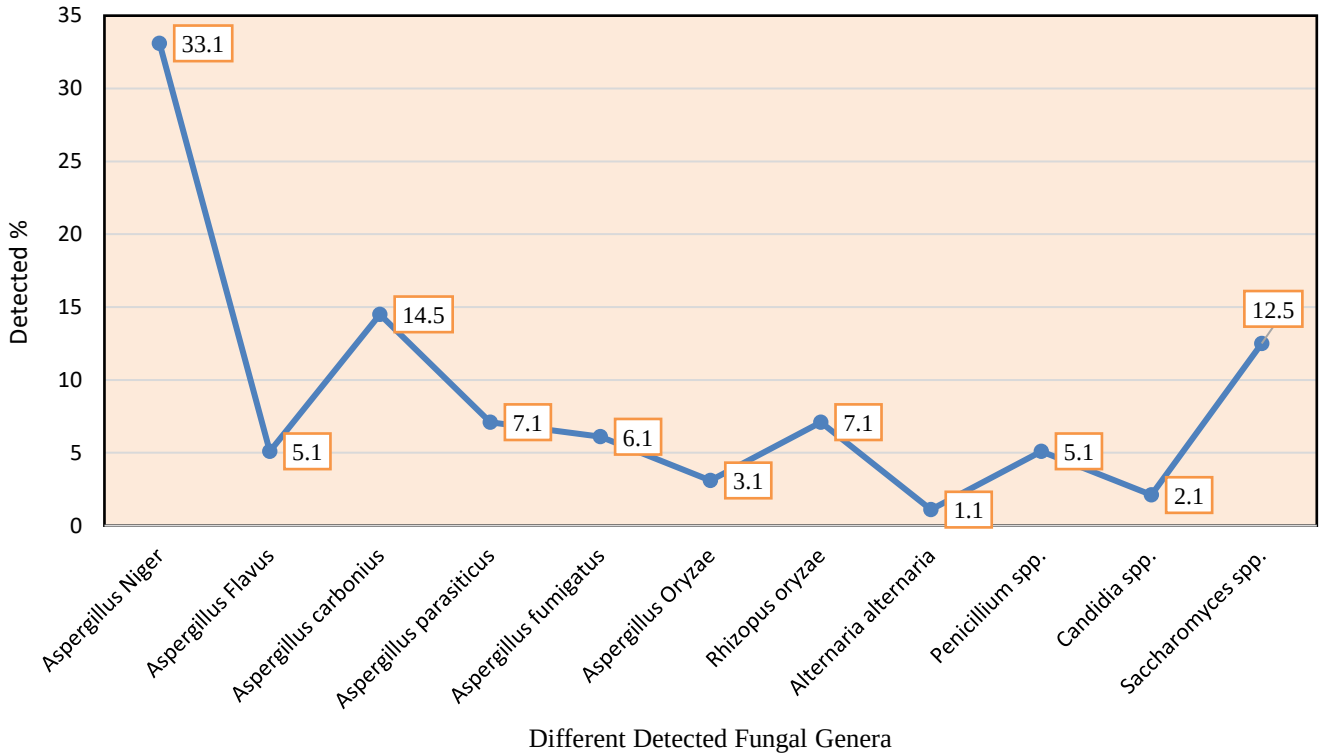


**Figure 2: Prevalence of different fungal genera in examined fish samples**

**Table 1: Incidence of Fungal Species in Different Examined Fish Samples**

| Types of Fish | Fungus Types | | | | | | | | | Yeast Types | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Aspergillus species* | | | | | | *Rhizopus oryzae* | *Alternaria alternaria* | *Penicillium* spp. | *Candidia* spp. | *Saccharomyces* spp. |
| | *Aspergillus niger* | *Aspergillus flavus* | *Aspergillus carbonius* | *Aspergillus parasiticus* | *Aspergillus fumigatus* | *Aspergillus oryzae* | | | | | |
| Salmon *"Salmoniformes"* | *(%05) 1* | *(%05) 1* | *(%05) 1* | *(%05) 1* | *(%10) 2* | *(%05) 1* | *(%05) 1* | *(%05) 1* | *(%00) 0* | *(%10) 2* | *(%20) 4* |
| Red sea Bream *"Pagrus pagrus"* | *(%50) 10* | *(%15) 3* | *(%25) 5* | *(%05) 1* | *(%00) 0* | *(%00) 0* | *(%05) 1* | *(%00) 0* | *(%25) 5* | *(%00) 0* | *(%15) 3* |
| Rabbitfish *"Siganus rivulatus"* | *(%65) 13* | *(%00) 0* | *(%20) 4* | *(%10) 2* | *(%10) 2* | *(%10) 2* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* |
| Spanish mackerel *"Scomberomorous commerson"* | *(%20) 4* | *(%00) 0* | *(%05) 1* | *(%00) 0* | *(%05) 1* | *(%00) 0* | *(%10) 2* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%15) 3* |
| Whiteleg shrimp *"Litopenaeus vannamei"* | *(%05) 1* | *(%00) 0* | *(%05) 1* | *(%05) 1* | *(%05) 1* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%15) 3* |
| Red mullet *"Mullus surmuletus"* | *(%10) 2* | *(%05) 1* | *(%05) 1* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%25) 5* | *(%00) 0* | *(%00) 0* |
| Spangled emperor *"Lethrinus nebulosus"* | *(%05) 1* | *(%00) 0* | *(%05) 1* | *(%10) 2* | *(%00) 0* | *(%00) 0* | *(%10) 2* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* |
| Yellowfin hind *Cephalopholi" "s hemistiktos* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* | *(%00) 0* |
| Total | *160/32 (%20)* | *160/5 (%3.1)* | *160/14 (%8.8)* | *160/7 (%4.4)* | *160/6 (%3.8)* | *160/3 (%1.9)* | *160/6 (%3.8)* | *160/1 (%0.6)* | *160/10 (%6.3)* | *160/2 (%1.3)* | *160/13 (%8.13)* |

## DISCUSSION

The diversity of fungi genera isolated from the different fish samples showed in figure (1 & 2); the highest fungal spoilage in fish were; 33.1% *Aspergillus niger,* 14.5% *Aspergillus carbonius,* 12.5% *Saccharomyces* spp., 7.1% *Aspergillus parasiticus,* 7.1% *Rhizopus oryzae,* 6.1% *Aspergillus fumigatus,* 5.1% *Aspergillus flavus,* 5.1% *Penicillium* spp., 3.1% *Aspergillus oryzae,* 2.1% *Candidia* spp. and 1.1.% *Alternaria alternaria,* respectively. Nearly similar results reported by Greco et al. (2015) investigated the fish in Nigeria and found; *Aspergillus niger* (33.3%), *Apergillus flavus* (33.3%), *Penicillium* spp., (16.7%). A similar results detected by Adebayo-Tayo *et al.* (2012[a,b]) in their study on fishes. Atawodi et al. (2017) who found about 31.30% *Aspergillus* spp. and (8.0%) *Penicillium* spp. from farm fish in Nigeria. According to Abbas et al. (2015) *Aspergillus* spp, were the higher fungus prevalence in fish followed by *Rhizopus* spp. then *Saccharomyces* spp. while the lowest fungal prevalence recorded in *Alternaria alternate* (Jimoh et al. 2014). Similar microorganisms were investigated by Abolagba and Igbinevbo (2010) in fish sold in Benin metropolis. Higher results reported by Atef et al. (2011) who studied fish in Giza Governorate and isolated about; *Aspergillus niger* (36.6%). Furthermore, Odu, & Imaku, (2013) found In Brazil, aquaculture fish; *Aspergillus* genus as the most prevalent (57.0%), followed by *Penicillium* (12.84%) and *A. flavus* (60.66%) as the most prevalent species. In addition to, Iqbal & Saleemi, (2013) who investigated fungal infection in some commercial fish in Lahore Fish Farms and reported the following; *Aspergillus* spp. (78.5%), *Penicillium* spp. (3.5%). Adebayo-Tayo et al. (2012[b]) recorded that; *Aspergillus niger* was the most predominant (35.0%), followed by *Penicillium* spp. (30.0%), and *Rhizopus spp.* (20.0%). Lower results revealed by Samaha et al. (2015) who detected about *Asperigellus niger* (24%), *Asperigellus flavus* (20%), *Asperigellus fumigates* (16%), while, *Alternaria alternate* (12%), *Rhizopus spp*. (8%). Different results were found by Atef et al. (2011) who studied fish in Giza Governorate and isolated about (90%) Alternaria spp., followed by Penicillium spp., and Candida *spp*. (70.0% for each). *Aspergillus flavus* (66.6%). Food borne diseases are diseases resulting from ingestion of microorganisms, and toxins (Ghaware & Jadhao, 2015). The fungal contamination of fish may occur prior to; catching due to improper sanitation, using contaminating equipment, handling, manufacturing, distribution, storage, transportation and marketing of fish or through exposure to contaminated water (Vogel et al. 2001; Hassan et al. 2007; Iwamoto et al. 2010 and Amusan et al. 2010). Moulds can survive on harsh conditions and moisture content which encourages fungi attack and subsequent production of toxins (Edema et al. 2008 and Ayolabi & Fagade, 2010). Contamination of the fish may occur from food handlers and retailer who sell these items (Adebayo-Tayo et al. 2011[a,b]). According to Abolagba & Igbinevbo, (2010) about 50% of annual fish harvest goes to waste due to poor treatment, management and storage. In addition, the landing sites are usually far from markets and consumption points, which leads to large amount of economic, lose. In order to reduce the wastage and spoilage during periods of oversupply and to enhance long storage, it is necessary to adopt appropriate as well as affordable (Mahmud et al. 2018).

Distribution of different fungal species detected from different tested fish species tabulated in table (1) as following; according to the numbers of fungal spoilage species, the highest incidence of fungal spoilage types were detected in Salmon *"Salmoniformes",* Red sea Bream *"Pagrus pagrus"*, Rabbitfish *"Siganus rivulatus"*, Spanish mackerel *"Scomberomorous commerson",* Whiteleg shrimp *"Litopenaeus vannamei"*, Red mullet *"Mullus surmuletus",* Spangled emperor *"Lethrinus nebulosus"* and Yellowfin hind "*Cephalopholis Hemistiktos"*, respectively. Inaddition to that table (1) showed that about 61.3% of the total fish tested samples were carrying different types of fungus species, the arrangement of different fungal species detected from different tested fish species as following; the highest fungal species detected was *Aspergillus niger* as 32 (20%) followed by 14 (8.8%) *Aspergillus carbonius,* 13 (8.1%) *Saccharomyces* spp., 10 (6.3%) *Penicillium* spp., 7 (4.4%) *Aspergillus parasiticus,* 6 (3.4%) *Aspergillus fumigatus & Rhizopus oryzae.* 5 (3.1%) *Aspergillus flavus,* 3 (1.9%) *Aspergillus oryzae,* 2 (1.3%) *Candidia* spp. While, *Alternaria alternaria,* were the lowest incidence in the different fish tested samples as 1 (0.6%). However, there were shortage in research studying the food poisoning fungal contamination, especially in examined fish species but during our research we found nearly similar results reported by (Nunes, 2009 and Odu, & Imaku, 2013) who detected about 67% fungal contamination. Lower

results detected by Iqbal & Saleemi, (2013) who showed about 37.84% fungus growth colonies grew on fish. According to Greco, et. al. (2015) fungal contamination were only detected on 10.7% of the samples. On the other hand, higher results reported by Samaha, et. al. (2015) who detected about the predominant genera of the isolated mould from *Salmoniformes* were *Penicillium spp.* (44%) followed by *Asperigellus niger* (32%), *Asperigellus flavus* and *Asperigellus fumigatus* (16%), and *Asperigellus Terrus* (8%). The consumption of food contaminated with many members of the isolated fungi and their toxins may causing; induced food poisoning, hepatotoxicity, pulmonary infections, nephrotoxicity, hemorrhages, arthritis, neurotoxicity, osteomylitis, dermatitis, endocarditis, dermatitis, meningitis and eye infection, immunosppression and hormonal effects carcinogenic. However, those organisms can also contribute spoilage of fish with undesirable changes during storage which has public health significance (Iqbal & Saleemi, 2013).

## CONCLUSION

Fungal contamination in fish often are indicative of a serious problem in fish aquaculturing, All measures must be performed during handling, processing and different stages of preparing of human food to prevent the reach of mould and their toxins to safe the human health.

Fish pathogenic fungal infection affects the fish value and its flesh. More attention in fish rearing facilities must be paid to improve fish health. Hence, this study suggests that fish should be reared in uncontaminated water for human consummation. In addition, caution should be taken by consumers in preparation and applying perfect cooking in consuming frozen fish to be safe for consumption. More education and efforts should be developed by fish farmers to avoid fishponds contamination. We recommended to further research should be done on fungal contaminations associated with different fishpond water species and their implication on the fish or the immediate consumer(s).

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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## AUTHOR CONTRIBUTIONS

This study has been approved by the Animal Rights and Ethical Use Committee of Jeddah University and New Valley University. NTE: Corresponding author of the manuscript, study design, shared in laboratory examination, drafted and revised the manuscript, and data analysis. WB: Performed the laboratory examinations, photography, revised the manuscript. AA: shared in study design, revised the manuscript. All authors read and approved the final manuscript.



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