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Review Article

DIFFERENT TYPES OF DATES IN SAUDI ARABIA AND ITS MOST FUNGAL SPOILAGE AND ITS MOST PRESERVATION METHODS

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ABSTRACT

Date palm (*Phoenix dactylifera*) contains 12 of the 1500species that belong to the date palm family. Dates are rich in carbohydrates, vitamins, fiber, minerals and polyphenols and considered one of the most important commercial products of Saudi Arabia; Ajwa, Sukkari, Barni, Shalabi and sogea dates. Fungi play a significant role in safety and quality of stored food commodities such as; *Aspergillus* sp., *Penicillium* spp., *Rhizopus* spp., *Cladosporium* spp., *Sporobolomyces* spp. may grow on high-moisture dates, especially when harvested following rain or high humidity periods. There is several techniques for date fruit preservation such as; Refrigeration and Freezing, vacuum packaging, drying, smoking, sweet preservation, canning. Although there is advanced preservation methods of date fruit including; Ultrasound, (UV-light), High pressure homogenization (HPH), Membrane filtration Ultrafiltration (UF) and microfiltration (MF), Natural antimicrobials and Nanotechnology. It is important to improve the storage preservation techniques of date fruit, which maintain its nutritious value and extend its shelf life.

INTRODUCTION

Background

Date palm (*Phoenix dactylifera*) contains 12 of the 1500species that belong to the date palm family. It is a monocotyledonous perennial tree, which has been cultivated as an economical fruit tree in the arid and semi-arid regions (Al-Bulushi *et al*, 2017). Date palm is a fruit of the date palm tree, an evergreen tropical plant. It is mainly cultivated in KSA and Middle East. There are more than four hundred varieties of dates available worldwide. They are mainly produced in the hot deserts of Southwest Asia and North Africa, and are considered as one of the chief commodities in the market throughout the world (Mirza *et al*, 2019).

Dates are considered one of the most important commercial products of Saudi Arabia. There are estimated to be 21 million trees of around 400 different varieties spread throughout the different agricultural areas of the Kingdom (Kadum *et al*, 2018) which marketed as a high value confectionery in desert regions (Gherbawy *et al*, 2012).

Dates are rich in carbohydrates, comprising 70-80% in the form of glucose and fructose. Date fruit also contains vitamins, fiber, minerals and polyphenols, a class of bioactive compounds, especially phenolic acids (Colman *et al*, 2012).

Date fruit has special religious importance for Muslims peopleall over the world as it mentioned in many places in the Quran. One of these importance also is the tradition to eat date fruit first to break the fast during Ramadan fasting (Flowers, *et. al,* 2019).

Saudi Arabian date fruits as following; Ajwa, Sukkari, Barni, Shalabi and sogea dates. Ajwa date is a unique variety that is mainly cultivated in the Al Madinah Al-Munawarah city of western Saudi Arabia. This date variety has great cultural, religious and social importance. The Ajwa date is one of the most luxurious and expensive soft dates, and it has significant medicinal properties (Al-Shwyeh, 2019).

Dates are prone to contamination in the field; during harvesting, transporting, storage, marketing and/or by the consumer. Although several fungal species were implicated in causing contaminating to date fruits such as (*Aspergillus, Rhizopus*and *Penicillium* spp.). Fungi play a significant role in safety and quality of stored food commodities (Oktay *et al,* 2012). The most predominant fungal genus in the fresh Saudi date cultivars was *Aspergillus* sp. (Al-Hindi *et al*, 2011). The

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contamination with *Aspergillus Niger* is regarded as potentially dangerous problem of date palm. It has been reported that black aspergilli, represent one of the most important source of mycotoxins contamination in date fruits (Colman *et al*, 2012).

Traditionally, packaging materials that primarily used as passive, inactive, and inert barriers designed to prevent moisture, dust and contaminants by microbes from reaching the food product, thereby preserving the date's quality in an acceptable range and protecting it against chemical and mechanical stresses (Hamad *et al*, 2012).

Over the years, the food industry has always shown huge interest in promote packaging with different materials, some toxic for humans and others not. Today, there are increasing effort in the development of approaches in packaging methods to enhance the quality and safety of food from microbial spoilage. One of these approaches is nanotechnology. Nanotechnology is a powerful interdisciplinary tool that exploited today in the development of food packaging due to their nano-sized (less than 100 nm) dimensions. These materials possess very large surface-to-volume ratio and surface activity (Abass, 2013).

There is no available report on the isolation and identification of fungal species from date palm fruits especially on Saudi Arabia.

REVIEW OF LITERATURES

Dates palm (Phoenix dactylifera)

Dates palm (*Phoenix dactylifera*) is one of the oldest and most important fruit trees in the Middle East. The total worldwide production of dates is around 7.2 million tons, with approximately 5.1 million tons produced by countries in the Middle East (Mohammed, *et al.,* 2014). The top 10 producers of dates are Egypt, Iran, Saudi Arabia, Algeria, Iraq, Pakistan, Oman, UAE, Tunisia and Libya. Besides being an important source of vitamins, minerals and other beneficial nutrients, date fruits were the main sources of calories for people living in this part of the world. There are hundreds of dates cultivars grown in the Middle East, differ in their types from one country to the other. There are over 200 different date palmcultivars such as; Khalas, Sukkari, Sogea, Burny and safawi (Zaid & de Wet, 2002 and Musselman, 2007).

Date fruits are usually harvested and either consumed directly or dried, packed and consumed at a later stage. The fresh and directly consumed dates are referred to as 'Rutab', while the dried and stored dates are referred to as 'Tamar'. The traditional way of drying dates involves exposing them to direct sun for a certain period of time few days to weeks. This is followed by packing and storing dates for several months until they are consumed. Middle East consider the main date palm production which mainly begin from May to October, the duration of consumption of fresh dates is variable, as it depends on the cultivars but mostly date consumed as fresh dates which known as (Rutab) (Al-Bulushi *et al*, 2017).

Date palm that belongs to an *Asteraceae* family is one of the oldest plants cultivated for its edible sweet fruit in arid and semiarid parts of the world, including Asia, Africa, the Middle East, and Arabian Peninsula. It is a crucial food and plays an important role in day-to-day life of people of these regions (Al-Fares, 2014). Its name dactylifera means "date-bearing" that from two Greek words dáktulos, which mean date and fero mean bearing. It has been mentioned in Holy Quran and poses great importance from the economic, medicinal, and nutritional points of view (Mirza *et al*, 2019).

The main food applications of date fruits are to be consumedas fresh and/or processed in many products suchas date jam, date butter, date bars, date chutney,date relish, and date pickles, date oil and date coffee (Benmeddour *et al.,* 2013). The date paste is widely used as filling for bakery products while date syrup is well known natural sweetener in dairy products (Ghnimi *et al.,* 2017).

Great number of research has been carried out on the date applications in different food formulas such in bakery and dairy products. Date fruits were observed to developethe nutritional value and the technological quality of the products (Manickavasagan *et al*., 2012).

Nevertheless, date fruits have high potential tobe used as functional food ingredient due to their properties including the high content of fiber, high content of bioactive compounds, copious production during seasons with several applications (Ghnimi *et al.,* 2017). Moreover, date fruits have numerous health benefits regardless of their varieties because of the nutrients contentsuch as carbohydrates, minerals, proteins, lipids,moisture, and phenolic compounds (Al-Shahiband Marshall, 2003). In addition, date fruitsphytochemicals are reported to have biological activities, such as antioxidant and anti-mutagenic, anti-carcinogenic, antimicrobial (AbdAlla& El-Kawy, 2010), and anti-inflammatory (Abu-Qaoud, 2015). On the other hand, a great number of researches demonstrated the correlation between the consumption of functional food rich with phytochemicals and the risk reduction of dietrelated diseases (Kadum *et al*, 2018).

There are several types of date cultivated in Saudi Arabia such as

Ajwain figure (1); is a kind of dates that are famous for Medina in Saudi Arabia, and may not be famous in the first year of the Prophet, where the city lived from Ajwa 20-30 tons per day, and the list of dates exported outside the UK 100 tons per year. It has a length between 2 to2.5 cm and the color tends to black. It is considered one of the most famous types of dates in the world, and this type is characterized by softness and dehydration and taste great, not to mention its medical benefits and in the treatment of many problems with the human body systems, which is mentioned in many hadiths, it has been proven and medically documented (Khan, *et. al.,* 2017).

Fig 1 Ajwa date

Sukkari figure (2); is another famous type of dates, which mainly grown in Qassim region, and comes in a yellow color or red color that called "red sugar" and It has a length about 3cm. This type of dates was known in the city of Basra more than 1200 years ago, and then moved centuries later as a result of settlement to the Qassim region and famous (Helmy, *et. al.,* 2004).

Fig 2 Sukkari date

Al-Sogea figure (3); is a kind of dates produced by the province of Al-Kharj in Saudi Arabia, characterized by the same fruit has a mixture of red and yellow, and It has a length about 2.5 cm, a cylindrical shape, and that there is no proportion of white sugar, only contains fructose and dextrose (Al-Farsi and Lee, 2008).

Fig 3 Al-Sogea date

Albarni figure (4); is one of most famous date in Iraq and village of Al Ais in Saudi Arabia. It is also where it is produced palm trees in the summer season each year. The hadith says: "The best Tamratkm Albrini out of the disease and no disease." In the tongue of the Arabs of the son of Manzoor (in the door of Berni): "Albrini" a bunch of dates yellow rounded, which is the finest dates, and one brown, It has a length range 3.5 to 4 cm (Ghinimi, *et. al.,* 2017).

Fig 4 Albrni date

Al-Safawi figure (5); Dates are characterized by their dark black color, long shape about 2.5 to 3cm and medium size and are close to the gap in terms of taste and softness. Safawi palm tree is characterized by a lot of giving and this is what makes the Safawi dates available abundantly and easy to get at any time unlike the rest of the varieties. However, despite its availability, it is considered one of the finest and most demanded dates in the Kingdom (Markhand, *et. al.,* 2010).

Fig 5 Al- Safawi Date

Fungal spoilage of date fruits

Fungi can be explained by their ability to grow anywhere, when sufficient moisture is available (at least 60% relative humidity), influenced by temperature and oxygen. The most frequent signs of fungal infection in date fruits are fermentation, souring and superficial growth caused by mesophilic aerobic fungi that considered the major causative agent of the spoilage of date fruits (Abass, 2013 and Teena *et al*, 2014).

Isolation of some fungal species from date fruit makes it evident that some fungus are generally more tolerant to low water activity levels than bacteria. The climatic conditions such as temperature and humidity during growth, ripening, harvest and storage determine the extent of fungal infestation of the date palm fruits (Al Hazzani *et al*, 2014).

Fresh fruits are prone to fungal contamination in the field; during harvest, transport, and marketing; and with the consumer. Fungi play a substantial role in spoilage of fruits and vegetables, because of their pathogeni city to the harvested products. Fungi (*Aspergillus, Alternaria,* and *Penicillium* spp.) may grow on high-moisture dates, especially when harvested following rain or high humidity periods. Mycological profiles for date palm fruits were studied previously in several places around the world, including Saudi Arabia (Sanzani, *et. al.,* 2016).

During the various stages of pathogenesis, however, some of these fungi may create different mycotoxins secondary metabolites that are toxic to humans and animals who consume the products. Aflatoxigenic fungi such as *Aspergillus parasiticus* and *Aspergillus flavus* produced aflatoxins as secondary metabolites. Several researchers documented aflatoxin production in date palm fruits (Gherbawy *et al.,* 2012).

Ochratox in A is a nephrotoxic mycotoxin naturally found in awiderange of food commodities throughout the world with teratogenic and carcinogenic effects, genotoxic, and immunosuppressive. Two Aspergillus sections are known to produce OTA: the section Circumdati (also called the *Aspergillus ochraceus* group) and the section Nigri (*Aspergillus carbonarius*and *Aspergillus niger*) (Kchaou, *et. al.,* 2016).

It was observed that the date palm fruits (*Phoenixdactylifera*) are mostly loaded with mixture of microbes; bacteria, fungi and yeast. People consumed dates after clearing their inner side, or without the cleaning the internal environment of the date fruits. The Agricultural industries sustained huge crop spoil asa result of fungal diseases of fruits and plants. Approximately, 80000 species of fungi have been described but fewer than 400 are of medically importance, and less than 50 species causes more than 90% of fungal infections of human and animals (Geo *et al.,* 2007).

The mycology with the highestincidence, Candidiasis and dermatophytosis are caused by fungi of the normal microbial flora and are highlyadapted to survival on the human host. Date palm fruits (*Phoenix dactylifera*) form a vitalcomponent of diet in Arabian Peninsula, especially SaudiArabia and are well being consumed in many countries of the world, Nigeria not exceptional (Bensch *et al.* 2010).

Alternaria spp. and *Aspergillus* spp. consider the mostfungi that causing spoilage of date fruits. These fungi have many kind of enzymes and poison that causes decay andloss of the nutritional value of the date and makes itunsuitable for consumption (Ibraheem&Klaef, 2003). Therefore, it becomes important toinvestigate both the inner and outer surface of the fruits, as regard the presence of mycotic agents, as well as its suitability for human and animal consumption (Colman *et al*, 2012).

Species belonging to the genera *Aspergillus*spp*., Rhizopus stolonifer, Penicillium* and *Alternaria* are major causative agents offruit spoilage; in addition, these fungi can producemycotoxins and, in this way, can cause significant economic losses for any process of the food industry, including drying (Atia, 2011).

Date palm fruits are much more prone to spoilage by *Aspergillus* spp than other fungal species. It was observed that the fruits being hawked around, sold in shops or market places were neither covered nor protected in any way from dust or atmospheric contamination, and when consumed without any form of clearing or washing could predispose such unsuspected consumers to imminent mycotic infection. Fungi, grew optimally at 37°C, which increase its adaptability and potential in causing disease in both man and animals (Colman *et al.* 2012).

Fungal date fruits infection may occur also during the growing season, harvesting, handling, transport and post-harvest storage. Date Fruits contain high amount of sugars andnutrients and their low pH values make them particularly desirable to fungal spoilage by their pathogenic or toxigenic effect (Al-Hindi*et al*,2011).

It was observed that the date palm fruits (*Phoenixdactylifera*) are mostly loaded by a lot of fungi, bacteria and yeast but people goahead eating after clearing the inner environment, whilesome eat it whole irrespective of the state of the internal environment of the fruits (Colman *et al*, 2012).

Dried date fruit moisture contents vary from 2 to 22%. These types are thought to be resistant to fungal spoilage because of their low water activity, high acidity and sugar content, as a consequence of drying process. In general, most dried fruits have sufficiently low water activity to inhibit fungal spoilage. Natural occurrence of fungi in fruits such as dates has only been found in tropical and subtropical regions with high temperature and humidity which are suitable climatic conditions for growth of fungi (Oktay *et al*, 2012).

Soft dates (Rutab) is a stage of maturity in which the date fruit can be consumed as human food. It is a freshdate's product that contains 45 to 48% sugars and 35 to 40% water (dry matter basis). Because of its high moisture content, highly susceptible to microbial growth and spoilage by fungi (Hamad *et al*, 2012).

The date fruits are loaded with much of microbes: Fungi, bacteria and yeast but people go ahead eating after clearing the pericarp, while some eat it whole irrespective of the state of the pericarp. Date palm spoilage mostly by; molds, followed by bacteria and yeast at all stages of ripening on trees, as well as during storage and processing which change the date quality by its effect on; size, color, texture, cleanliness, freedom from defects like fermentation(Anjili *et al,* 2015).

Dates fruits are exposed to contamination by microorganisms such as fungi through direct contact with soil, dust, water and by handling at harvest or during postharvest processing (Palou *et al*, 2016). Date palm fruits which containing (up to 30%) water content usually easily infected by fungi at field and markets, nutritive value are making them a good target for invading with many fungi. Majority of fungal spoilage have been concentrated in the date palm nearest to the high level of humidity could contribute to the spread of these fungal infections (Abass, 2016).

Microorganisms, especially fungi, are known to destroy date fruits, thereby reducing the quantity for consumption and the profits obtained from sales of fruits. There is need to identify these micro-organisms especially those that are pathogenic to humans so as to reduce the risk of contamination and infection arising from handling and consumption of fruits (Mailafia *et al*, 2017). Date fruits could contain harmful spoilage fungi even when protective measures are taken during the cropping stage procedure that can control harmful fungi and slowness deterioration of fresh date fruit include; washing, chemical, coating, heat/cooling treatments, high pressure water, partial vacuum and modified atmosphere packaging (MAP) (Palou *et al.*, 2016 and Belbahi *et al*, 2017).

Species belonging to the genera Aspergillus, Penicillium and Rhizopus are major causative agents offruit spoilage; in addition, these fungi can producemycotoxins and, in this way, can cause significant economiclosses for any process of the food industry (Anjili *et al.,* 2015).

The fungi produce many kinds of enzymes that cause decay and loss of the nutritional value of date and make it unsuitable for consumption. Therefore, it becomes important to investigate both the inner and outer surface of the fruits, as regard the presence of mycotic agents(Hasnae *et al*., 2013).The contamination with *Aspergillus, Penicillium, Alternaria* and *Fusarium*is regarded as potentially dangerous problem of date palm due to production of toxic substances that diffuse in the flesh of fruit causing severe problems to human health. Major mycotoxins produced by this group of filamentous fungi are ochratoxin A (OTA) and fumonisins of the B series, in particular FB2.3 OTA is mainly known for its nephrotoxicity (Nasser, 2017).

Date fruit infected by pathogenic fungi, which may be associated with mycotoxin production, while spoilage fungi can cause deterioration of fruit quality. Mycotoxigenic species such as *Aspergillus niger*, *A. flavus* and Fusarium. Controlling fungal contamination becomes increasingly difficult because of the emergence of antifungal-resistant strains (Wilson, *et. al.,* 2002).

Most Common Fruit Mould Spoilage

Aspergillus species

Aspergillus is a genus of fungi that consists of about 300 identified species. Aspergillus can be found in a variety of environments throughout the world given that their growth is largely determined by the availability of water. Appropriate temperature and moisture content, Fungi can germinate and resultant hyphae can infect the inner tissue of fresh or dried date fruits. Filamentous fungi and endogenous yeasts (such as *Sporobolomyces roseus* and*Cladosporium cladosporioides*). The most predominant *Aspergillus* Species which contaminate food such as; *Aspergillus niger, A. flavus, A. fumigatus*, *A. ochraceus*, in addition to; *Penicilliums*pp. and *Rhizopus stolonifer* also isolated in fruits including dates (Paulussen, *et al.,*2016).

Aspergillius niger is a filamentous fungi ascomycete fungus that is ubiquitous in different environments and the most common member of the microbial communities found in soil, air and many other environments. Fungi hasa wide range ofoxidative and hydrolytic enzymes with a saprophytic activity. Presence of moistureandfood enhance the fungal growth. The *Aspergillius niger* fungus appears to be a strong contaminant of date fruit in Iraq (Abass, 2013).

Filamentous fungi such as *Aspergillus niger*, is the fungus whichhas filaments (hyphae) resembling to the plant structure. When viewed under the microscope, *A. niger* has a colorless smooth conidiophores and spores. A closer look will reveal the conidial heads of the organism to beglobose and dark brown in color that have been shown to divide into a number of columns as the *A. niger* continues to age. Compared to the other types, *A. niger* Secretesdark or dark brown spores from their conidial heads (biserite). This is a characteristic that has only been seen on *A. niger* and none of the others. In microscopy, the carbon black/dark brown color of the spores (as well as the conidia) is used to distinguish *A. niger* from other species in the same genus (Diba, *et. al.,* 2007).

Aspergillus flavus are saprophytes that can be found in soil samples where they obtain their nutrition from dead and decaying matter. In particular, *A. flavus* are a nuisance to farmers given that they tend to infect and contaminate crops (seeds). *A. flavus* also produces hyphae, this includes the vegetative and reproductive hyphae. In the vegetative hyphae (mycelium) *A. flavus* produces enzymes that are responsible for the breakdown of food material into simpler forms that can be absorbed. While the organism has been shown to produce spores (conidiospores) asexually, studies have shown the genetic diversity of this species to be as a result of sexual reproduction where ascospores are produced within the sclerotia of *A. flavus*. Under the microscope, *A. flavus* appear to have radiating conidial heads while the conidiophores will appear rough (Díaz, *et. al.,* 2009).

*A. flavus*fungus is divided into two major groups based on their morphology. These include; S strain of *Aspergillus flavus*, also referred to as Group I strain has a sclerotia (hardened mass of mycelium) that is less than 400 mm in size, which is its defining characteristic. This strain has been shown to produce a consistently high content of aflatoxin that affects crops and animals alike. S Strain - Compared to the L strains, where the diameter of sclerotia of L strain of *Aspergillus flavus* be larger than 400 mm. While this strain also produces aflatoxins, the amount produced vary from high to low and thus not consistent as is the case with the S strain (Ohkura, *et. al.,* 2018).

In human beings, aflatoxins produced by Aspergillus tend to cause serious intestinal problems as well as liver cancers. *A. flavus* is the second leading cause of Aspergillosis among patients with weak immunity. This is an infection of the lungs by the fungi (fungi balls)(Williams, *et. al.,* 2004).

Aspergillus fumigatus is one of the most common Aspergillus found in most environments. One of the most unique characteristics that separates *A. fumigatus* from the rest of the Aspergillus is that it can survive very high temperatures (thermotolerant) which is one of the reasons as to why it is more prevalent. *A. fumigatus* also exists as a saprophyte that plays an important role in the cycle of carbon and nitrogen in nature. Because it is very prevalent, the spores of *A. fumigatus* are also in high concentration in air, which presents a serious health issues for those with poor immunity. Compared to other species in this genus, *A. fumigatus* has been shown to be the leading infectious pathogen among those with compromised immunity (Ehrlich, *et. al.,* 2005).

A filamentous fungi including *Aspergillus fumigatus*that reproduced sexually or/and asexually. In asexual reproduction, conidia are produced through mitotic division. Here, mitotic division take place within the conidophore vesicle and are released by any disturbance of the immediate environment. This causes the spores to be in high concentration in air where they can be easily inhaled (causing health problems for those with compromised immunity) - asexual reproduction in *Aspergillus fumigatus* takes place when the mycelia does not interact with other haploid mycelia (McClenny, 2005).

When the mycelia comes in contact with the hyploid mycelia, then sexual reproduction occurs. According to studies, this means of reproduction in *A. fumigatus* often occurs when there is a low supply of nutrients particularly when the growing season comes to the end. This is therefore a beneficial means of production in that it allows the *A. fumigatus* to continue reproducing in unfavorable conditions. Here, the haploid hyphae come in contact allowing their nuclei to fuse. This is then followed by meiotic division of the diploid ascus to form ascospores (four of them) that are then released in air to continue the cycle (Õzkara, *et. al.,* 2007 and Panda, *et. al.,* 2009).

Morphology of *Aspergillus Fumigatus* produce spores of between 200 and 400 mm, color of the stipes is gray around the apex, the surface of the conidia is either smooth or spinose (El-Deeb, *et. al.,*2006).

A. ochraceus grow rapidly (45 to 55 mm/7 days) at 25°C. Plating of the vegetative mycelium in the agar, appear as typical arrangement of the conidial heads. The characteristic

colour of the colony is yellow (Mateo, *et. al.,* 2011). *Aspergillus ochraceus* has purple or pink irregular colonies, pebble-like sclerotia up to 1 mm in diameter. The reverse look on a petri dish is pale to brownish (Bennet, 2010). In naked eye, the conidiophores of *A.ochraceus* appear as a powdery mass. Microscopically, appears as; finely roughened or smooth phialides which arranged on the conidial heads, such as; phialides which attached to intermediate cells which known as; metulae, which attached to the vesicle. In culture the conidial heads at first appear globose, but with age, the conidial chains adhere and develop into two or three divergent columns (Ghibaudo, & Peano, 2010). The conidiophores is pale yellow-brown to chalky yellow colour. The heights of the conidiophores are up to 1500 µm high. Conidiophores appeared as a pale, granular, with yellow-brown walls and has a globose vesicles, with thin walls and a diameter of 35 × 50 µm, and over their entire surface sterigmata grown. The primary sterigmata measures 15-25 × 5-6 µm, while the secondaries are 7-11 × 2-3.3 µm(Oliveira, *et. al.,* 2005). The conidia are arranged in dry, upright chains, often massing into two or more short columns per head, in wet microscopic mounts hyaline. The diameter of the conidia are around 2.5-3.5 µm. Amycotoxinproduced by *Aspergillus ochraceus* knownas; ochratoxin A (OTA). Melleinand4-hydroxymellein are other toxic metabolites produced by this fungus (Cui, *et. al.,* 2010 and Ostry, *et. al.,* 2013).

Penicillium species

Penicillium spp. are rapid growing, flat, filamentous, and velvety, woolly, or cottony in texture. The colonies are initially white and become after that blue green, gray green, olive gray, yellow or pinkish in time. The plate reverse is usually pale to yellowish (Barna, *et. al.,* 2008). *Penicillium* spp. is filamentous dimorphic thermally, radially sulcate, flat, colonies at 25°C. These colonies are greenish-blue-graycenterally and white periphery. *Penicillium* spp. colonies is slightly pink or creamy in color, rapidly diffusing. At 37°C, and glabrous to convolute in texture (Amiri & Bompeix, 2005). Microscopically; Penicillium spp., septate hyaline hyphae (1.5 to 5 µm in diameter), simple or branched conidiophores, metulae, phialides, and conidia are observed. Conidiophores form secondary branches known as; Metulae. The metulae carry the flask-shaped phialides that organized at the tips of the conidiophores is very typical, forming a brush-like clusters which are also referred to as "penicilli". The conidia (2.5-5µm in diameter) are unicellular, round, and visualized, unbranching chains at the tips of the phialides. Initsfilamentousphase, *Penicillium* species is microscopically similar to the other *Penicillium* species (Visagie, *et. al.,* 2014).

Rhizopus spp.

Rhizopus spp. referred to as zygomycosis. Macroscopically Colonies of Rhizopus grow very rapidly, fill the Petri dish, and mature in 4 days. The texture is typically cotton-candy like. From the front, the colony is white color and turns yellowish brown to grey by time. The reverse is white to pale. Pathogenic species of Rhizopus can grow well at 37°C (Alfaro-Gutiérrez, *et. al.,* 2014).

Microscopically; Nonseptate or sparsely septate broad hyphae (6-15 µm in diameter), sporangiophores, rhizoids (root-like hyphae), sporangia, and sporangiospores are visualized. Sporangiophores are unbranched brown color. They can be solitary or form clusters. Rhizoids are aggregated where the sporangiophores and stolons meet. Sporangia diameter range from (40-350 µm) and aggregated at the tip of the sporangiophores. They are round with flattened bases. Apophysis is absent or rarely apparent and columellae are hemispherical. Sporangiospores (4-11 µm in diameter) are unicellular, round to ovoid in shape, hyaline to brown in color, and smooth or striated in texture (Jennessen, *et. al.,* 2008).

Most Common Fruit Yeast Spoilage

Cladosporium species

Cladosporium species are ubiquitous worldwide, and commonly isolated from organic matter which consider the most frequently isolated airborne fungi. The genus has undergone a number of revisions. Thermotolerant is 'the true human-pathogenic species, that including; *C. bantiana, C. carrionii* and *C. devriesii*, characterised by the absence of conidiophores, and unpigmented conidial scars, were reclassified in *Cladophialophora* (Bensch *et al.* 2012). The remaining species of medical interest were *C. cladosporioides, C. herbarum, C. oxysporum,* and *C. sphaerospermum*. More recently, extensive revisions based on polyphasic approaches have recognised 169 species, and demonstrated that *C.cladosporioides, C.herbarum* and *C.sphaerospermum* are species complexes encompassing several sibling species that can only be distinguished by phylogenetic analyses (Zalar *et al.* 2007).

Cladosporium species Colonies are slow growing, mostly olivaceous-brown to blackish-brown but also sometimes grey, buff or brown, suede-like to floccose, often becoming powdery due to the production of abundant conidia. The reverse is olivaceous-black. Vegetative hyphae, conidia and conidiophores are equally pigmented. Conidiophores are more or less distinct from the vegetative hyphae, being erect, straight or flexuose, unbranched or branched only in the apical region, with geniculate sympodial elongation in some species. Conidia are produced in branched acropetal chains, being smooth, verrucose or echinulate, one to four-celled, and have a distinct dark hilum. The term blastocatenate is often used to describe chains of conidia where the youngest conidium is at the apical or distal end of the chain. Note: The conidia closest to the conidiophore, and where the chains branch, are usually "shield-shaped". The presence of shield-shaped conidia, a distinct hilum, and chains of conidia that readily disarticulate, are characteristic of the genus *Cladosporium* (Crous *et al.* 2007).

Sporobolomyces roseus

Sporobolomyces roseus colonies are dimorphic, with the center flat to somewhat raised, glabrous to velvety hirsute, smooth to somewhat irregularly furrowed, dull, pale creamish-white to yellowish-brown. Growth near the margin is zone, somewhat hairy to velutinous, and with the margin fringed. Yeast cells size range between 5-35×1.5-3 µm and has fusiformtocylindrical shape. Conidiogenesis is polaron short denticles. Hyphae are abundant, usually with the cytoplasm retracted in cells, 25-60×1.5-2.2 µm. Cultivation after 5 days/ 17°C then identified morphologically, extensive hyphae may be formed with the cytoplasm retracted. Aerobic cultivation appear as; pinkish-creamor whitish dullwith smoothsurface growth, pustulate may turn to reticulate covered with tiny

hairsorhyphal fascicles. The aerial mycelium is made up of ramifying acropetal chains of fusiform blastoconidia being formed on sterigmata (Vayalil, 2012). *Sporobolomyces* spp. is dimorphic basidiomycetousyeast, based on the morphological resemblance of ballistoconidia with actively discharged basidiospores. The life cycles of basidiomycetous yeasts include heterothallic and homothallic systems, which may occur within a single species (Vale´rio, *et. al.,* 2008). In many basidiomycetes the dikaryotic hyphal state may be parasitic on either green plants or fungi. However, putative host associations have not been identified from any yeast taxa and their sexual states are only known from observations on culture media (Gadanho, *et. al.,* 2003).

Traditional Methods of Date Preservation

Food preservation is an effective route of saving food and preventing it from being wasted. In fact, peoples around the world have been employing food saving methods for centuries in order to prolong its shelf life. Foods preservation were important for the soldier, merchant, sailor. For fruits and vegetables to be enjoyed out of season, they had to be preserved; and in some regions, a particular foodstuff could only be enjoyed in its preserved form, because it didn't grow (or wasn't raised) nearby. All fruit are susceptible to be altered in a greater or lesser time, due to the action of microorganisms that contaminate them or enzymatic reactions of the food itself. The alteration and deterioration of fruit have been a constant concern and reason for research for humans in order to conserve them as long as possible and ensure their availability such as; refrigeration, freezing, canning, packaging, honeyed, dried, sealing, vacuum foods, sterilized, etc. The National Institute of Nutrition (INN) recommends to ensure good health through proper selection, purchase and hygienic handling of the good preserved foods (Kalaivani, *et. al.,* 2015).

Refrigeration and Freezing of Date (Figure 6)

The cold causes fungi bacteria and to grow more slowly or, if very intense, to stop their activity almost completely. Hence, we use refrigeration and freezing as fruit preservation techniques. The cooling (in refrigerators) preserves date fruit a few days. The freezing below -10°C in domestic freezers, allows us to preserve food much longer (never indefinitely), provided that the cold chain is not broken (Melissa, *et. al.,* 2010).

Fig 6 Refrigeration of date

Vacuum Packaging (Figure 7)

The vacuum packaging consists of extracting the oxygenfrom the container that contains the product, in this way it prevents the oxidation and putrefaction of the food to be preserved, prolonging its expiration date in more than 30 days and up to 1 year.

Fig 7 Vacuum Packaging of Date

Hygiene and quality, avoids the oxidation caused by oxygen, and therefore the putrefaction of date fruit is zero. Increase the storage times of the date fruit. It cancels the development of microorganisms in the absence of oxygen. Allows date fruit to retain its hardness and texture (Krishnan, *et. al.,* 2014).

Drying (Figure 8)

It is consists of drying some products such as grains, cereals, fruits and vegetables, exposing them to extreme heat, in order to eliminate a large amount of water in them, avoiding the development of bacteria and ensuring the conservation of vitamins in dehydrated products. Food drying through oven dehydrating or by solar exposure. Maintains the flavor and freshness of food which allows the slowly consuming of fruit quantities. Other ways to stop or block microbial growth by reducing water, while providing flavor to foodare: sometimes by addition of sugar. Also having a reverse osmosis water filter in your home can be a good investment to drink pure water (Rupasinghe and Yu, 2012).

Fig 8 Drying of date

Smoked (Figure 9)

The method of smoking is based on the combustion of fruit date, the smoke affects the fruit date. The smoked have some characterized changes in date such as; flavor, coloring and elimination of microbes. It is mainly applied to products fruit

date thanks to the combined effects of dehydration and the antiseptic effect of smoking (Corbo, *et. al,* 2009).

Fig 9 Smoked Date

Sweet Preserves (Figure 10)

Fruits were often dried, but a far more tasty method of preserving them past their season was to seal them up in honey. Occasionally, they might be boiled in a sugar mixture, but sugar was an expensive import, so only the cooks of the wealthiest families were likely to use it. Honey had been used as a preservative for thousands of years, and it wasn't limited to preserving fruit; meats were also stored in honey on occasion (Caminit, *et. al.,* 2011).

Fig 10 sweet Preservation of date

Canning

The term "canning" is a little misleading. If you're canning at home, you're probably using mason jars or something very similar. This relatively simple method of preservation involves sealing fruit date in a sterile, airtight environment. Both cooked and raw fruit date can be successfully canned using heat to sterilize and seal the jar. The principle involves killing bacteria inside the jar with heat. Steam pressure is applied to the airtight container that leaves a sterile vacuum in which food can stay safe and relatively fresh for several months (Torres, *et. al.,* 2011).

Modern Preservation Technology of Date Preservation

Ultrasound (US) Power

Ultrasound has emerged as non-thermal technique for preservation of food products over the last decade. US uses a lower frequency range of 20 to 100 kHz and a higher sound intensity of 10 to 1000 W/cm2 (Baumann *et al.* 2005).

The principle of ultrasonic processing explained as follows: Firstly, the ultrasonic transducers convert electrical energy to sound energy. Secondly, when the ultrasonic waves propagate in liquid, small bubbles will be formed and collapsed thousands of times per second. This rapid collapse of the bubbles (cavitation) results in high localized temperatures and pressure, causing breakdown of cell walls, disruption of cell membranes and damage of DNA (Knorr *et al.* 2004).Effectiveness of ultrasound on inactivation of microorganisms in fruit (O'Donnell *et al.* 2010).

Ultraviolet light

Ultraviolet light (UV-light) technology utilizes radiation with the electro-magnetic spectrum in the range of 100 to 400 nanometers, between visible light and x-rays. It could be further divided into UV-A (320-400 nm), UV-B (280-320 nm) and UV-C (200-280 nm). UV-C is known to have biocidal effects and destroys microorganisms by degrading their cell walls and DNA which inactivate microorganisms such as bacteria, yeasts, moulds, among others, the amount of cell damage depends on the kind of medium, microorganisms and the applied UV dose (Ngadi *et al.* 2003). For fruit and beverage processing, the wavelength of 254 nm is widely used (Guerrero-Beltrán & Barbosa-Cánovas, 2004). For the a non-thermal preservation method, UV-C treatment takes the advantages of no toxic or significant non-toxic by-products being formed during the treatment, very little energy being required when compared to thermal pasteurization processes, and maximum aroma and color of the treated fruits being maintained (Keyser, *et. al.,* 2008).

High pressure homogenization (HPH)

High pressure homogenization (HPH) is considered to be one of the most promising nonthermal technologies proposed for preservation of fruit and beverages. HPH has been identified as a combination of spatial pressure and velocity gradients, turbulence, impingement, cavitation and viscous shear, which leads to the microbial cell disruption and food constituent modification during the HPH process. HPH has shown its ability to increase the safety and shelf-life of fruit (Lacroix *et al.* 2005), up to 350 MPa processing pressure was required to achieve an equivalent 5-log inactivation of L. Innocua; required lower pressure than *E. coli* (> 250 Mpa) in date fruit (Hutzler, *et al.* 2012). Another instance is that a higher 72 Food Additive reduction of *Saccharomyces cerevisiae* 635 was observed in carrot juice (5-log reduction) than in apricot juice. (3-log reduction) using up to 8 passes of100 MPa pressure level (Patrignani, *et al.* 2009).

Membrane filtration Ultrafiltration (UF) and microfiltration (MF)

Membrane filtration Ultrafiltration (UF) and microfiltration (MF) are the most commonly used membrane filtration techniques for fruit processing. They have been used commercially for the clarification of fruit. Through this processing, a "pasteurized" product could be produced with flavours better than thermally treated products (Cassano *et al.* 2003).

Ultrafiltration (UF) unit, with polysulphone membranes of 10 kDa and 50 kDa pore sizes and trans-membrane pressures of up to 155 kPa, were used to treat date fruit. Results relative colour

changes were observed for both membranes, which was more detectable for the larger pore membrane treatment (Zarate-Rodriguez *et al.* 2001).

Natural antimicrobials

Natural antimicrobials such as bacteriocins, lactoperoxidase, herb leaves and oils, spices, chitozan and organic acids have shown feasibility for use in some food products. Some of them have been considered as; generallyrecognized as Safe (GRAS) additives in foods (Corbo *et al.* 2009). Spicesand herbs contain essential oils, which are natural antimicrobials. The main elements of these antimicrobials are phenolic compounds, including cinnamic, caffeic, gallic acids andferulic oleuropein, thymol and eugenol (Gould 2001). Among them, sage (*Salvia officinalis*), rosemary (*Rosemarinus officinalis*), clove (*Eugenia aromatica*), coriander (*Coriandrum sativum*), garlic (*Allium sativum*) and onion (*Allium cepa*)). The oils of bay leaves, cinnamon, clove and thyme were also proven to be highly effective for food pathogenic microorganisms including *Campylobacter jejuni*, *Salmonella enteritidis*, *Escherichia coli, Staphylococcus aureus* and *Listeria monocytogenes*. It is believed that Gram-positive bacteria were more sensitive to inhibition by plant essential oils than the Gram-negative bacteria (Yuste and Fung 2004).

Application extending successfully from citrus fruits extracts to vegetables and fruits (Fisher & Phillips, 2008). *Pichia subpelliculosa*, *Bacillus licheniformis*, *Candida lusitaniae*, *Lactobacillus* spp., and *Saccharomyces cerevisiae*considered the most spoilage microorganisms which inhibited by nanomaterials to not less than 100 to 150 ppm concentration (Conte *et al.* 2007). Chitosan is one of the new naturalfood preservativedue to its strong antimicrobial activity. Chitosan molecules could interact with the negatively charged microbial cell membranes, which would affect the cell permeability and lead to the leakage of intracellular compounds or through interaction of diffused hydrolysis substances with microbial DNA could lead to the inhibition of the mRNA and protein synthesis of the microorganisms (Rhoades and Roller 2000).

Nanotechnology

Nanotechnology transact with the atoms, molecules, or the macromolecules with the size of 1-100 nm to use and create materials that have novel properties. The next decade predicted that nanotechnology will be used for more than 25% of commercially food packaging by using about 400-500 nano-packaging products (Reynolds, 2007). By 2003, over 90% of nano-packaging was based on nanocomposites, in which nanomaterials were used to improve the barrier function of plastic wrapping for foods, and plastic bottles for beer, soft drinks and juices. Nano-packaging can also be designed to release antimicrobials, antioxidants, enzymes, flavours and nutraceuticals to extend shelf life (Cha, *et al.,* 2004 and LaCoste, *et al.,* 2005).

The significant purpose of nano-packaging is to set longer shelf life by improving the barrier function of food packaging to reduce gas and moisture exchange and UV light exposure (Sorrentino, *et al.,* 2007).

It is observed that these materials have unique properties unlike theirmacroscale counterparts due to the high surface to volume ratio and other novel physiochemical properties like colour, solubility, strength, diffusivity, toxicity, magnetic, optical, thermodynamic, etc. (Rai, *et al.,* 2009and Gupta, *et al.,* 2016).

Novel nanoantimicrobials such as; silver, zinc oxide, gold, magnesium oxide, titanium dioxide, chlorine dioxide, have shown promising effects on safeguarding food deterioration. Nano-based “smart” and “active” food packaging confer several advantages over conventional packaging methods from providing better packaging material with improved mechanical strength, barrier properties, antimicrobial films to nanosensing for pathogen detection and alerting consumers to the safety and quality of food (Mihindukulasuriya and Lim, 2014). The main aim of food protection is to maintain the nutritious compound of the food such as; vitamins, antioxidants, proteins and as well as carbohydrates, may be achieved using several methods for the enhancement of food shelf life and stability (Sekhon, 2010).

Application of various edible nano-coatings materialsprovide a barrier to gas exchangeand moisture and deliver antioxidants. flavours, enzymes, colours, andanti-browning agents and could prolong the foods shelf-life, even after the packaging isopened (Weiss, *et al.,* 2006).

Nanotechnology applied in the food analysis to detect toxins produced by microorganisms. For example, *Aspergillus flavus, A. parasiticus, Staphylococcus aureus, Listeria monocytogenes*. These applications of nanotechnology systems in food analysis would improve food safety and quality and control the hazards, which could affect human health (Alfadul, and Elneshwy, 2010).

CONCLUSION AND RECOMMENDATIONS

Date fruit consider one of the perishable food, so they need treatment, conservation and handling conditions. These techniques have allowed date fruit to be consumed permanently and fully exploited and It is important to improve the storage preservation techniques of date fruit, which maintain its nutritious value and extend its shelf life. Combination of physical and chemical methods It is proved that some individual non-thermal methods as well as natural antimicrobials in addition to nanotechnology are effective in inactivating microorganisms and at the same time do not adversely affect the sensory and nutritional quality of the date fruit. Moreover, the combination of these techniques could provide synergistic effects on prolonging the date fruit shelf-life and potentially as replacement for traditional pasteurization methods.

Reference

1. Abass, M. H. (2013). Microbial contaminants of date palm (Phoenix dactylifera L.) in Iraqi tissue culture laboratories. *Emirates Journal of Food and Agriculture*, 875-882.
2. Abass, M. H. (2016). Identification of Different Fungal Fruit Rot Pathogens of Date Palm (Phoenix dactylifera L.) using ITS and RAPD Markers. *Basrah Journal for Date Palm Research*, *15*(1-2), 1-10.
3. AbdAlla, M. M., & El-Kawy, A. M. A. (2010). Karyotype analysis for date palm (Phoenix dactylifera L) compared with tissue culture derived plants. *New York Science Journal*, 3(11), 165-170.

4. Abu-Qaoud, H. (2015). Date Palm Status and Perspective in Palestine. In Al-Khayri, J. M., Jain, S. M. & Johnson, D. V. (Eds.), Date palm genetic resources and utilization. Africa and the Americas. 2: 423-439.
5. Al Hazzani, A. A., Shehata, A. I., Rizwana, H., Moubayed, N. M., Alshatwi, A. A., Munshi, A., & Elgaaly, G. (2014). Postharvest fruit spoilage bacteria and fungi associated with date palm (Phoenix dactylifera L) from Saudi Arabia. *African Journal of Microbiology Research*, *8*(11), 1228-1236.
6. Al-Bulushi, I. M., Bani-Uraba, M. S., Guizani, N. S., Al-Khusaibi, M. K., & Al-Sadi, A. M. (2017). Illumina MiSeq sequencing analysis of fungal diversity in stored dates. *BMC microbiology*, *17*(1), 72.
7. Alfadul, SM. and Elneshwy, AA. (2010). Use of nanotechnology in food processing, packaging and safety- Review. African journal of food agriculture nutrition and development. 10 (6): 2719-2739.
8. Al-Fares, A. (2014).The reality of Date Palm cultivation in Palestine. Proceedings of the fifth international Date Palm conference. 16-18, March, 2014, Abu Dhabi, United Arab Emirate
9. Alfaro-Gutiérrez, I.C.; Guerra-Sánchez, M.G.; Hernández-Lauzardo, A.N. and Velázquez-del Valle, M.G. (2014). Morphological and Physiological Changes on Rhizopus stolonifer by Effect of Chitosan, Oligochitosan or Essential Oils. *Journal of phytopathology*. 162 (11): 723-730.
10. AL-FARSI, MA. and LEE, CY. (2008). Nutritional and Functional Properties of Dates: A Review. Critical Reviews in Food Science and Nutrition, 48:877-887.
11. Al-Hindi, R. R., Al-Najada, A. R., & Mohamed, S. A. (2011). Isolation and identification of some fruit spoilage fungi: Screening of plant cell wall degrading enzymes. *African Journal of Microbiology Research*, *5*(4), 443-448.
12. Al-Shahib, W., & Marshall, R. J. (2003). The fruit of the date palm: its possible use as the best food for the future. *International journal of food sciences and nutrition*, 54(4), 247-259.
13. Al-Shwyeh, H.A. (2019).Date Palm (*Phoenix dactylifera* L.) Fruit as Potential Antioxidant and Antimicrobial Agents. *Journal of Pharmacy & BioAllied Sciences*. 11(1): 1-11.
14. Amiri A. and Bompeix G. (2005). Diversity and population dynamics of Penicillium spp. on apples in pre- and postharvest environments: consequences for decay development. Plant Pathology 54: 74-81.
15. Anjili, S. M., Channya, F. K., & Chimbekujwo, I. B. (2015). Fungi Associated with Post-harvest Spoilage of Date Palm (Phoenix dactylifera L.) in Yola, Adamawa State. *International Journal of Research*, *14*.
16. Atia MMM (2011). Efficiency of physical treatment and essential oil in controlling fungi associated with some stored date palm fruits. Aust. J. Basic Appl. Sci. 5(6):1572. Geo FB, Karen CC, Janet SB, Stephen AM and Timothy AM (2007). Medical mycology. Med. Microbiol. 24: 621-657.
17. Barna, B., E. Leiter, N. Hegedus, T. Bíró, and I. Pócsi, 2008 Effect of the Penicillium chrysogenum antifungal protein (PAF) on barley powdery mildew and wheat leaf rust pathogens. *J. Basic Microbiol*. 48: 516-520.
18. Baumann, A.R.; Martin, S.E. and Feng, H. (2005). Power ultrasound treatment of *Listeriamonocytogenes* in apple cider, *Journal of food protection*, 68 (11): 2333-2340.
19. Belbahi, A., Bohuon, P., Leguérinel, I., Meot, J. M., Loiseau, G., & Madani, K. (2017). Heat Resistances of C andida Apicola and A spergillus Niger Spores Isolated From Date Fruit Surface. *Journal of Food Process Engineering*, *40*(1), e12272.
20. Benmeddour Z, Mehinagic E, Meurlay D Le, Louaileche H. (2013). Phenolic composition and antioxidant capacities of ten Algerian date (*Phoenix dactylifera* L.) cultivars: a comparative study. *J Funct Foods*. 5: 346-354.
21. Bennet, J.W. (2010). Mycology Series. New Orleans, Louisiana: Tulane University. pp. 294-295.
22. Bensch K, Groenewald JZ, Dijksterhuis J, Starink-Willemse M, Andersen B, Shin H-D, Dugan FM, Schroers H-J, Braun U, Crous PW (2010). Species and ecological diversity within the Cladosporium cladosporioides complex (Davidiellaceae, Capnodiales). Studies in Mycology 67: 1-94.
23. Bensch, K.; Braun, U.; Groenewald, JZ. And Crous, PW. (2012). The genus Cladosporium. Studies in Mycology. 72: 1-401.
24. Caminiti, I.M., Noci, F., Munoz, A., Whyte, P., Morgan, D.J., Cronin, D.A. & Lyng, J.G. (2011). Impact of selected combinations of non-thermal processing technologies on the quality of an apple and cranberry juice blend, Food Chem 124(4): 1387-1392.
25. Cassano, A.; Drioli, E.; Galaverna, G.; Marchelli, R.; Silvestro, D.G. and Cagnasso, P. (2003). Clarification and concentration of citrus and carrot juice by integerated membrane process, *Journal of Food Engineering*. 57: 153-163.
26. Cha D and M Chinnan (2004). Biopolymer-based antimicrobial packaging: A review. Critic Rev Food Sci Nutrit. 44:223-237.
27. Colman, S., Spencer, T. H. I., Ghamba, P. E., & Colman, E. (2012). Isolation and identification of fungal species from dried date palm (Phoenix dactylifera) fruits sold in Maiduguri metropolis. *African Journal of Biotechnology*, *11*(57), 12063-12066.
28. Conte, A.; Speranza, B.; Sinigaglia, M. and Del Nobile, MA. (2007). Effect of lemon extract on foodborne microorganisms, *Journal of Food Protection*. 70: 1896-1900.
29. Corbo, M. R., Bevilacqua, A., Campaniello, D., D'Amato, D., Speranza, B. & Sinigaglia, M. (2009). Prolonging microbial shelf life of foods through the use of natural compounds and non-thermal approaches - A review, *International Journal of Food Science and Technology* 44(2): 223-241.
30. Crous PW, Schubert K, Braun U, Hoog GS de, Hocking AD, Shin H-D, Groenewald JZ (2007). Opportunistic, human-pathogenic species in the Herpotrichiellaceae are phenotypically similar to saprobic or phytopathogenic species in the Venturiaceae. Studies in Mycology 58: 185-217.
31. Cui, CM; Li, XM; Meng, L; Li, CS; Huang, CG; Wang, BG (Nov 29, 2010). "7-Nor-ergosterolide, a pentalactone-containing norsteroid and related steroids

from the marine-derived endophytic Aspergillus ochraceus EN-31". *Journal of Natural Products*. 73 (11): 1780-4.
32. Díaz GA, Torres R, Vega M, Latorre BA 2009- Ochratoxigenic Aspergillus species on grapes from Chilean vineyards and Aspergillus threshold levels on grapes. *International Journal of Food Microbiology* 133, 195-199.
33. Diba, K.; Kordbacheh, P.; Mirhendi, SH; Rezaie, S. and Mahmoudi, M. (2007). Identification of Aspergillus Species Using Morphological Characteristics. Pakistan Journal of Medical Science (Part-II). 23(6): 867-872.
34. Ehrlich, K. C., J. Yu, and P. J. Cotty, 2005 Aflatoxin biosynthesis gene clusters and flanking regions. *J. Appl. Microbiol*. 99: 518-527.
35. El-Deeb HM, Lashin SM, Arab YA (2006). Distribution and pathogenesis of date palm fungi in Egypt. International Society for Horticultural Science, ISHS Acta Horticultural 736:22-46.
36. Fisher, K. and Philips, C. (2008). Potential antimicrobial uses of essential oils in food: is citrus the answer? Trends in food science and technology, 19: 156-164.
37. Flowers, J.; Khaled, M.H.; Muriel, G.; Ziyi, M.; Konstantina, K.; Andreas, P.; Sylvie, F.; Hussam, S.M.; Khierallah, D.Q.; Fuller, F.; Aberlenc, Ch. and Michael, D.P. (2019). "Cross-species hybridization and the origin of North African date palms". Proceedings of the National Academy of Sciences USA. 116 (5): 1651-1658.
38. Gadanho, M., Almeida, J. M. F. & Sampaio, J. P. (2003). Assessment of yeast diversity in a marine environment in the south of Portugal by microsatellite-primed PCR. Antonie van Leeuwenhoek 84, 217-227.
39. Gherbawy, Y. A., Elhariry, H. M., & Bahobial, A. A. S. (2012). Mycobiota and mycotoxins (aflatoxins and ochratoxin) associated with some Saudi date palm fruits. *Foodborne pathogens and disease*, *9*(6), 561-567.
40. Ghibaudo, G. and Peano, A (2010). "Chronic monolateral otomycosis in a dog caused by Aspergillus ochraceus". Veterinary Dermatology. 21 (5): 522-6.
41. Ghinimi, S.; Umer, S.; Karim, A.; Kamal-Eldin (2017). Review Article: Date fruit (Phoenix dactylifera L.): An underutilized food seeking industrial valorization. NFS journal, 6: 1-10.
42. Gould, GW. (2001). Symposium on "Nutritional effect of new processing technologies" New processing technologies: an overview, proceeding of the Nutrition Society, 60: 463-474.
43. Guerrero-Beltrán, JA. and Barbosa-Cánovas, G. (2004). Review: advantages and limitations on processing foods by UV light. Food Science and Technology International. 10: 137-147.
44. Gupta, A., Eral, H.B., Hatton, T.A. and Doyle, P.S. (2016). Nanoemulsions: formation, properties and applications. SoftMatter, 12: 2826-2841.
45. Hamad, S. H., Saleh, F. A., & Al-Otaibi, M. M. (2012). Microbial contamination of date rutab collected from the markets of Al-Hofuf City in Saudi Arabia. *The Scientific World Journal*, *2012*.
46. Hasnae, T., Faouzi, E., Lotfi, A., & Rachida, C. (2013). Microbiological Quality of Dates in the North Center Region of Morocco. *Journal of Life Sciences*, *7*(12).
47. Helmy, HM.; E.; Kaindl R.; Fritz, H. and Loizenbauer, J. (2004). The Sukari Gold Mine, Eastern Desert-Egypt: structural setting, mineralogy and fluid inclusion study. Mineralium Deposita, 39: 495-511.
48. Hutzler, M.; Ried, R.; Koob, J. and Jacob, F. (2012). Fermentation and spoilage yeasts and their relevance for the beverage industry-A review. Brewing Science, 65: 33-52.
49. Ibraheem IAM, Klaef MNH (2003). Date palm culture service and production in Arab home cland. Alis Kanjeriya Press. p.789
50. Jennessen, J.; Rer, J.S.; Olsson, J.; Samson, R.A.; Dijksterhuis, J. (2008). Morphological characteristics of sporangiospores of the tempe fungus Rhizopus oligosporus differentiate it from other taxa of the R. microsporus group. Mycological research. 112: 547-563.
51. Kadum, H., Hamid, A., Abas, F., Ramli, N. S., Mohammed, A. K. S., & Muhialdin, B. J. (2018). Applications of Date (Phoenix dactylifera L.) Fruits as Bioactive Ingredients in Functional Foods. *vol*, *12*, 1101-1108.
52. Kalaivani, R., Renuka, C, Saravanan, K and S. Elavarasi (2015). Preservation of Vegetable by Traditional and Natural Methods. National Seminar on Biodiversity and Conservation: Present Status and Future Perspectives. 46-59.
53. Kchaou W, Abbès F, Mansour RB, Blecker C, Attia H, Besbes S. (2016). Phenolic profile, antibacterial and cytotoxic properties of second grade date extract from Tunisian cultivars (Phoenix dactylifera L.) Food Chem. 194: 1048-1055.
54. Keyser, M.; Muller, IA.; Cilliers, FP.; Nel, W. and Gouws, PA. (2008). UV radiation as a non-thermal treatment for the inactivation of microorganisms in fruit juice, Innovative food science and emerging technologies, 9(3): 348-354.
55. Khan, F.; Khan, TJ.; Kalamegam, G.; Pushparaj, PN.; Chaudhary, A.; Abuzenadah, A.; Kumosani, T.; Barbour, E. and Al-Qahtan, M. (2017). Anti-cancer effects of Ajwa dates (*Phoenix dactylifera* L.) in diethylnitrosamine induced hepatocellular carcinoma in Wistar rats. BMC Complementary and Alternative Medicine. 17:418- 428.
56. Knorr, D.; Zenker, M.; Heinz, V. and Lee, D. (2004). Applications and potential of ultrasonics in food processing. Trends in Food Science & Technology, 15(5): 261-266.
57. Krishnan, V.; Seervi, P.; Bhati, A.; Singhal, H.; Sushil, I.S. And Prazapati, P. (2014). Study of Traditional Methods of Food Preservation, Its Scientific Understanding and Technological Intervention. Istp (Group-7) Final Report. 35-39.
58. LaCoste A, Schaich K, Zumbrunnen D and K Yam Advanced controlled release packaging through smart blending. Packag Technol Sci 2005; 18:77-87.
59. Lacroix, N.; Fliss, I. and Makhlouf, J. (2005). Inactivation of pectin methylesterase and stabilization of

opalescence in orange juice by dynamic high pressure. Food res. Int. 38(5): 569-576.
60. Mailafia, S., God'spower Richard Okoh, H. O., Olabode, K., & Osanupin, R. (2017). Isolation and identification of fungi associated with spoilt fruits vended in Gwagwalada market, Abuja, Nigeria. *Veterinary world*, *10*(4), 393.
61. Manickavasagan, A.; Essa, M. M. and Sukumar, E. (2012). Dates Production, Processing, Food, and Medicinal Values, Medicinal and Aromatic Plants-Industrial Profiles. Taylor & Francis Group.
62. Markhand, Gs.; Abul-Soad, Aa.; Mirbahar, Aa.; Kanhar, Na. (2010). Characterization Of Pakistani Dates. Pak. J. Bot., 42(6): 3715-3722.
63. Mateo, EM; Valle-Algarra, FM; Mateo-Castro, R; Jimenez, M (January 2011). "Impact of non-selective fungicides on the growth and production of ochratoxin A by Aspergillus ochraceus and A. carbonarius in barley-based medium". Food Additives & Contaminants: Part A. 28 (1): 86-97.
64. McClenny N. (2005). Laboratory detection and identification of Aspergillus species by microscopic observation and culture. J Md Mycol. 1:S125-S128.
65. Melissa A. Click; Ronit Ridberg, Saving Food: Food Preservation as Alternative Food Activism, Environmental Communication: *A Journal of Nature and Culture*, Vol. 4, No. 3, September 2010, pp. 301-317.
66. Mihindukulasuriya, S.D.F. and Lim, L.T. (2014). Nanotechnology development in food packaging: a review. Trends Food Sci. Technol., 40: 149-167.
67. Mirza, M. B., Syed, F. Q., Khan, F., Elkady, A. I., Al-Attar, A. M., & Hakeem, K. R. (2019). Ajwa Dates: A Highly Nutritive Fruit with the Impending Therapeutic Application. In *Plant and Human Health, Volume 3* (pp. 209-230). Springer, Cham.
68. Mohammed, R., M.; Fageer, A., S.; Eltayeb, M., M., and, I., A. (2014). Chemical composition, antioxidant capacity and mineral extractability of Sudanese Date Palm (Phoenix dactylifera L.) fruits, *Journal of Food Sci. Nutr*. 2 (5): 478-489.
69. Musselman, L. J. 2007. Figs, Dates, Laurel and Myrrh: Plants of the Bible and the Quran. Timber Press, Inc., Portland, OR, pp. 114-119.
70. Nagdi, MO.; Smith, JP. And Cayouette, B. (2003). Kinetics of ultraviolate light inactivation of Echerichia coli O157:H7 in liquid foods. *Journal of Science food and agriculture*, 83: 1551-1555.
71. O'donnell, CP.; Tiwari, BK.; Bourke, P. and Cullen, PJ. (2010). Effect of ultrasonic processing on food enzymes of industrial importance. Trends in Food Science & Technology, 21(7): 358-367.
72. Ohkura, M.; Peter, J.; Cotty, T. and Orbach, M.J. (2018). Comparative Genomics of Aspergillus flavus S and L Morphotypes Yield Insights into Niche Adaptation. G3 "Genomes, Genomics, Genetics. 8: 3915-3930.
73. OKTAY, Ö. H., BAŞEĞMEZ, H., & Ozay, G. (2012). Mycotoxin Risk and Toxigenic Fungi in Date, Prune and Dried Apricot Among Mediterranean Crops.
74. Oliveira M, Ribeiro H, Abreu I 2005 - Annual variation of fungal spores in atmosphere of Porto. Annals Agricultural Environmental Medicine 12, 309-315.
75. Ostry, V; Malir, F; Ruprich, J (Sep 17, 2013). "Producers and important dietary sources of ochratoxin A and citrinin". Toxins. 5(9): 1574-86. doi:10.3390/toxins5091574. PMC 3798874. PMID 24048364.
76. Õzkara A, Ocak I, Korcan S, Konuk M 2007-Determination of fungal air spora in Afyonkarahisar, Turkey. Mycotaxon 102, 199-202.
77. Palou, L., Rosales, R., Taberner, V., & Vilella-Espla, J. (2016). Incidence and etiology of postharvest diseases of fresh fruit of date palm (Phoenix dactylifera L.) in the grove of Elx (Spain). *Phytopathologia Mediterranea*, *55*(3), 391-400.
78. Panda T, Panda B, Mishra N 2009-Seasonal Incidence Of Air Borne Fungi In Coastal Belt Of Orissa. Journal Of Human Ecology 26(3), 205-207.
79. Patrignani, F.; Vannini, L.; Kamdem, SLS.; Lancciotti, R. And Guerzoni, ME. (2009). Effect Of High Pressure Homogenization On Saccharomyces Cerevisiae Inactivation And Physicochemical Features In Apricot And Carrot Juice. International Journal Of Food Microbiology. 136: 26-31.
80. Paulussen, C.; Hallsworth, J.E.; Álvarez-Pérez, S.; Nierman, W.C.; Hamill, P.G.; Blain, D.; Rediers, H. and Lievens, B. (2016). Ecology of aspergillosis: insights into the pathogenic potency of Aspergillus fumigatus and some other Aspergillus species. Microb Biotechnol. 10(2): 296-322.
81. Rai, M., Yadav, A. And Gade, A. (2009). Silver Nanoparticles As A New Generation Of Antimicrobials. Biotechnol. Adv. 27 76-83. 10.1016/ *J.Biotechadv*.2008.09.002.
82. Reynolds G 2007 FDA recommends nanotechnology research, but not labelling.FoodProductionDaily.com News 26 July 2007. Available at http://www.foodproductiondaily-usa.com/news/ng.asp?n=78574-woodrowwilsonnanotechnologyhazardous(accessed 24 January 2008)
83. Rhoades J. and Roller S. (2000). Antimicrobial actions of degraded and native chitosan against spoilage organisms in laboratory media and foods. Appl Environ Microbiol. ; 66:80-86.
84. Rupasinghe, H.P.V. and Yu, L.J. (2012). Emerging Preservation Methods for Fruit Juices and Beverages. Food Additive journal. 66-82.
85. Samson RA, Varga J 2007-Aspergillus systematics in the genomic era. Studies in Mycology 59, 1-206.
86. Sanzani S.M., Reverberib M., Geisen R. (2016). Mycotoxins in harvested fruits and vegetables: Insights in producing fungi, biological role, conducive conditions, and tools to manage postharvest contamination. Postharvest Biol. Technol. 122: 95-105.
87. Schubert K, Braun U, Groenewald JZ, Crous PW (2007). Cladosporium leaf-blotch and stem rot of Paeonia spp. caused by Dichocladosporium gen. nov. Studies in Mycology 58: 95-104.
88. Sekhon, B. (2010). Food nanotechnology-An overview. Nanotech., Sci. Applic., 3: 1-15.
89. Sorrentino A, Gorrasi G and V Vittoria Potential perspectives of bionanocomposites forfood packaging applications. Trends Food Sci Technol 2007 18:84-95.

90. Teena, M. A., Manickavasagan, A., Ravikanth, L., & Jayas, D. S. (2014). Near infrared (NIR) hyperspectral imaging to classify fungal infected date fruits. *Journal of Stored Products Research*, *59*, 306-313.
91. Torres, B., Tiwari, B.K., Patras, A., Cullen, P.J., Brunton, N., ODonnell, C.P. (2011). Stability of anthocyanins and ascorbic acid of high pressure processed blood orange juice during storage. Innovative Food Science and Emerging Technologies 12(2), 93-97.
92. Vale´rio, E., Gadanho, M. & Sampaio, J. P. (2008). Sporidiobolus johnsonii and Sporidiobolus salmonicolor revisited. Mycol Prog (in press). Published online ahead of print 6 September 2007. doi:10.1007/s11557-007-0547-8.
93. Vayalil P. K. (2012). Date fruits (Phoenix dactylifera Linn): an emerging medicinal food. Crit. Rev. Food Sci. 52, 249-471.
94. Visagie, C.M.; Houbraken, J.; Frisvad, J.C.; Hong, S.B.; Klaassen, C.H.W.; Perrone, G.; Seifert, K.A.; Varga, J.; Yaguchi, T. and Samson, R.A. (2014). Identification and nomenclature of the genus Penicillium. STUDIES IN MYCOLOGY 78: 343-371.
95. Weiss, J., Takhistov, P. and McClements, J. (2006). Functional materials in food nanotechnology. J. Food Sci., 71 R107- R116. 10.1111/j.1750-3841.2006. 00195.x.
96. Williams, J. H., T. D. Phillips, P. E. Jolly, J. K. Stiles, C. M. Jolly *et al*., 2004 Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions. Am. J. Clin. Nutr. 80: 1106-1122. https://doi.org/10.1093/ajcn/ 80.5.1106
97. Wilson, DM; Mubatanhema, W; Jurjevic, Z (2002). Biology and ecology of mycotoxigenic Aspergillus species as related to economic and health concerns. Advances in Experimental Medicine and Biology. 504: 3-17.
98. Yuste, J. and Fung, DY. (2004). Inactivation of Salmonella typhimurium and Echerchia coli O157:H7 in apple juice by a combination of nisin and cinnamon. *Journal of Food Protection*, 67: 371-377.
99. Zaid, A. and P. F. de Wet. 2002. Botanical and systematic description of the date palm. In A. Zaid and E. J. Arias-Jiménez (eds.), Date Palm Cultivation. FAO Plant Production and Protection Paper 156 Rev. 1. Rome, Italy.
100. Zalar P, Hoog GS de, Schroers H-J, Crous PW, Groenewald JZ, Gunde-Cimerman N (2007). Phylogeny and ecology of the ubiquitous saprobe Cladosporium sphaerospermum, with descriptions of seven new species from hypersaline environments. Studies in Mycology 58: 157-183.
101. Zarate-Rodriguez, E.; Ortega-Rivas, E. (2001). Effect of membrane pore size on quality of ultrafiltered apple juice. *International Journal of Food Science and Technology*. 36(6): 663-667.

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