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البيضاء، ليبيا

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Annotated List of the Family Lygaeidae Schilling, 1829 (Heteroptera) in Libya

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Abstract: In this study, subfamilies, genera, and species of Lygaeidae are given, accompanied by synonyms, local and general distribution. This study was carried out during the years 2007-2010 in the country of Libya. This study revealed the presence of 111 species in Libya under 52 genera to 8 subfamilies. 31 are recoded from Libya for the first time in the present study.

Keywords: Lygaeidae; Heteroptera; Libya; Synonyms; Local & General Distribution; Seed Bugs.

INTRODUCTION

The State of Libya is a country in the Maghreb region in North Africa, bordered by the Mediterranean Sea to the north, Egypt to the east, Sudan to the southeast, Chad to the south, the Niger to the southwest, Algeria to the west, and Tunisia to the northwest. The sovereign state consists of three historical regions: Tripolitania (west), Fezzan (East), and Cyrenica (East). With an area of almost 1.8 square kilometers, Libya is the fourth largest country in Africa.

The family Lygaeidae Schilling (Heteroptera) of Libya is still incompletely known. The earliest work on Libyan Lygaeidae is probably that of (Zavattari, 1934; Damiano 1960; Eckerlein & Wagner, 1969; Linnavuori, 1969)

This family is a large and well-known group of the order Hemiptera-Heteroptera, & easily recognized by 4-segmented antennae; located below a line drawn through the middle of the eye, 4-segmented rostrum, forewing with 4 or 5 veins in membrane, female ovipositor usually laciniate, spermatheca usually with distinct bulb and flange. They are often referred to as Seed bugs.

MATERIALS AND METHODS

Lygaeid specimens were either hand-collected or by using a sweeping net or sheet-screen while resting on the host plants. Collected specimens were killed by ethyl alcohol, Mounted, and stored. The taxonomic study of the family Pentatomdae was carried out in two steps:-

1-examining the specimens collected during the present work as well as the specimens kept in the main Egyptian reference collections.

2-Identification of specimens was made by the authors based on the relevant literature such as Stichel (1960, 1961), Baranowski, (1990), Harrington (1980), Malipatil (1978), Ashlock (1967), Slater (1985, 1992), Goss (1965), Gross & Scudder (1963), Scudder (1962c).

RESULTS

SUBFAMILY: Blissinae

Genus: *Geoblissus* Hidaka, 1959
Type species: *Geoblissus rotundatus* Hidaka**, 1959.**

***Dimorphopterus brachypterus* (Rambur,**

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1839).
Synonym: *Pachymerus brachypterus* Rambur, 1839.
Distribution in Libya: Jagbob, Misrata.
General Distribution: France, Japan, Algeria, Cyprus, Egypt, Ethiopia, Sudan, Italy, Spain, Tunisia, Turkey, China, Saudi Arabia, Yemen, India, Chad**.**
Remarks: *Dimorphopterus brachypterus* (Rambur, 1839) was listed as *Stenoblissus curtulus* (Dhrn, 1860) by Wagner & Slater, 1964.

***Geoblissus hirtulus* (Burmeister, 1835)**
Synonym: *Geoblissus rotundatus* Hidka, 1959
Distribution in Libya: Jagbob, Misrata, Benghazi.
General Distribution: Algeria, Cyprus, Egypt, Ethiopia, Sudan, Libya, Spain, Tunisia, Japan, Turkey, Egypt, China, Yemen, Borneo, India, Chad, Ethiopia, and Sudan.

SUBFAMILY: Lygaeinae

Genus: *Apterola* Mulsant & Rey, 1866
Type species: *Apterola kuenckeli* M & R, 1866.

***Apterola* (*Apterola*) *kuenckeli* M& R, 1866**
Synonym: *Apterola gridellii* Mancini, 1942 Boll. Soc. ent. Ital. 92-93.
Distribution in Libya: Cyrenica (Mancni, 1942a)
General Distribution: France, Iberian Pen., Italy, Malta, Sardinia, Sicily, Spain, Algeria, Morocco, Tunisia, and Libya.
Remarks: In Libya (as synonym *Apterola gridellii* Mancini, 1942).

***Apterola* (*A*) *k. kuenckeli* M& R, 1866**
Synonym: *Apterola gridellii* Mancini, 1942: Boll. Soc. ent. Ital. 92-93.
Distribution in Libya: El Merj.
General Distribution: Bulgaria, France, Great Britain, Italy, Malta, Macedonia, Spain, Tunisia, Morocco, Libya, Egypt, and Algeria.

Genus: Cosmopleurus Stal, 1872.
Type species: *Lygaeus fulvipes* Dallas 1852.

***Cosmopleurus fulvipes* (Dallas, 1852)**
Synonym: *Lygaeus fulvipes* Dallas, 1852. List. Hem. B. M. 2:536
Distribution in Libya: Fezzan: Wadan, Jerma, El Khomos, Jebel Soda, El Kufra, Houn(Mancini, 1936), Gateron, Ghat, Wadi Iseien, Wadi Tanezzuft, Jebel El Wuenat (Mancini, 1935, 1936a, 1940).
General Distribution: Spain, Croatia, Malta, Algeria, Egypt, Libya, Morocco, Tunisia, Iran, Jordan, Saudi Arabia, Syria, Yemen, Pakistan, and Mauritania.

***Cosmopleurus fulvipes* (Dallas, 1852)**
Synonym: *Lygaeus degeni* Distant, 1918: Ann. Mag. Nat. Hist. (9): 2: 257.
Distribution in Libya: Fezzan, Murzak, Kufra, Obary.
General Distribution: Western Africa, Algeria, Saudi Arabia, Cape Verde, Egypt, Morocco, Iran, Sudan, Syria, and Libya.

Genus: *Lygaeus* Fabricius, 1794
Type species: *Cimex equestris* Linnaeus 1758

***Lygaeus creticus* Lucas, 1853**
Synonym: *Lygaeus sexmaculatus* Garbiglietti, 1869, Boll. Soc. ent. Ital. 1:41-112.
Distriution in Libya: Derna (Mancini, 1854)
General Distribution: Libya, Greece, Italy, Saudi Arabia, Afghanistan, Turkey, Cyprus, Iran, Syria, Bosnia, Croatia, Macedonia, Jordan, and Lebanon.

Genus: *Hormopleurus* Horvath, 1884
Type species: *Hormopleurus nysioides* Horvath, 1884

***Hormopleurus nysioides* Horvath, 1884**
Synonym: *Lygaeosoma hoggari* Bergevin, 1932 Bull. Soc. Hist. nat. Afr. N. 286-287
Distribution in Libya: Fezzan: Tin Caraden, Bir Tahala (Mancini, 1942a).
General Distribution: Syria, Algeria, Libya, Egypt, Morocco, Iraq, Saudi Arabia, Yemen, Ivory Coast, and Sudan.

Genus *Horvathiolus* Josifov, 1965
Type species *Horvathiolus adonis* Linn, 1978.

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***Horvathiolus fulvescens* (Puton, 1874)**
Synonym: *Melanocoryphus fulvescens* Puton, 1874Pet. Nouv. Ent. 6: 112: 452
Distribution in Libya: Al-Bayda, Jebel Akhdar, Messa (Eckerlein & Wagner, 1969).
General Distribution: Spain, Algeria, Turkey, Italy, Tunisia, and Libya.

***Horvathiolus guttatus* (Rambur, 1839)**
Lygaeus guttatus Rambur. 1839 Faun. Andalus, pp. 155-156
Distribution in Libya: Cyrenica (Eckerlien and Wagner, 1969).
General Distribution: France, Portugal, Spain, Algeria, Egypt, Morocco, Tunisia, and Libya.

****Horvathiolus guttatus guttatus* (Ram, 1839)**
Synonym: *Melanocoryphus persimilis* Horvath, 1916: Ann. Mus. Nat. Hung. 14: 466
Distribution in Libya: El Mej, Gubba
General distribution: Albania, Russia, Cyprus, Portugal, Russia, Caucasus, Algeria, Morocco, Turkey, Tunisia, Spain, and Libya.
Remarks: *Horvathiolus guttatus guttatus* (Ram, 1839) was listed as *Melanocoryphus persimilis* Horvath by Zavattari (1934), & Linnavuori (1965), and Eckerlen & Wagner 1969 as *Horvathiolus persimilis* Horvath, 1916, listed as synonym by Vidal 1952.

Genus: *Melanocoryphus* Stal
Type Species *Cimex apuanus* Ross, 1794

***Melanocoryphus albomaculatus* (Goeze, 1778)**
Synonym: *Cimex albomaculatus* Goeze, 1778**.** Reuter. Rev.d Ent, 4:202
Distribution in Libya: El Merj (Mancini 1942a).
General Distribution: Holland, Turkey, France, Germany, Romania, Russia, Iran, Italy, and Libya.

****Melanocoryphus albomaculatus albomaculatus* Goeze, 1778**
Synonym: *Cimex apuanus* Rossi, 1794
Distribution in Libya: El Merj, Al-Bayda, and Gubba.
General Distribution: England, Brazil, Turkestan, Caucasus, Astrakhan, Albania, Austria, Belgium, Iran, Czechoslovakia, France, Germany, Greece, Holland, Hungary, Iraq, Italy, Poland, Portugal, Romania, Russia, Spain, Switzerland, Yugoslavia, Algeria, Libya, Turkey, Tadzhikistan Bosnia, Bulgaria, Croatia, Slovakia, Slovenia, Ukraine, Morocco, Tunisia, Azerbaijan, Kazakhstan, Armenia, Kirgizia, Turkmenistan, and Uzbekistan.

Genus*: Spilostethus* Stal, 1868
Type species: *Cimex militaris* Faricius 1775.

***Spilostethus pandurus* Scopoli, 1763**
Synonym: *Cimex pandurus* (Scopoli, 1763), Ent. Carn. Exhib. Ins. Carniol. N.363:126.
Distribution in Libya: Jagbob, Tobruk, Al-Bayda, Benghazi, Zuara, Tripoli, El Homs, Sebha, Misrata, Tajora.
General Distribution: Albania, Andorra, Austria, Bosnia, Bulgaria, Croatia, Czech, Iran, Turkey, France, India, Greece, Hungary, Italy, Macedonia, Malta, Moldavia, Portugal, Spain, Syria, Romania, Russia, Slovakia, Slovenia, Switzerland, Ukraine, Algeria, Egypt, Libya, Morocco, Tunisia, Cyprus, Yemen, China, Armenia, Azerbaijan, Afghanistan, Kuwait, Iraq, Jordan, Turkmenistan, Uzbekistan, Australia, and Philipines.

****Spilostethus* (*pandurus) pandurus* (Scopoli, 173)**
Synonym: *Cimex civilis* Fabricius, 1787: Mant. Ins. II: 298 (O.D.)
Distriution in Libya: Tobruk, Al-Bayda, Benghazi, and Zoura.
General Distribution: Albania, Austria, Bulgaria, Corsica, Cyprus, Czech, France, Germany, Greece, Iran, Hungary, Italy, Portugal, Russia, Sardinia, Spain, Switzerland, Algeria, Egypt, Morocco, Nigeria, Senegal, Sierra, Leone, Sudan, Kenya, Arabia, Iraq, India, Syria, Turkey, and Australia.

***Spilostethus (pandurus) militaris* (Fabricius, 1775)**
Synonym: *Lygaeus militaris* (Fab, 1775)

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Distribution in Libya: El Khomos, El Bordy, and Jagbob.
General Distribution: Albania, Austria, Belgium, Bulgaria, Corsica, Cyprus, France, Czechoslovakia, Germany, Greece, Italy, Majorca, Malta, Portugal, Romania, Russia, Italy, Spain, Switzerland, Algeria, Egypt, Ethiopia, Morocco, Indonesia, Iran, Mozmbique, Senegal, Sierra Leone, Sudan, Tunisia, Australia, India, Iraq, Syria, Turkey, and Libya.

***Spilostethus saxatilis* (Scopoli, 1763)**
Synonym: *Cimex saxatilis* Scopoli, 1763. Ent. Carn. Exhib. Ins.Carniol., 128:371

Distribution in Libya: Khomos (Mancini1936).
General Distribution: Albania, Austria, Bulgaria, Croatia, Czech Republic, France, Italy, Germany, Greece, Hungary, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Switzerland, Turkey, Ukraine, Spain, Slovenia, and Libya.

***Spilostethus saxatilis lusitanicus* (Herrich-Schaeffer, 1850)**
Synonym: *Lygaeus saxatilis* (Scop, 1794)
Distribution in Libya: El Khomos.
General Distribution: France, Portugal, Spain, Algeria, Egypt, Morocco, and Libya.

***Spilostethus longulus* (Dall, 1852)**
Synonym: *Lygaeus longulus* Dallas, 1852.
Distribution in Libya: Fezzan, Wadan, Jerma, El Khomos, Jebel Soda, El Kufra, Huon, Gateron, Ghat, Wadi Tanezzuft, Wadi, Iseien, Jebel El Wuenat.
General Distribution: Sudan, Eritrea, Ethiopia, Nigeria, Algeria, Egypt, Arabia, Iran, India, Tunisia, Morocco, Afghanistan, Jordan, Syria, Kuwait, Yemen, and Libya.

Genus: *Paranysius* Horvath, 1895
Type species: *Paranysius fraterculus* Hor, 1895

***Paranysius fallaciosus* (Put 1895)**
Synonym: *Paranysius fallaciosus libycus* Mancini, 1935: Bull. Soc. Ent. Ital. 67: 79-80
Distribution in Libya: Fezzan, Obari, Wadi Iseil (Mancini, 1936, 1942).
General Distribution**:** Algeria, Libya, Morocco, Tunisia**,** and Sudan.

Genus: *Caenocoris* Fieber, 1860
Type species: *Lygaeus nerii* Germar, 1847

***Caenocoris nerii* (Germer, 1847)**
Synonym: *Lygaeus semirubes* Walker, 1872: Cat. Hem. Het. B. M. 5: 58
Distribution in Libya: Gharyian (Menozzi 1940), Derna (Mancini, 1942), and Jagbob.
General distribution: Albania, Bulgaria, Cyprus, Russia, Italy, Eritrea, Ethiopia, Mozambiue, China, Syria, Algeria, Malta, Tunisia, Morocco, Turkey, India, Pakistan, Jordan, Saudi Arabia, and Libya.

Genus: *Horvathiolus* Josifov, 1965
Type species: *Horvathiolus amoenulus* (Gerstaecker, 1873)

***Horvathiolus fulvescens* (Puton, 1874)**
Synonym: *Melanocoryphus fulvescens* Puton, 1874: Pet. Nouv. Ent. 6: 112: 452
Distribution in Libya: Al-Bayda, Jebel Akhder, and Messa.
General Distribution: Italy, Spain, Algeria, Turkey, Tunisia, and Libya.

***Horvathiolus guttatus* (Rmbur, 1842)**
Synonym: *Melanocoryphus persimilis* Horvath, 1916
Distribution in Libya: El Merj.
General Distribution: France, Portugal, Spain, Algeria, Egypt, Morocco, Tunisia, and Libya.

****Horvathiolus guttatus guttatus* (Rambur, 1839)**
Synonym: *Melanocoryphus atakoricus* Bergevin, E. 1932. Bull. Soc. Hist. nat. Afr. Nord. 23: 281-283.
Distribution in Libya: Derna, El Marj, and Gubba.

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Generall Distribution: Albania, Cyprus, Algeria, Spain, Russia, Morocco, Caucasus, Tunisia, and Libya.

***Horvathiolus superbus* (Polich, 1781)**
Synonym: *Cimex superbus* Pollich, 1781
Distribution in Libya: El Bakour 60Km east of Benghazi (El Meghrab.M.S.2001).
General Distribution: Albania, Andora, Austria, Belgium, Bosnia, Bulgaria, Canary Isles, and Croatia.

***Horvathiolus superbus superbus* (Pollich, 1783)**
Synonym: *Cimex discolor* Pollich, 1790 Gmelin.
Carol. Linn. Syst. Nat. 13th Ed.
Distribution in Libya: El Bakour 60Km east of Benghazi.
General Distribution: Egypt, Syria, Albania, Austria, Belgium, Bulgaria, Czechoslovakia, France, Germany, Greece, Italy, Poland, Portugal, Russia, Spain, Algeria, Libya, Morocco, and Switzerland.

SUBFAMILY: Pachygronthinae
Genus: *Cymophyes* Fieber, 1870
Type species: *Cymophyes ochroleuca* Fieb, 1870.

***Cymophyes ochroleuca* Fieber, 1870**
Synonym: *Cymophyes* (*C*) *ochroleuca* Fieber, 1870: Verh. Zool. Bot. Ges. Wien. 20: 247-8
Distribution in Libya: Cyrenica (de Bergevin, 1930).
General Distribution: Cyprus, Greece, Russia, Egypt, Caucasus, Syria, Turkey, Turkestan, Iran, and Libya.

SUBFAMILY: Rhyparochromiae

Genus: *Gastrodes* Westwood, 1840
Type Species: *Gastrodes* (*Orsillodes*) *longirostris* Puton, 1884.

***Gastrodes* (*Orsillodes*) *longirostris* Puton, 1884**
Synonym: *Gastrodes* (*Orsillodes*) *longirostris* Puton, 1884:a pp. 143-4.

Genus: *Hyalochilus* Fieber, 1861
Type species: *Cymus ovatulus* Costa, A.1855

***Hyalochilus ovatulus* (Costa, 1855)**
Synonym: *Hyalochilus cordiger* Fieber, 1861: Wien: Gerold vi, Eur. Hem. p. 190.
Distribution in Libya: Wadi Belgader (Mancini, 1942a).
General Distribution: Tunisia, Morocco, France, Turkestan, Canary Isles, Greece, Italy, Malta, Spain, Portugal, Russia, Algeria, and Libya.

Genus: *Camptocera* Jakovlev, 1877
Type species: *Rhyparochromus glaberrimus* (Walker, 1872).

***Camptocera glaberrima* (Walker, 1872)**
Synonym: *Tropistethus aurantiacus* Distant, 1918: Fn. Brit. Ind. Rhynch. 7: 197
Distribution in Libya: Fezzan, Ghat, (Mancini, 1942), El Khomos (Linnavuori, 1965).
General Distribution: Italy, France, Russia, Spain, Algeria, Egypt, Syria, Turkestan, Iran, Morocco, Caucasus, Turkey, Eritrea, Sudan, India, and Libya.

Genus: *Rhyparochromus* Hahn, 1826
Type species: *Rhyparochromus pini* (L, 1758)

***Rhyparochromus* (*Microtomideus*) *carbonarius*] (Rambur, 1839)**
Synonym: *Pachymerus* (*Microtomideus*) *dasycnemis* Reuter, 1885: Rev. d'Ent., Caen. 4: 221, 223.
Distribution in Libya: El Merj (Mancini 1942a)
General Distribution: Germany, Italy, Spain, Algeria, Morocco, and Libya.

****Rhyparochromus* (*Xanthochilus*) *saturnius* Rossi, 1790**
Synonym: *Pachymerus rhombeus* Fieber, 1837: Beitr. Ges. Natur- Heilwissen.1: 346.
Distribution in Libya: Benghazi.
General Distribution: Bulgaria, Corfu, Corsica, Crimea, France, Germany, Greece, Italy, Malta, Portugal, Russia, Spain, Algeria, Canary Isles., Egypt, Morocco, Tunisia, Caucasus, Syria, and Libya.

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Genus: *Remaudiereana* Hoberlandt, 1954
Type species: *Remaudiereana tibialis* Hoberlandt, L. 1954: Bull. Inst. franc. Afr. Noire. 16: 922-4

***Remaudiereana annnulipes* (Baerennsprung, 1859)**
Synnym: *Remaudiereana africana* Hoberlandt, 1954:Bull. Inst. Franc. Afr. Noire 16: 925-6
Distribution in Libya: Benghazi (Mancini, 1942a), El Merj (Linnavuori,1965).
General Distribution: Burma, Ceylon, Egypt, India, Japan, Sudan, France, Portugal, Libya, Algeria, Morocco, Ethiopia, Iran.

Genus *Proderus* Fieber, 1861
Type species: *Pachymerus suberythropus,* Costa, A.:1841.

***Proderus amabilis* Puton, 1873**
Synonym: *Stenocarenus vulsus* Jakovlev, 1876: Trud. Ent. Ross. 9: 223.
Distribution in Libya: Fezzan: Fewat (Mancini 1942a).
General Distribution: Algeria and Libya.

Genus: Acompus Fieber, 1860
Type species *Acompus rufipes* (Wolff, 1802)

***Acompus rufipes nigrescens* Bergevin, 1930**
Synonym: *Lygaeus rufipes* Wolff, 1804: Icon. Cimic. Desc. Illust. 4: 151, IV. Palm, Erlangae, pp. 127–166.

Distribution in Libya: Cyrenica (de Bergev, 1930 & Zavattari, 1934).

General Distribution: Austria, Belarus, Belgium, Bosnia, Bulgaria, England, Croatia, Russia, Czech Republic, and Libya.

Genus: *Aphanus* Laporte & de Castelnau, 1832
Type species: *Aphanus rolandri* Linn, 1758.

***Aphanus aethiops* (Douglas & Scott, 1868)**
Synonym: *Pachymerus rolandri* variety *morio* Gradl, 1881:. Ent. Nach. Machr. 7: 308-9

Distribution in Libya: Magrun 90Km West of Benghazi (Mancini, 1942a).
General Distribution: Austria, Cyprus, Czechoslovakia, France, Germany, Greece, Italy, Egypt, Iran, Jordan, Syria, Turkey, and Libya.

Genus: *Dieuches* Dohrn, 1860
Type species: *Dieuches syriacus* Dohrn Dohrn, F.A. 1860. Stettin Ent. Zeit. 21:99-109

***Dieuches mucronatus* (Stal, 1865)**
Synonym: *Dieuches pallidulus* Distant, 1904: Distant: Fn. Brit. Ind. Rhynch. 2: 85.
Distriution in Libya: Tripoitania (El Brakat), Fezzan (Ghat, Tin Alcun) (Mancini,1942a)
General Distribution: India, Arabia, Egypt, Cape Verde Is., Nubia Is., Uganda, and Libya.

Genus: *Neurocladus* Fieber, 1860
Type species: *Rhyparochromus brachiidens* Dufour, L.**1851**

***Neurocladus brachiidens* (Dufour, 1851)**
Synonym: *Neurocladus ater* Fieber, 1861.
Distriution in Libya: Benghazi (Mancini, 1936), El Abiar (Mancini,1942a).
General Distribution: Bulgaria, Cyprus, France, Greece, Italy, Portugal, Romania, Russia, Spain, Algeria, Canary Isles., Libya, Madeira, Morocco, Tunisia, Caucasus, Iran, Syreia, Turkestan, and Turkey.

Genus: *Gonianotus* Fieber, 1861
Type species: *Gonianotus marginepunctatus* (Wolff, 1802): Icon. Cimic. 4: 150.

***Gonianotus marginepunctatus* (Wolff, 1804)**
Synonym: *Lygaeus marginepunctatus* Wolff, 1804: Icon. Cimic. 4: 150.
Distribution in Libya: Tripolitan, ElAzizia
General Distribution: Austria, Belarus, Belgium, Bosnia, Bulgaria, Russia, and the Czech Republic.

SUBFAMILY: ORSILLINAE
Genus: *Camptocoris* Putom, 1886
Type species: *Camptocoris* maculatus Jakovlev 1885.

***Camptocoris longicoris* (Putom, 1874)**
Synonym: *Nysius longicoris* Putom, 1874.

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Distribution in Libya: Tripolitan (Leptis Magna).
General Distribution: Italy, Turkey, Syria, Palestine, and Libya.

Genus: *Orsillus* Dallas, 1852
Type species: *Orsillus depressus* Dallas, W.S., 1952.

***Orsillus maculatus* (Fieber, 1861)**
Synonym: *Orsillus longirostris* Mulsant & Rey, 1870: Opusc. Ent. 14: 232
Distribution in Libya: Wadi El Cuf (Mancini, 1942a).
General Distribution: Albania, Bosnia, Bugaria, Croatia, Czech Republic, France, Italy, Greece, Macedonia, Russia, Slovenia, Spain, Ukraine, Azerbaijan, Turkey, Cyprus, Georgia, Jordan, Algeria, and Libya.

*** *Orsillus maculatus maculatus* (Fieber, 1861)**
Synonym: *Orsillus longirostris* Mulsant & Rey , 1870: Opusc. Ent. 14: 232
Distribution in Libya: Al-Bayda.
General Distribution: Albania, Austria, France, Greece, Italy, Russia, Spain, Algeria and Libya.

***Orsillus depressus* Dallas, 1852**
Synonym: *Heterogaster depressus* Mulsant & Rey, 1852: Ann. Soc. linn. Lyon 1850-52: 112-113.
Distribution in Libya: El Merj (Linnavuori, 1965).
General Distribution: Iran, France, Germany, Hungary, Italy, Portugal, Russia, Spain, Iran, Switzerland, Morocco, Tunisia, Turkey, Albania, Austria, Belgium, Bosnia, Bulgaria, Croatia, Czech Republic, England, Greece, Liechtenstein, Luxembourg, Macedonia, Armenia, Romania, Slovakia, Slovenia, Ukraine, Algeria, Azerbaijan, Kazakhstan, Tadzhikistan, Turkmenistan, Uzbekistan Netherlands, and Libya.

*** *Orsillus maculatus maculatus* (Fieber, 1861)**
Synonym: *Orsillus longirostris* Mulsant & Rey , 1870: Opusc. Ent. 14: 232
Distribution in Libya: El Mej.
General Distribution: Albania, Austria, France, Greece, Italy, Russia, Spain, Yugoslavia, And Libya.

Genus: *Nysius* Dallas 1852
Type species: *Lygaeus thmi* Wolff, 1804.

***Nysius (Nysius) ericae* (Schilling, 1829)**
Synonym: *Heterogaster ericae* Schilling: Beit. Z.Ent, 1-86.
Distribution in Libya: El Khomos (Mancini, 1942a)
General Distribution: Austria, Belgium, Bosnia, Bulgaria, Egland, Russia, Croatia, and Libya.

***Nysius ericae ericae* (Schilling, 1829)**
Synonym: *Nysius albidus* Jakovlev, 1867:
Distribution in Libya: Tripoli
General Distribution: Egypt, Senegal, Astrakhan, Turkestan, USA, Mexico, Panama, Puerto Rico, China, Iran, Austria, Belgium, Iraq, Czech Republic, England, France, Germany, Hungary, Poland, Armenia, Portugal, Romania, Russia, Spain, Sweden, Arabia, Switzerland, Yugoslavia, Algeria, Mongolia, Bulgaria, Croatia, Greece, Slovakia, Ukraine, Morocco, Tunisia, Yemen, Turkey, Taiwan, Armenia, and Libya.

***Nysius* (*Macroparius*) *cymoides* (Spinola, 1837)**
Synonym: *Arthenesis cymoides* Spinola, 1837: Essai, Gen. Ins.Hem:252
Distribution in Libya: Sahabi, Gialo, El Kufa (Zavattari, 1934).
General Distribution: Russia, Turkey, Spain, Sudan, and Libya.

****Nysius senecionis senecionis* (Schilling, 1829)**
Synonym: *Nysius senecionis aegypticus* Priesner & Alfieri, 1953:Bull.Soc.Fouad. Ent.37:43.
Distribution in Libya: Ajdabiya (de Bergevin, 1932).
General Distribution: Sudan, Syria, Albania, Austria, Belgium, Bulgaria, Mongolia, France,

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Germany, Greece, Hungary, Italy, Poland, Portugal, Egypt, Armenia, Croatia, Romania, Russia, Spain, Switzerland, Algeria, Yemen, Morocco, China, Turkey, Denmark, England, Netherland, Slovakia, Slovenia, Ukraine, Tunisia, Kazakhstan, Turkmenistan, Uzbekistan, Czech Republic, Saudi Arabia and Libya.

***Nysius immunis* (Walker, 1872)**
Synonym: *Nysius stalianus* Horvath, 1890.
Distribution in Libya: El Bieda
General Distribution: France, Greece, Italy, Algeria, Morocco, Turkey, Canary Isles, Croatia, France, Italy, Portugal, Britain, Spain, Switzerland, Algeria, Morocco, Tunisia, Turkey, and Libya.
Remarks: species *Nysius* (*Tropinysius*) *stalianus* (Walker, 1872) was synonymized as species *Nysius immunis* (Walker, 1872).

SUBFAMILY: Geocorinae

Genus *Geocoris* Fallen, 1814
Type Species *Cimex grylloides* Linnaeus, 1761,

***Geocoris* (*Eillatus*) *confalonierii* de Bergvin, (1932)**
Synonym: *Geocoris massoni* Villiers, 1956: Villiers, A. 1956. Bull. Inst. franc. Afr. N. Noire 18: 840-841.
Distibution in Libya: El Kufra, Bezema (Mancini, 1940).
General Distribution: Mauritania, Algeria, Egypt, Sudan, and Libya.

***Geocoris* (*Geocoris*) *acuticeps* Signoret, 1881**
Synonym: *Geocoris acuticeps falsatus* Montandon, 1916: Bull. Soc. Ent. Egypt 4: 50
Distribution in Libya: Fezzan: Murzuk (Mancini, 1942a).
General Distribution: Greece, Malta, Egypt, Iran, Iraq, Saudi Arabia, Uzbekistan, Turkmenistan, Tadzhikistan, Yemen, Sudan, Kuwait, Syria, and Libya.

***Geocoris* (*Geocoris*) *lineolus* (Rambur, 1839)**
Synonym: ***Geocoris*** lineola Ramur, Linnavouri 1978: Acta.Zoo.Fenn.153:60.
Distribution in Libya: Tripolitania: Leptis Magna, Misrata (Mancini, 1936).
General distribution: Europe and Africa.

****Geocoris* (*Geocoris*) *lineolus lineolus* (Rambur, 1839)**
Synonym: *Geocoris erythrophthalmus* Reuter:. Ofvers. Finsk: Ofv. Finsk. Vet. Soc. Forh. 22: 9
Distribution in Libya: Benghazi.
General Distribution: Turkey; Corsica, Russia, Caucasus, France, Greece, Italy, Portugal, Spain, Algeria, Canary Isles., Egypt, Tunisia, Morocco, Iran, Syria, Saudi Arabia, Turkey, Iraq, Cyprus, Albania, Bosnia, Bulgaria, Yemen, and Libya.

***Geocoris nigriceps* Reuter, 1891**
Synonym: *Geocoris nigriceps* Reuter, 1891.
Distribution in Libya: Fezzan: Sebha, Ain Kirim, Tripolitania: Misrata, El Homos (Mancini, 1936), Kufra (Mancini, 1940).
General Distribution: Egypt, and Libya.

***Geocoris nigriceps henoni* Puton, 1892**
Synonym: *Geocoris nigriceps henoni* Puton, 1892.
Distribution in Libya: Fezzan: Sebha, Ain Kirim, Tripolitania: Misrata, El Homos (Mancini, 1936), Kufra (Mancini, 1940).
General Distribution: Palestine, Egypt, and Libya.

****Geocoris* (*Geocoris*) *erythrops* (Dufour, 1857)**
Remarks: Species *Geocoris scutellaris* Puton, 1886 was synonymized as species *Geocoris erythrops* (Dufour, 1857).
Distribution in Libya: El Kufra, El Giof, El Giululad, Bir El Achuan, El Wenat, El Talab, Gialo, Wadi El Ghaza (Mancini,1940).
General Distribution: Algeria, Egypt, Tunisia, Kurdistan, Cape Verde Is, and Libya.

***Geocoris* (*Geocoris*) *megacephalus* (Rossi, 1790)**
Synonym: *Ophthalmicus phaeopterus* Germar, 1837: Silber. Rev. Ent. 5: 137
Distribution in Libya: Jagbob (de Bergevin, 1930).

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General Distribution: Albania, Austria, Belgium, Bosnia, Bulgaria, Croatia, France, Syria
Germany, Greece, Hungary, Italy, Macedonia, Malta, Netherlands, Poland, Romania, Iraq
Russia, Slovenia, Spain, Algeria, Egypt, Iran, Morocco, Tunisia, Afghanistan, Azerbaijan, Uzbekistan, Armenia, Turkey, Cyprus, Jordan, and Libya.

***Geocoris* (*Geocoris*) *collaris* Puton, 1878**
Synonym: *Geocoris thoracicus* Puton, 1874: Pet. Nouv. Ent. 6: 452.
Distribution in Libya: Huon (Mancini, 1942, Gialo).
General Distribution: Algeria, Canary Isles, Iraq, Egypt, Morocco, Tunisia, Saudi Arabia, Somalia, Yemen, Ethiopia, Pakistan, and Libya.

****Geocoris* (*Piocoris*) *erythrocephalus erythroc ephalus* (Lepelitier & Serville, 1825)**
Synonym: *Geocoris scutellaris* Puton, 1886.
Distriution in Libya: Sebha, El kufra.
General Distribution: Albania, Bulgaria, Corfu, Crimea, Cyprus, Czechoslovakia, France, Germany, Italy, Iraq, Greece, Hungary, Portugal, Romania, Russia, Spain, Algeria, Egypt, Morocco, Astrakhan, Caucasus, Lebanon, Syria, Turkestan, Turkey, and Libya.

***Geocoris* (*Piocoris*) *luridus* (Fieber, 1844).**
Synonym: *Ophthalmicus luridus* Fieber, 1844.
Distribution in Libya: El Kufra, Sebha, Ain Kirim, El Giof, El Giululad (Mancini, 1942), Jagbob (de Bergevin,1930), Gialo, Augia, (de Bergevin, 1932).
General Distriution: Algeria, Egypt, Tunisia, Sudan, Saudi Arabia, and Libya.

****Geocoris* (*Piocoris*) *luridus luridus* (Fieber, 1844)**
Synonym: *Piocoris obesus* Stal, 1872.
Distribution in Libya: El Kufra, Sebha, Gialo.
General Distribution: Algeria; Egypt; Iraq, Turkmenstan, Tunisia, Sudan, Arabia, Caucasus, Iran, Syria, Turkestan, Turkey, Morocco, Tunisia, Uzb-ekistan, Azerbaijan, Armenia, Georgia, Jordan Iran, SaudiArabia, Tadzhikistan, Ethiopia, Yemen, Sudan, Turkmenistan, and Libya.

Genus: *Stenophthalmicus* Costa, 1875
Type species: *Stenophthalmicus fajoumensis* Costa, A., 1875.

***Stenophthalmicus fajoumensis* Costa, 1875**
Synonym:
Stenophthalmicus mixtus Montandon, 1897: Rev. d'Ent. 16: 98-99.
Distribution in Libya, Tajura, Zuara, Triploi.
General Distribution: Algeria, Egypt, Tunisia, Sudan, Cyprus, Greece, Italy, Spain, and Libya.

***Stenophthalmicus biskrensis* Puton, 1887.**
Synonym: *Stenophthalmicus biskrensis* Puton, 1887: Bull. Soc. Ent. Egypt. 4: 51
Distribution in Libya: Fezzan: Wadi Tanezzuft (Mancini, 1936a).
General Distribution: Algeria, Egupt, Tunisia, Turkestan, Mauritania, Somalia, Niger, Iran, Morocco, Turkmenistan, and Libya.

SUBFAMILY: Henestarinae

Genus: *Henestaris* Spinola, 1837
Type species: *Henestaris genei* Spinola, M.**1837:** Essai Gen. Hem. pp. 228-230.

*** *Henestaris laticeps laticeps* (Curtis, 1837)**
Synonym: *Henestaris curtulus* Horvath, 1911:. Bull. Soc. ent. Egypt >> Note: Bull. Soc. Ent. Egypt 2: 106-7.
Remarks: species *Henestaris curtulus* Horvath, 1911 was synonymized a species *Henestaris laticeps laticeps* (Curtis, 1837).
Distribution in Libya: El Bordy (100Km east Tobruk).
General distribution: France, Algeria, Greece, Spain, Algeria, Egypt, Morocco, Austria, Belgium, Germany, Albania, Bulgaria, England, Croatia, Italy, Portugal, Turkey, Spain, and Libya.

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Genus: *Engistus* Fieber, 1864
Type species: *Engistus brucki* Fieber:. 1864. Wien. Ent. Mschr. Ent. Monat. 8: 67-8.

***Engistus boops* (Dufour, 1857)**
Synonym: *Engistus boops* (Dufour, 1857): Ann. Ent. Soc. Fr. (3): 5: 70.
Distribution in Libya: Zuara, Tripoli (Linvouri, 1965).
General distribution: Greece, France, Portugal, Italy; Spain, Algeria, Morocco, Tunisia, Canary Isles., Cyprus, Egypt, and Libya.

***Engistus boops boops* (Dufour, 1857)**
Synonym: *Engistus brucki* Fieber, 1864 Fieber: Wien. Ent. Mschr. Monat. 8: 68.
Distribution in Libya: Zuara, Tripoli, Benghazi.
General Distribution: Spain, Algeria, Portugal, Greece, France, Italy, Cyprus, Egypt, Morocco, Canary Isles., Tunisia, and Libya.

**** Engistus exsanguis exsanguis* Stal, 1872**
Distribution in Libya: Jebel El Wenat.
General distribution: France, Astrakhan, Cabo Verde, Turkestan, Morocco, Tunisia, Iran, Spain, Tukey, Russia, Algeria, Egypt, Greece, Ukraine, Syria, Canary Isles, Afghanistan, Kazakhstan, Iraq, Armenia, Iraq, Jordan, Kirgizia, Kuwait, Saudi Arabia, Sudan, Turkmenistan, Uzbekistan, Tadzhikistan, Pakistan, and Libya.

***Engistus exsanguis* (Stal, 1873)**
Synonym: *Engistus exsanguis* Stal, C. 1872. Ofvers. Vetensk Akad. Forh, Stockh. >> Note: Ofv. Vet. Akad. Forh. 29: 45.
Distribution in Libya: Jagbob Oasis El Wenat, Murzzuk (Mancini, 1935, 1940, 1942).
General Distribution: Turkestan, Kuwait, Iran, Eremian zone, Sudan, Pakistan, and Libya.

SUBFAMILY: Cyminae

Genus *Cymus* Hahn, 1831
Type species: *Lygaeus claviculus* Fallen, 1807

***Cymus minutus* Lindbg, 1939**
Synonym: *Cymus minutus* Lindbg, 1939:Bull. Soc. Fouad Ent. 22: 14-15.
Distribution in Libya: El Kufra, Benzema, El Giof (Mancini, 1940), Ghat (Mancini, 1942).
General Distribution: Egypt, Syria, Turkey, Saudi Arabia, Algeria, and Libya.

****Cymus gracilicornis* Vidal, 1940**
Synonym: *Cymus* gracilicornis Vidal, 1940:Bull. Soc. Hist. Nat. Afr. Nord 30: 442.
Distribution in Libya: El Kufra.
General Distribution: Canary Isles., Cape Verde Isles, Morocco, Sudan, Albania, Egypt, Tunisia, Turkey, Iraq, Saudi Arabia, Yemen, Iran, Libya.

SUBFAMILY: Heteogastrinae

Genus: *Heterogaaster* Schilling, 1829
Type species: *Cimex urticae* Fabricius, J.C., 1775.

***Heterogaster nasuta* Horvath, 1895**
Synonym: *Heterogaster nasuta* Horvath, G. 1895. Rev. Ent., Caen. 14: 157-8
Distribution in Libya: Al-Bayda.
General Distribution: Algeria, Morocco, Tunisia, and Libya.

****Heterogaster cathariae* (Geoffroy, 1785)**
Synonym: *Phygas nepetae* Fieber, 1837: Beitr. Ges. Natur.-Heil.-Wiss 1: 348
Distribution in Libya: Jebel Akhder.
General Distribution: Andorra, Austria, Bosnia, Bulgaria, Croatia, Romania, Germany, Italy, Czech Republic, France, Greece, Hungary, Moldavia, Russia, Switzerland, Slovakia, Spain, Ukraine, Yugoslavia, Algeria, Morocco, Azerbaijan, China, Kazakhstan, Armenia, Turkey, Cyprus, Georgia, Iran, Kirgizia, Tadzhikistan, Uzbekistan, Turkmenistan, and Libya.

Genus: *Platyplax* Fieber, 180
Type species: *Heterogaster salviae* Schilling, 1829

***Platyplax inermis* (Rambur, 1839)**
Synonym: *Heterogaster salviae* Schilling, 1829.
Distribution in Libya: El Merj.

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General Distribution: Albania, Bosnia, Hercegovina, Croatia, France, Greece, Macedonia, Italy, Portugal, Spain, Algeria, Canary Isles, Yemen, Ethiopia, Tunsia, Cyprus, Turkey, Morocco, Tunisia, and Libya.

SUBFAMILY: Oxycarninae

Genus: *Oxycarenus* Fieber, 1860
Type species: *Stenogaster tardus* Hahn (= *Oxycarenus lavaterae*), 1883.

***Oxycarenus hyalinipennis* (A. Costa, 1847)**
Aphanus hyalinipennis A.Costa, 1843: Att. R. Ist. Sci. Nat. Napol. 7: 184-185.
Distribution in Libya: Cyrenica (1942a).
General Distribution: Bosnia and Herzegovina, Bulgaria, Croatia, France, Greece, Italy, Portugal, Spain, Albania, and Libya.

***Oxycarenus (Oxycarenus) hyalinipennis* (Costa, 1847)**
Synonym: *Oxycarenus castaneus* Bergevin, 1932 Bull. Soc. Hist. nat. Afr. N.
Distribution in Libya: El Merj.
General Distribution: Argentina, Bolivia, Brazil Paraguay, Tunisia, Angola, Austria, France, Italy, Greece, Hungary, Italy, Portugal, Russia, Spain, Algeria, Egypt, Morocco, Sudan, Ethiopia, Iraq, Congo, Ethiopia, Kenya, Madagascar, Syria, Mauritania, Mozambique, Rawanda, Sengal, Uganda, Burma, China, India, Iran, and Libya.

***Oxycarenus pallens* (Herrich-Schaeffer & G.H.W., 1850)**
Synonym: *Stenogaster pallens* Herrich-Schaeffer, 1850: Wanz. Ins. 9: 214-216.
Distribution in Libya: Jebel Nefousa.
General distribution: Holomediterranean, extending to Middle and Central Asia, India, Sudan, Turkestan, and Libya.

Genus: *Bycanistellus* Reuter, 1890
Type species: *Bycanistes naso* Stal, C. 1872: Ofv. Vet. Akad. Forh. 29: 50.

***Bycanistellus naso* (Stal, 1872)**
Bycanistellus naso (Stal, 1872): Ofv. Vet. Akad. Forh. 29: 50.
Distribution in Libya: Tobruk, and El Khomos.
General Algeria, Egypt, Morocco, Tunisia, and Libya.

Genus: *Leptodemus* Reuter, 1900
Type species: *Leptodemus minutus* variety *pallidula* Reuter, O.M,1900.

***Leptodemus bicolor* Lindberg, 1924**
Synonym: *Cyproplax avenae* Lindberg, 194 Comment. Biol. 10: 7: 68, 69, 167.
Distribution in Libya: Jebel Nefousa, Gharyian.
General distribution: Greece, Italy, Egypt, Iran, Greece, Italy, Egypt, Cyprus, Tadzhikistan, Iran, Turkmenistan, Kirgizia, Uzbekistan, Iraq, Libya.

***Leptodemus bicolor ventralis* Schmidt, 1939**
Leptodemus bicolor variety *ventralis* Bull. Soc. Fouad Ent. 23: 20-21.
Distribution in Libya: Jebel Nefousa, Gharyian.
General Distribution: Egypt, and Libya.

***Leptodemus minutus* (Jakovlev, 1876)**
Synonym: *Leptodemus scorteccii* Mancini, 1936 Att. Soc. Ital. Sci. Nat. 75: 303-304
Distribution in Libya: El Khomos (Mancini, 1936), Kufra-Benezema, Giaidi, Haufun, kufra-l Tag, Bir El Harraso, El Weinat-Ain Murr, Ain Doua (Mancini, 1940), Gialo (deBergreven, 1932). Benghazi, Gialo (Zavattari, 1934).
General Distribution: Algeria, Turkey, Saudi Arabia, Morocco, Tunisia, Afghanistan, Iran, Egypt, Jordan, Kirgizia, Kuwait, Mongolia, Iraq, Canary Isles, Cyprus, Turkey, Kazakhstan, Saudi Arabia, Azerbaijan, Tadzhikistan, Turkmenistan, Iraq, Syria, Yemen, Uzbekistan, and Libya.
Remarks *Leptodemus scorteccii* Mancini, 1936.
Synonym: of *Leptodemus minutus* (Jakovlev, 1876).

***Leptodemus minutus minutus* (Jakovlev, 1876).**

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Synonym: *Leptodemus scorteccii* Mancini, 1936: Att. Soc. Ital. Sci. Nat. 75: 303-304
Distribution in Libya: Benghazi, and Gialo.
General Distribution: Cyprus, Russia, Algeria, Egypt, Morocco, Mauritania, Astrakhan, Caucasus, Turkestan, Turkey, and Libya.

Genus: *Microplax* Fieber, 1860
Type species: *Oxycarenus plagiatus* Fieber, F.X., **1860.**

***Microplax plagiatus* (Fieber, 1837)**
Synonym: *Microplax plagiatus* (Fieber, 1837) Beitr. Ges. Nat. Heilwiss. p. 342.
Distribution in Libya: Jebel Nefousa, Ghryian, Azizia, Gaser El Garabulli, Misrata (Mancini,1936).
General Distribution: Portugal, Italy, Algeria, Morocco, Tunisia, and Libya.

SUBFAMILY: Aphaninae

***Genus*: *Megalonotus* Fieber, 1860**
Type species: *Lygaeus chiragra* Fabric 1794. (= *Megalonotus chiragrus chiragrus*)

***Megalonotus puncticollis* (Luc, 1849)**
Synonym: *Megalonotus praetextatus* (Herrich-Schäffer, 1850): Wanz. Ins. 4: 12-13.
Distribution in Libya: Khomos (Mancini, 193)
General Distribution: Algeria; Canary Isles, Morocco, Caucasus, Tunisia, Syria, Spain, France, Greece, Italy, and Libya.

***Megalonotus* (*Megalonotus*) *puncticollis pun cticollis* (Lucas, 1849)**
Synonym: *Rhyparochromus luctuosus* Lucas, 1849: Expl. Alger. Zool. 3: 3: 77.
Distribution in Libya: Gharyian
General distribution: Albania, France, Italy, Greece, Italy, Russia, Spain, Yugoslavia, Algeria, Canary Isles, Morocco, Caucasus, Tunisia, Syria, and Libya.

Genus *Aellopus* Wolf, 1811
Type species: *Cimex atratus* Goeze, 1778.

***Aellopus atratus* (Gz, 1778)**
Synonym *Cimex atratus* (Goeze, 1778) Ent. Beytr. Ritter Linne 2: 268.
Distribution in Libya: Cyrenica (Mancini, 1942a).
General Distribution: Austria, Cyprus, Bulgaria, Belgium, Bosnia, Croatia, Cyprus, Czech Republic, Turkey, and Libya

***Aellopus atratus atratus* Goeze, 1778**
Synonym *Lygaeus aterrimus* Fabricius, 1798: Supp. Ent. Syst
Distribution in Libya: Benghazi.
General Distribution: Austria, Belgium, Italy, Bulgaria, Cyprus, France, England, The Czech Republic, Germany, Greece, Hungary, Holland, Spain, Portugal, Poland, Romania, Switzerland, Iran, Russia, Algeria, Morocco, Tunisia, Iran, India Syria, Turkestan, Turkey, Astrakhan, Caucasus, and Libya.

Genus: *Taphropeltus* Stal, 1872
Type species: *Lygaeus hamulatus* Thomson, 1870.

***Taphropeltus nervosus* (Fieber, 1861)**
Synonym: *Scolopostethus nervosus* Fieber, 186. Wien: Gerold vi, 1: Eur. Hem. p. 189
Distribution in Libya: Wadi-Belgader (Mancini, 1942a).
General Distribution: Croatia, Cyprus, Turkey, Italy, Malta and Libya.

***Taphropeltus nervosus nervosus* (Fieber, 1861)**
Synonym: *Taphropeltus nervosus nervosus* (Fieber, 1861), Wien: Ger vi, E. H. p. 189
Distribution in Libya: El Wueinat.
General Distribution: Portugal, France, Italy, Greece, Spain, Algeria, Morocco, Tunisia, Syria**,** and Libya.

Genus *Scolopostethus* Fieber, 1860
Type species:*Tritomacera aphanoides* Fieber, 1860 (= *Scolopostethus cognatus*).

***Scolopostethus decoratus* (Hhn, 1831)**
Synonym: *Scolopostethus brevis* Saunders, 1876: Ent. Mo. Mag. 12: 221
Distribution in Libya: Derna (Mancini, 1942a).

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General Distribution: France, Germany, Holland, Spain, Algeria Albania, Austria, Italy, England, Bulgaria, Denmark, Estonia, Poland, Belgium, Greece, Hungary, Ireland, Czech Republic, and Libya.

Genus: *Lethaeus* Dall, 1852
Type species: *Lethaeus africanus* Dallas, 1852,

***Lehaeus lethierryi* (Put, 1869)**
Synonym: *Lethaeus lethierryi lethierryi* (Puton, 1869) Ann. Soc. Ent. Fr. p. 142
Distribution in Libya: El Bordy, Cyrenica (de Bergevin, 1930, Zavattari, 1934).
General Distribution: Algeria;Arabia;Canary Isles, Cape Verde Isles, Egypt, Mauritania, Iran, Tunisia, Caucasus, Iran, Syria, Jordan, Turkey, and Libya.

Genus: *Lasiocoris* Fieer, 1860
Type species: *Pachymerus anomalus* Kolenati, 1845. (= *Lasiocoris anomalus anomalus*)

***Lasiocoris crassicornis* (Luc, 1849)**
Synonym: *Lasiocoris antennatus* Montandon, 1889: Rev. d'Ent. 8: 288
Distribution in Libya: Cyrenica (Mancini, 1942a).
General Distribution: Greece, Italy, Turkey, Iran, Turkestan, Algeria, and Libya.

Genus: *Peritrechus* Fieber, 1860
Type species: *Beosus angusticollis* Sahlberg, 1848**.**

***Peritrechus meridionalis* Put, 1877**
Synonym: *Peritrechus meridionalis* Put, 1877: Pet. Nouv. Ent. 2: 168: 117.
Distribution in Libya: Cyrenica (Mancini, 1942a).
General Distribution: Algeria, and Libya.

***Peritrechus meridionalis fuscatus* Ferrari, 1888**
Syn: *Peritrechus meridionalis fuscatus* Ferrari, 1888:Ann. Mus. Civ. Stor. Nat. Gen. (2): 6: 545, 557.
Distribution in Libya: Cyrenica (Mancini, 1942a).
General Distribution: France, Italy, Algeria, Libya.

Genus: *Stygnocoris* Douglas & Scott, 1860
Type species: *Lygaeus rusticus* Fallen, 1807 (= *Stygnocoris rusticus rusticus*)

***Stygnocoris rusticus* (Fallen, 1807)**
Synonym: *Lygaeus rusticus* Fallen, 1807: Monog. Cim. Suec. p. 70.
Distribution in Libya: El Bordy (de Bergevin, 1930, Zavattari, 1932).
General Distribution: Austria, Belarus, Russia, Belgium, Bosnia, England, Bosnia, Bulgaria, Czech Republic, Croatia, and Libya.

****Stygnocoris rusticus rusticus* (Fallen, 1807)**
Synonym *Stethotropis incana* Fieber, 1870, Verh. Zool. Bot. Ges. Wien. pp. 245-6.
Distribution in Libya: Tobruk.
General Distribution: Austria, Belgium, Spain, Denmark, Italy, England**,** Estonia**,** The Czech Republic, Finland, France, Germany, Hungary, Holland, Hungary, Ireland, Holland, Portugal, Poland, Romania, Russia, Sweden, Switzerland, Wales, Caucasus, Astrakhan, Algeria, Morocco, USA, Canada, and Libya.

Genus: *Camptocera* Jakowleff, 1877
Type species: *Rhyparochromus glaberrimus* Walker, 1872 (= *Camptocera glaberrima*).

***Camptocera glaberrima* (Walker, 1872)**
Synonym: *Tropistethus aurantiacus* Distant, 1918Fn. Brit. Ind. Rhynch. 7: 197.
Distribution in Libya: Ghat (Mancini, 1942a), El Khomos (Linnavuori, 1965).
General Distribution: France, Russia, Spain, Algeria, Canary Isles, Egypt, Morocco, Astrakhan, Caucasus, Iran, Israel, Syria, Turkestan, Turkey, Eritrea, Sudan, India, Iran, and Libya.

Genus: *Ischnopeza* Fieber, 1860
Type species: *Pachymerus hirticornis* Herrich-Schaeffer, 1850.

***Ischnopeza pallipes* Put, 11892**

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Ischnopeza pallipes Put, 11892:Rev. d'Ent. 11: 27.
Distribution in Libya: Merj (Mancini, 1942a).
General Distribution: Cyprus, France, Algeria, Egypt, Lebanon, Syria, Turkey, and Libya.

Genus *Emblethis* Fieber, 1860
Type species: *Lygaeus verbasci* Fabricius, 1803 (= *Emblethis verbasci verbasci*)

***Emblethis ciliatus* Horvath, 1875**
Synonym: *Emblethis ciliatus* Horv, 1875.
Distribution in Libya: El Bordy (de Bergevin, 1936, Zavattori, 1934).
General Distribution: Austria, Bulgaria, Crete, The Czech Republic, Germany, Greece, Hungary, Romania, Russia, Egypt, Morocco, Turkey, Iraq, Caucasus, Kurdistan, Siberia, Syria, Algeria, and Libya.

***Emblethis verbasci* (F, 1803)**
Synonym: *Lygaeus verbasci* Fabricius, 1803.
Distribution in Libya: Benghazi (Mancini, 1942a), El Bordy (de Bergevin, 1930, Zavattari, 1934).
General Distribution: Turkey, Kazakhstan, Turkestan, France, Iran, Ukraine, Italy, Poland, Spain, and Libya.

****Emblethis verbasci verbasci* (F, 1803)**
Synonym: *Lygaeus pilifrons* Zetterstedt, 1819: Kongl. Vet. Akad. Handl. pp. 71-2.
Distribution in Libya: El Merj, Benghazi.
General Distribution: Albania, Austria, Cyprus, Bulgaria, Poland, Belgium, England, Germany, Iran Holland, France, Greece, Hungary, Switzerland, Malta, Spain, Portugal, Czechoslovakia, Syria, Romania, Russia, Sweden, Yugoslavia, Algeria, Afghanistan, Egypt, Morocco, Turkey, Canary Isles, Tunisia, Mongolia, and Libya.

***Emblethis angustus* Mont, 1890**
Synonym: *Emblethis angustus* Montandon, 1890
Distribution in Libya: 60 Km east of Nalut.
General Distribution: Bulgaria, Portugal, Canary Isles, Croatia, Italy, Macedonia, and Libya.

***Emblethis gracilicoris* Put, 1883**
Synonym: *Emblethis oblongus* Wagner, 1959.
Distribution in Libya: Jebel Soda, Valle Uosca (Mancini, 1936).
General Distribution: Spain, Algeria, Egypt, Morocco, Arabia, Iran, Kenya, Iran, and Libya.

Genus: *Macropternella* Slater, 1957
Type species: *Oxycarenus inermis* Fieber, 1852.

***Macropternella marginalis* (Fieb, 1861)**
Synonym: *Macropternella marginalis* Fieber, 1861.
Distribution in Libya: 20 Km west Azizia.
General Distribution: France, Italy, Portugal, Spain, Morocco, West Africa, and Libya.

Genus: *Brachyplax* Fieber, 1860
Type species: *Brachyplax albidus* Fieber, 1860. (= *tenuis tenuis*).

***Brachyplax tenuis* (Mulsant & Rey, 1852)**
Synonym: *Pachymerus palliatus* Costa, 1855.
Distribution in Libya: Cyrenica: Mancini, 1942a.
General Distribution: Austria, Bosnia, Bulgaria, Croatia, Czech Republic, Turkey, France, Hungry, Italy, Macedonia, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Algeria, Slovkia, Kaz-khstan, Switzerland, Ukraine, Egypt, Tunisia, Azerbaijan, Armenia, Syria, Georgia, Cyprus, Kirgizia, Tadzhikistan, Turkmenistan, Uzbekistan, and Libya.
Remarks: Species *Brachyplax tenuis* (Mulsant & Rey, 1852) was listed as *Brachyplax palliata* (Costa, 1852) by Eckerlein & Wagner, 1969.

****Brachyplax tenuis tenuis* (M & R, 1852)**
Synonym: *Brachyplax albidus* Fieber, 1861.
Distribution in Libya: El Mej.
General Distribution: Cyprus, France, Greece, Hungary, Italy, Lesbos Isles, Portugal, Romania, Russia, Spain, Algeria, Egypt, Morocco, Caucasus, Turkestan, Turkey, and Libya.

Genus: MetopoplaxFiebe, 180
Type species: *Pachymerus ditomoides* Costa, 1847.

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***Metopoplax ditomoides* (Costa, 1847)**
Synonym: *Pachymerus ditomoides* Costa, 1847
Distribution in Libya: Benghazi.
General Distribution: France, Czech Republic, Hungary, Syria, Turkey, German, Holland, Malta, Portugal, Portugal, Spain, Switzerland, Tunisia, Morocco, Belgium, Bosnia, Bulgraia, Algeria, Morocco, Belgium, Bosnia, Bulgaria, Luxemburg, Macedonia, Malta, and Libya.

SUBFAMILY: Atheneinae

Genus: *Artheneis* Spinola, 1837
Type species: *Artheneis foveolata* Spinola, **1837.**

***Artheneis alutacea* Fieber, 1860**
Distribution in Libya: Fezzan: Rhoddua.
General Distribution: Macedonia, Algeria, Egypt, Greece, Italy, Tunisia, Cyprus, Jordan, Morocco, and Libya.

***Artheneis aegyptiaca* Lindbg, 1939.**
Synonym *Artheneis aegyptiaca* Lindberg, 1939.
Distribution in Libya: Kufra Oasis, Zaraga, Bir Ygub (Mancini, 1940).
General Distribution: Yemen, Sudan, Saudi Arabia, Egypt, Syria, Iran, and Libya.

***Artheneis balcanica* (Kormilev, 1938)**
Synonym: *Karamania balcanica* Kormilev, N 1938.
Distribution in Libya: El Kufra.
General Distribution: Bulgaria, Greece, Ukraine, Azerbaijan, Turkmenistan, Iraq, Syria, Bulgaria, Tajikistan, Uzbekistan, Turkmenistan, Greece, Macedonia, Ukraine, Syria, Turkey, Cyprus, Uzbekistan, and Libya.

***Artheneidea tenuicornis* Kiritshenko, 1913**
Synonym: *Artheneis chlorotica* de Bergevin, 1930: Ann. Mus. Civ. Stor. Nat. Gen. 55: 35
Distribution in Libya: Jagbob (de Bergevin, 1930, Zavattri, 1934).
General Distribution: Libya, Iraq, Turkestan, Algeria, Egypt, Tunisia, Kazakhstan, China, Iran, Mongolia, Saudi Arabia, Uzbekistan, Tadzhikistan, Turkmenistan, Sudan.
Remarks: *Artheneidea tenuicornis* Kiritshenko, 1913 was listed as *Artheneis chlorotica* de Bergevin, 1930 by Eckerlein& Wagner, 1969.

***Artheneis beieri* Wagner, 1963.**
Artheneis beieri Wagner, 1963: Zootaxa 3408, pp. 1-33.
Distribution: 20 Km west to Gasr Garabulli.
General distribution: Iran, Turkmenistan, Uzbekistan, Yemen, Sudan, Algeria, and Libya.

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نبذة مختصرة عن رتبة حشرات بق البذور Schilling, 1829 التابعة لمختلفة الأجنحة في ليبيا

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المستخلص: تتناول الدراسة عرض شعب وأجناس وأنواع فصيلة حشرات بق البذور Lygaeidae و تمت دراستها مصحوبة بالأسماء المرادفة والتوزيع المحلي والعالمي.هذه الدراسة أجريت خلال المدة 2007–2010 في البلاد الليبية، و كشفت عن 111 نوع موجود في ليبيا، تحت 52 جنس تابع 8 تحت فصيلة.31 نوع تسجل لأول مرة في ليبيا.

الكلمات المفتاحية: عائلة بق البذور Lygaeidae ، مختلفة الأجنحة، ليبيا، المرادفات، توزيع محلي وعام، بق البذور.

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Isolation and Identification of Fungi Contaminating Potato Chips Intended for Children's Consumption and Assessing their Toxins

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Abstract: The study aims to investigate the presence of fungi and their toxins in different samples of potato chips imported from different origins. Fifteen chips' samples were collected from the local markets of Mosul city/Iraq which included various global origins with several flavors of pepper, paprika, hot spices, and cheese. It appears that all potato chips' samples were contaminated with fungi and mycotoxins. It was evident that *Penicillium* spp. were the most predominant fungi followed by *Aspergillus* spp. and *Rhodotorella* spp. came third, while *Geotrichum*spp and yeasts came in fourth. Potato chips from the brand Pringles was contaminated with *Penicillium* spp., and *Geotrichum* spp. at a percentage of 50, 30% respectively. The Hum Hum brand samples were contaminated with *A.terrus* and *Penicillium* spp. at 40, 30% respectively. Dream brand samples were contaminated with *A.jamanicum*., and *Penicillium.,* at percentages of 30, 60% respectively. Lays1 with tomato ketchup samples were contaminated with four genera: *Penicillium* spp., *Mucor* spp., *Rhodotorella*spp., and yeast with percentages of 40, 20, 10, and 10% respectively. Lays2 with French cheese variety was contaminated with the same fungi of lays2 type but with the addition of Aspergilli (*A. versicolor* and *A. niger*), which were 60 and 30% respectively. The Patos brand potato chips were contaminated with two Aspergilli (*A.astus* and *A.jamanicum*), at 30 and 40% respectively. Zearalenone was found to be the highest contaminant (13.81ppm) of mycotoxins followed by aflatoxins (0.26ppm). Ochratoxin was the least contaminant (0.16ppm) in the analyzed potato chips. It can be concluded that all tested potato chips' samples showed the presence of fungi and mycotoxins. However, all mycotoxins (aflatoxin, ochratoxin, and zearalenone) in the food commodities were within the permissible limits intended for human consumption.

Keywords: Contaminated Chips, Mycotoxins, Aflatoxins, Zearalenone, Ochratoxin.

INTRODUCTION

Food contamination is a major problem, and contaminants vary with different food commodities. Fungi are regarded as one of the most persistent food contaminants, having the ability to produce toxins known as mycotoxin under favorable conditions. These toxins may lead to serious diseases called mycotoxicosis (Manjula et al., 2016). More than 300 fungal toxins have been discovered that are produced by different fungal species (Tairo et al., 2008). The most significant fungi agriculturally are *Aspergillus, Penicillium, and Fusarium*, which can produce toxins such as aflatoxin, ochratoxin, zearalenone, and trichothecenes (Martins et al., 2001; Milani et al., 2013). The preservation of processed foods from fungal contamination may be achieved by the incorporation of food additives (Jonathan et al., 2012).

Food additives, such as antifungal agents, are chemicals that are usually added to processed foods in order to preserve them from undesirable changes in their color, flavor, or nutritional values as a result of fungal growth (Manjula et al., 2016).

Antifungal agents are usually prepared from

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natural sources, plants, or produced chemically (Mmasa et al., 2012). Preferably, they are prepared from natural sources including, spices and flavor materials.

Aflatoxins are secondary metabolites produced by strains of *Aspergillusflavus*, *A. parasiticus*, and *A. nomius*. These metabolites are furocoumarins, including AFB1, AFB2, AFG1, and AFG2 (Amri & Lenoi, 2016). Aflatoxins are fully soluble in solvents such as methanol and chloroform. The presence of a lactone ring in aflatoxin molecules makes them more susceptible to hydrolysis by alkaline solutions (Azizi et al., 2012; Bankole & Adebanjo, 2003).

In humans and animals, aflatoxins affect different cell wall tissues, inhibit RNA function in DNA synthesis, and act as immunosuppressive agents. Aflatoxins are a serious fungal toxin responsible for the contamination of food commodities and the emergence of liver cancer in humans which poses a significant threat to human health (Croft et al., 1986; Wyllie & Morehouse, 1978).

The World Health Organization (1979) has identified the permissible limits of aflatoxin in adult foods to be not more than 20 ppb and 0.5 ppb in milk, whereas it should be 20 ppb in feeds. However for baby food, there are no limits allowed Smith and Moss, 1985 U.S.
Ochratoxins are a group of mycotoxins produced by several species of *Aspergillus*, especially *A. ochraceous* and some species of *Penicillium* (Gnonlonfin et al., 2012).

They are colorless, crystalline in texture, with blue fluorescence usually emitted from them when exposed to ultraviolet rays. These toxins dissolve in acidic solutions, with moderate solubility in methanol and chloroform. OTAs have the ability to bind to serum albumin. OTAs could cause intestinal ulcers, affect the liver and reduce its efficiency, and affect kidneys, and cause intestinal disorders. Zaralennon is another mycotoxin and is one of the phenolic compounds with estrogenic characteristics (Savino et al., 2007). It is a crystalline compound, white in color, and glows with blue-green fluorescence usually emitted from this toxin when exposed to wide UV long-waves. Its discovery was in 1916 when symptoms of vomiting and poisoning were described in humans due to the consumption of bread made of wheat infected by *Fusarium*, (especially *F. graminearum*) (Bullerman & Bianchini, 2007).

This study aimed to identify, isolate, and investigate the presence of fungi in different samples of potato chips imported from different origins, then estimate some mycotoxins in these products.

MATERIALS AND METHODS

Sample collection: Fifteen samples of potato chips were collected from the local markets of Mosul city, which included various global origins with different flavors (pepper, paprika, hot spices, and cheese: Table 1).

Isolation of fungi: One gram from every of potato chips' sample was grounded and transferred to glass bottles containing 9 ml of sterilized distilled water, mixed with a stirrer, and left to settle down. Subsequently, 1 ml of the mixture was streaked on three plates of PDA for each Sample. Plates were incubated at 28^{o}C for one to two weeks. Plates were then examined for the developing fungal colonies and diagnosed according to the approved diagnostic keys (de Hoog & Guarro, 1995; Pitt & Hocking, 2007)

Diagnosis of *Aspergillus* species: Diagnosis was based on the growth on different media and under different temperatures according to (Pitt & Hocking, 2007) by using three types of media for diagnosis, Czapek Yeast-extract Agar (CYA), Malt Extract Agar (MEA), and Glycerol (25%) Nitrate agar (G25N)

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Table (1) Types of Potato Chips, Country of origin and flavor additive.

Sample No.	Flavor additive	Manufacturing Country	Product name
1	Hot&Spicy	Belgium	Pringles
2	HotPepper	Syria	HumHum
3	Ketchup	Iran	MazMaz
4	HotFlavor	Turkey	Patos
5	HotPepper	SaudiArabia	Dream
6	HotFlavor	Turkey	Cipso
7	Paprika	Jordan	SnackMix
8	HotPepper	Turkey	Doritos
9	Cheese And Onion	Kuwait	Fico Fresh
10	Tomato ketchup	SaudiArabia	Lays1
11	French Cheese	SaudiArabia	Lays2
12	Cheese	Turkey	Patos
13	Ketchup	Syria	Lux
14	Cheese	Syria	Boshr
15	Garnish	Syria	Mamito

Isolates of the *Aspergillus* species were diagnosed depending on the morphological cultural characteristics and its image under the microscope by plating them on PDA and incubating at 28 ^{o} C for seven days. Culturing was done by using a sharp cork borer to transfer part of the edge of the colony under septic conditions and placing them in the center of three agars mentioned above, with three replicates of each fungal isolate. Agars were incubated in an inverted state under three temperatures, 5^{o} C, 25 ^{o} C, and 37 ^{o} C for seven days. Species of the *Aspergillus* genus were diagnosed through their form of growth, colony colour, and colony diameter depending on the taxonomic key of the *Aspergillus* species (Pitt & Hocking, 2007).

Mycotoxins analyses of potato chips: Before opening potato chip packages, sterilization of outer covering was done with 70% alcohol. Twenty grams of potato chips samples were grounded, placed in plastic bags, and subjected to extraction for mycotoxins analyses. Aflatoxin, ochratoxin, and zearalenone, were analysed using enzyme-linked immunosorbent assay (ELISA) at the veterinary laboratory in the province of Erbil.

Method of mycotoxins extraction:

Five grams of grounded potato chips samples were transferred to conical flasks. To these samples, 25 ml of 70% methanol was added when aflatoxin and zearalenone were extracted, and 50% was used when ochratoxin was extracted. Samples were shaken for three minutes then filtered using Whatman No.1 filter papers. 5 ml of the filtrate was transferred to a test tube. However, in the case of zearalenone, 1 ml of the filtrate was diluted four times with sterile distilled water (1:4). All samples were placed in the refrigerator until analysis.

ELISA technique was used for samples analyses using Neogene Kits and as follows: 100 µl of samples and control were pipetted in the red plate wells followed by 100 µl of Enzyme conjugate, mixed two to three times for homogenization. Mixtures were transferred to white wells in another plate and left for 10-20 seconds at room temperature. A plate was washed with distilled water five times. Then 100 µl of the substrate were added and mixed for 10-20 seconds and left for 3 minutes at room temperature. 100µl of stop solution was finally added. Results were obtained using Neogen Vertex software Vera tax ELISA Reader.

RESULTS

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As illustrated in Table 2, it appears that all potato chips' samples were contaminated with fungi and mycotoxins. Pringles potato chips brand was contaminated with the following fungi; *A. niger, A. astus, Penicillium* spp., *Geotrichum* spp., and *Chaetomium* spp., at a percentage of 20, 30, 50, 30, and 10% respectively. Hum Hum potato chips were contaminated with three fungi: *A. terrus, A. niger*, and *Penicillium* spp. at 40, 20, and 30% respectively. Three fungi contaminated the MazMaz brand samples and included *Penicillium*spp., *Geotrichum*spp, and *Rhodotorella*spp. in descending percentages of 30, 20, and 10% respectively. Potato chips were also contaminated with three fungi; *Penicillium*spp., *Geotrichum* spp. and *Mucor* spp., at 40, 20, and 10% respectively.

The Dream brand of potato chips was contaminated with *A. jamanicum*., *Penicillium, Geotrichum* spp., and *Chaetomium* spp. at percentages of 30, 60, 30, and 10% respectively. The same fungi were isolated from the Dream and Cipso brands except for *Aspergillus*, which was *A. flavus,* and these fungi were in the following percentages 50, 70, 40, and 10% in the same order respectively. Two species of Aspergilli, *A. flavus*and *A. parasiticus* were isolated from Snack Mix potato chips at a percentage of 80 and 60%, in addition to *Penicillium* spp. and *Geotrichum* spp. at a rate of 60 and 10% respectively.

The same *Aspergillus* spp. of Snack Mix was also contaminating samples from Doritos potato chips in addition to *A. niger* at a rate of 70, 70, and 30%. *Penicillium* was also isolated from the chips brand at a percentage of 20%. Five fungi were isolated from Fico Fresh potato chips brand including *A. niger*, *A.astus*, *Penicillium* spp., *Rhizopus* spp., and *Trichoderma*spp, at a rate of 30, 40, 40, 10, and 20% respectively. Lays with tomato ketchup was contaminated with three fungi namely *Penicillium* spp., *Mucor* spp., *Rhodotorella*spp., and yeast with percentages of 40, 20, 10, and 10% respectively (Table 2). Lays2 with French cheese potato chips were found to be contaminated with the same fungi of the previous Lays type, but with the addition of Aspergilli (*A. versicolor* and *A. niger*), which were 60 and 30% respectively. The Patos brand chips were contaminated with two Aspergilli (*A. astus* and *A. jamanicum*), at 30 and 40% respectively, and 20% for *Penicillium, Rhodotorella* spp. and yeasts.

The Lux type of potato chips was also contaminated with two Aspergilli (*A. astus and A. niger*) at 20 and 10%, with *Penicillium*10%, and Yeasts 10% (Table 2).

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Table (2) Percentage of fungi isolated from chips.

Product No.	Product name	Fungi	% of Isolation
1	Pringles	*Aspergillusniger*	20
		A.astus	30
		Penicillium spp.	50
		Geotrichum spp.	30
		Chaetomium spp.	10
2	Hum Hum	*A. terrus*	40
		Aspergillusniger	20
		Penicillium spp.	30
3	MazMaz	*Penicillium spp.*	30
		Geotrichum spp.	20
		Rhodotorella spp.	10
4	Patos	*Penicillium spp.*	40
		Geotrichum spp.	20
		Mucor spp.	10
5	Dream	*A.Jamanicum*	30
		Penicillium spp.	60
		Geotrichum spp.	30
		Chaetomium spp.	10
6	Cipso	*A.flavus*	50
		Penicillium spp.	70
		Geotrichum spp.	40
		Chaetomium spp.	10
7	Snack Mix	*A.flavus*	80
		A.parasiticus	60
		Penicillium spp.	60
		Geotrichum spp.	10
8	Doritos	*A.flavus*	70
		A.parasiticus	70
		Aspergillusniger	30
		Penicillium spp.	20
9	Fico Fresh	*A.astus*	30
		Aspergillusniger	40
		Penicillium spp.	40

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Product No.	Product name	Fungi	% of Isolation
		Rhizopus spp.	10
		Trichoderma spp.	20
10	Lays 1	*Penicillium spp.*	40
		Mucor spp.	20
		Rhodotorella spp.	10
		Yeasts	10
11	Lays 2	*A.versicolor*	60
		A.niger	30
		Mucor spp.	20
		Penicillium spp.	30
		Rhodotorella spp.	20
12	Patos	*A.astus*	40
		A.Jamanicum	30
		Penicillium spp.	20
		Rhodotorella spp.	20
		Yeasts	20
13	Lux	*A.astus*	20
		A.niger	10
		Penicillium spp.	10
		Yeasts	10
14	Boshar	*A.candidus*	20
		A.niger	10
		Penicillium spp.	20
		Mucor spp.	20
		Rhodotorella spp.	30
		Yeasts	40
15	Mamito	*A.parasiticus*	20
		Penicillium spp.	30
		Geotrichum spp.	10
		Rhodotorella spp.	20
		Yeasts	30

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Five species of molds and yeasts were contaminating Bushar potato chips brand; *A. candidus* (20%), *A.niger* (10%), *Penicillium* (20%), *Mucor* spp. (20%), *Rhodotorella spp*. (30%), and yeast (40%). the Mamito chips were contaminated with four species of fungi and yeast which were, *A. parasiticus* (20%), *Penicillium* spp. (30%), *Geotrichum* spp. (10%), *Rhodotorella* spp. (20%), and yeasts (30%). From figure (1) it is evident that *Penicillium*spp. was the most predominant fungi which contaminated different potato chips' brands (27.45%), followed by *Aspergillus* spp. (23.52%). In third place was *Rhodotorella* spp. (13.72%), while in fourth place was *Geotrichum*spp. and yeasts (9.8%). *Chaetomium*spp was in fifth place being 7.84%. *Mucor*spp and *Trichoderma*spp. were the least isolated contaminant of different chips' types which accounted for 5.88 and 1.96% respectively.

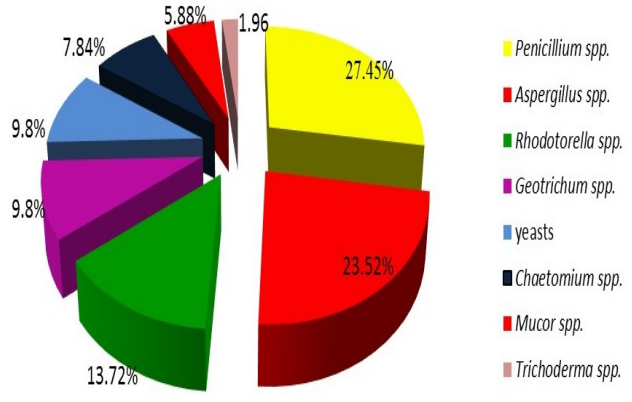

Figure (1): Percentages of different fungi and yeasts isolated from different potato chips' brands.

The amount of mycotoxins in chips' samples was determined in this study. Table (3) shows that all of the chips' types were contaminated with aflatoxin with a percentage ranging from 0.1 to 2.5 ppm. While Patos, Dream, Cipso, Snack Mix, Doritos, Fico Fresh, in addition to Mamito, had no aflatoxin contamination. Percentages of ochratoxin were between 0.1 and 0.5 ppm. While Pringles, Maz Maz, Patos, Doritos, Fico Fresh, and Lay's 2 had no ochratoxin contamination. Potato chips' types contaminated with zearalenone had percentages ranging from 4.5 to 46.4 ppm. However, MazMaz, Fico Fresh, and Lay's 1 showed no zearalenone contamination. Finally, Boshar potato chips were the most contaminated samples with three mycotoxins: aflatoxin, ochratoxin, and zearalenone, with percentages of 2.6, 0.5, and 33.2 ppm respectively.

It appears that zearalenone was the most abundant contaminant (13.81 ppm) among the three examined mycotoxins (Fig, 2), followed by aflatoxin (0.26ppm), whereas ochratoxin, was the least contaminant (0.16ppm) in the tested potato chips.

Table (3) Occurrences of mycotoxins in potato chips' samples.

Sample No.	Product name	Mycotoxins		
		Aflatoxin ppm	Ochratoxin ppm	Zearalenone ppm
1	Pringles	0.3	0.0	6.5
2	Hum Hum	0.3	0.4	4.5
3	MazMaz	0.2	0.0	0.0
4	Patos	0.0	0.0	14.7
5	Dream	0.0	0.4	7.9
6	Cipso	0.0	0.1	10.2
7	Snack Mix	0.0	0.5	11.2
8	Doritos	0.0	0.0	19.9
9	Fico Fresh	0.0	0.0	0.0
10	Lays1	0.1	0.2	0.0
11	Lays2	0.1	0.0	12.1
12	Patos	0.0	0.1	26.4
13	Lux	0.3	0.1	13.2
14	Boshar	2.6	0.5	33.2
15	Mamito	0.0	0.4	46.4

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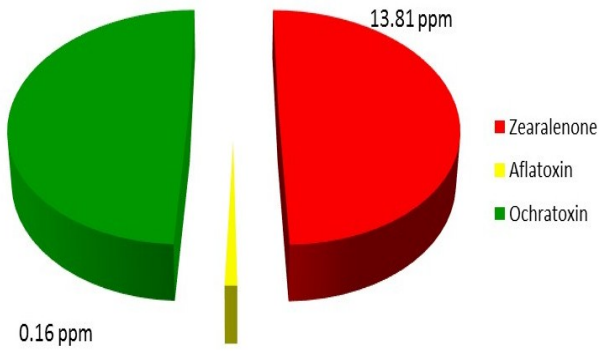

Figure (2): Mycotoxins in analyzed potato chips.

DISCUSSION

When different foods are contaminated by various fungi, producing and non-producing mycotoxins depends on the fungi itself, the type of food product, and the surrounding environment (Milani et al., 2013). Despite the difficulty of the final elimination of pollution, molds, and the presence of mycotoxins, hard work is needed to minimize the adverse effects of these toxins by using the best way possible, whether physical or chemical (Do & Choi, 2007).

In the presence of such fungal mycotoxins in different imported brands of potato chips, there is evidence that Iraqi authorities have failed to conduct an inspection and standardization and quality control measures. Fortunately, the contamination of various brands is located within the limits of 20 ppb, based on the rates approved by AOAC. The presence of this low percentage could be due to the physical separation of the good potatoes from those contaminated before the preparation of potato chips. This may remove 40-80% of the aflatoxin that is considered to be the most toxic and potent carcinogen which has been directly correlated to adverse health effects, such as liver cancer. Aflatoxins have acute and chronic toxicity produced mainly by *Aspergillus parasiticus* and *Aspergillus flavus* in tropical and subtropical regions (Milani et al., 2013).This may be due simply to the contamination of food additives and pepper, which is often contaminated with *Aspergillus*, or because of the composition of potato chips, consisting of a mixture of corn, rice, flour, and potatoes, as there may be a source of pollution or fungal toxins within these components. Also, heat treatment and autoclave treatment do not completely remove aflatoxin from foods (Thieu et al., 2008), despite the fact that some studies have shown that roasting is a good way to reduce levels of aflatoxin in peanuts.

The significance of *Aspergillus* fungi in food comes from its toxic, mutagenic, and carcinogenic effects. It has been ranked by the International Agency for Research on Cancer as one of the first-class carcinogens, and there are studies on liver poisoning in Kenya and India, that showed that viral hepatitis could increase the likelihood of cancer due to the presence of ochratoxin residues in samples of potato chips that have been studied and produced by fungi Asperdillus and Penicillium. Fortunately, the level of ochratoxin was within the limits allowed in food (20 ppb) and not more than 5 ppb per kg of body weight per day.

According to data provided by the European Commission, the daily consumption of ochratoxin ranges from 0.02-1.9 ppb /kg body weight /day (Christensen et al., 1977).

It is interesting to note that some types of potato chips contained moderate levels of zearalenonem despite that no *Fusarium* spp. were isolated from the tested chips. Such results may appear confusing, but it could be said that *Fusarium* spp. are the most fungal species present in the processing methods for chips' preparation, while the other species of fungi like *Aspergillus* and *Penicillium* spp. were present during the storage of these food products. The presence of zearalenone residues in potato chips may be due to its high stability against different processing methods, Different concentrations of zearalenone were found in all tested potato chips (both in

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temperate areas like Belgium, or subtropical areas such as Saudi Arabia), the worldwide incidences of *Fusariumgraminearum* and zearalenone produced by this fungus have been well documented (Bahrami-Samani et al., 2017).

As potato chips are considered as a light snack the current study's results were near to the average zearalenone level of 20 ppb of breakfast cereals, snack foods, popcorn, and cornmeal, in the U.S.A. (warner).The hypothesis stated that potato chips may be made of a mixture of rice, wheat, corn, and other ingredients, which may explain here the presence of zearalenone, which is frequently found in all major cereal grains worldwide, also, ubiquity of *Fusarium* spores (Nelson et al., 1983).

F.graminearum (the producer of zearalenone) a soil inhabiter, it is also considered as a storage fungus, since growth and toxin production may occur under various storage condition. Corn and wheat are most susceptible to invasion by this fungus (Bahrami-Samani et al., 2017).

Efforts have been made to reduce the level of zearalenone by various chemical, physical, and biological processing methods. In this study, potatoes were subjected to physical methods of heat treatment. The fate of zearalenone depends on its distribution in the food matrix and its chemical properties, such as heat stability (Krnjaja et al., 2013).

Although all the tested residual mycotoxins (aflatoxin, ochratoxin, and zearalenone) were within the permissible limits of these toxins in the food commodities intended for human consumption, however the new legislation indicates that products intended for human consumption, or as an ingredient in food must comply with a limit of 4 ppb for total aflatoxin, ochratoxin and zearalenone.(Park & Stoloff, 1989).

Prevention of mycotoxins formation is believed to be the best means of managing hazards associated with mycotoxins contamination. In addition, an effective food safety management program must include prevention, setting regulatory limits, the establishment of monitoring programs, control through good agricultural practices, control through processing, decontamination through specific treatments, and consumer and producer education (Park & Stoloff, 1989).

CONCLUSION

Based on the results, it appears that all potato chips' samples were contaminated with fungi and mycotoxins, especially *Penicillium* spp. and *Aspergillus* spp. in addition to some other fungi. The study also concluded that zearalenone was the highest contaminant (13.81 ppm) among the three examined mycotoxins, followed by aflatoxin (0.26ppm). Whereas ochratoxin was the least contaminant (0.16ppm) in the analyzed potato chips.

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عزل وتعريف الفطريات الملوثة لرقائق البطاطس المخصصة للأطفال وتقدير السموم الفطرية الموجودة فيها

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المستخلص: تهدف الدراسة الحالية إلى التحري عن وجود الفطريات في عينات مختلفة من رقائق البطاطس المستوردة من مناشيء مختلفة. وتضمنت الدراسة جمع 15 عينة من رقائق البطاطس من الأسواق المحلية لمدينة الموصل العراق من مصادر عالمية مختلفة بنكهات مختلفة من الفلفل والبابريكا والتوابل الحارة والجبن. تبين أن عينات رقائق البطاطس جميعها كانت ملوثة بالفطريات والسموم الفطرية، وبينت الدراسة أن أنواع فطر *Penicillium spp.*. كانت الأكثر انتشارًا ثم أنواع الفطر *Aspergillus spp.* وفي المرتبة الثالثة أنواع خميرة *Rhodotorella spp.* ثم جاءت أنواع *Geotrichum spp.* وبقية الخمائر. رقائق البطاطس من نوع *Pringles* كان ملوثا بالفطريات *Penicillium spp.* ، *Geotrichum spp.* بنسبة 50، 30٪ على التوالي. تلوث عينات رقائق البطاطس *Hum Hum* بـ *A.terrus* و *Penicillium spp..* بنسبة 40 و30٪ على التوالي. أظهرت عينات رقائق البطاطس من نوع *Dream* بـ *A. jamanicum.*، و *Penicillium.* بنسب مئوية 30، 60٪ على التوالي. تلوثت عينات رقائق البطاطس *Lays1* بنكهة الطماطم بأربعة أجناس هي *Penicillium spp.* و *Mucor spp.* و *Rhodotorella spp.*، والخميرة بنسب 40 و20 و10 و10٪ على التوالي. وتلوث رقائق البطاطس نوع *Lays2* بالجبنة الفرنسية بالفطريات نفسها للنوع السابق فضلا عن أجناس *A. versicolor* و *A. Niger* بنسبة 60 و30٪. تلوث رقائق البطاطسPatos باثنين من الفطريات وهي *A.astus* و *A. Jamanicum* بنسبة 30 و40٪ على التوالي. أظهرت النتائج وجود السموم الفطرية في عينات رقائق البطاطس وأن سم *zearalenone* الملوث الأعلى وبنسبة 13.81 جزء في المليون، يليها الأفلاتوكسين (0.26 جزء في المليون)، والأوكراتوكسين كان الاقل نسبة بين العينات (0.16 جزء في المليون). من الدراسة يمكن استنتاج أن عينات الرقائق المدروسة كلها أظهرت وجود الفطريات وبنسب مختلفة ومنها بعض الفطريات المنتجة للسموم الفطرية. كذلك فإن السموم الفطرية جميعها في العينات *aflatoxin* و *ochratoxin* و *zearalenone* كانت ضمن الحدود المسموح بها للاستهلاك البشري.

الكلمات المفتاحية: تلوث رقائق البطاطس، السموم الفطرية، الأفلاتوكسين، زيرالينون، الأوكراتوكسين.

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Neonatal Mortality in the Neonatal Intensive Care Unit at Benghazi Pediatric Hospital– Libya

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Abstract: This research aims to study mortality rates and identify the direct causes of neonatal deaths among newborns at Benghazi Pediatric Hospital**.** A descriptive case series study was conducted during 2015. Data included; birth weight, gender, residency, duration of hospital stay, age of neonates at death, and causes of death. Out of 1610 neonatal admissions reviewed, the total number of deaths was 122 during 2015. The data focused on death certificates of neonates and showed that the male gender was predominant (62.3 %). Most of them had a birth weight ranged between 2-2.9 Kg. Approximately 52 % of neonatal deaths in one day were of newborns <1 week old, and 54% were full-term newborns. The most frequent direct single cause of death in neonates was prematurity, then neonatal sepsis and congenital heart disease respectively. The study concluded that the most frequent causes of infant mortality related deaths were prematurity then neonatal sepsis. Furthermore, future research is recommended, and the calculation of early and late neonatal mortality rate with the availability of total live births.

Keywords: Neonate, mortality, causes.

INTRODUCTION

The neonatal period (an infant in the first 28 days after birth) is a highly vulnerable period of life when a neonate may develop certain serious problems which lead to death (Babaei & Dehghan, 2018; Kumar, Mundhra, Jain, & Jain, 2019; Weldearegawi et al., 2015). Neonatal mortality is highest in the first 24 hours of life and accounts for 65% of infant mortality (Babaei & Dehghan, 2018). The neonatal mortality rate is the number of neonates dying before reaching 28 days of age, per 1,000 live births in a given year (Babaei & Dehghan, 2018; Kalita, Kalita, Dutta, & Sharma, 2019). A World Health Organization (WHO) report stated that worldwide neonatal mortality rates decreased from 36 deaths per 1,000 live births in 1990 to 19 cases per 1,000 live births in 2015, which indicates that the neonatal mortality rate has fallen by 45 to 47% during these years. Whereas according to the latest statistics released by the United Nations Children's Fund (UNICEF), 2.6 million children died in the first month of life in 2016 – approximately 7,000 newborn deaths every day – most of which occurred in the first week, with about 1 million dying on the first day and close to 1 million dying within the next six days(Kliegman, 2016). For every baby who dies in the first week after birth, another is born dead (fetal deaths or stillbirths). Causes and determinants of neonatal deaths and stillbirths differ from those causing and contributing to post-neonatal and child deaths. Neonatal deaths and stillbirths stem from poor maternal health, inadequate care during pregnancy, poor management of complications during pregnancy and delivery, poor hygiene during delivery and the first critical hours after birth, and lack of newborn care. Health workers at the primary and secondary level of care often lack the skills to meet the needs of newborn infants, since the recognition of opportunity is only just emerging globally, and their experience in this area is therefore limited. Over the

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last two decades, infant and child survival has remained a top global priority. 7.6 million children die each year from preventable causes worldwide, and of these, about 40% die in the neonatal period (Aleshina & Redmond, 2005; Bairoliya & Fink, 2018). The majority of the neonatal deaths took place in impoverished countries where the neonatal care standard is below the desired level. Under-five mortality is declining at a rate of around three percent, yet the reduction in the neonatal mortality rate (2.1% per year) lags behind the rate of reduction among older ages. As infant mortality is the most sensitive indicator of population health, a high infant mortality rate (IMR) reflects the presence of unfavorable social, economic, and environmental conditions during the first year of life (Kumar et al., 2019; Weldearegawi et al., 2015).

Furthermore, the neonatal outcome is an important indicator of obstetrics and health care, as it has a significant role in providing the information needed to improve the health status of pregnant women, and newborns (Babaei & Dehghan, 2018). Five leading causes of infant death: the United States, 2010–2017 were congenital malformations, short gestation, low birth weight, maternal complications of pregnancy, sudden infant death syndrome, and accidents (unintentional injuries) (Ely & Driscoll, 2019; He, Akil, Aker, Hwang, & Ahmad, 2015)Globally, the leading causes of death are estimated to be preterm birth (28%), severe infections (26%), asphyxia (23%), and congenital anomalies (7%).

Advances in perinatal and neonatal care have significantly reduced neonatal mortality rates and have benefited preterm infants admitted to neonatal intensive care units (NICU) in the last decades. The survival and health of newborn babies are a critical part of the push towards lower child mortality in the Millennium Development Goal 4 and 5. The aim of the United Nations' Millennium Development Goal (MDG4 and MDG5) is to reduce newborn mortality in every country to 12 or fewer deaths per 1,000 live births, and to reduce under-five mortality in every country to 25 or fewer deaths per 1,000 live births [(11)]. The neonatal outcome is an important indicator of obstetrics and health care. It has a significate role in providing the information needed to improve the health status of pregnant women, and newborns [(11).] Neonatal mortality rate (NMR) differs from the perinatal mortality rate in that it focuses only on deaths among live births and covers an extended period after birth. Early neonatal deaths (neonatal deaths in the first week of life) are more closely associated with pregnancy-related factors and maternal health, whereas late neonatal deaths (neonatal deaths 7-28th day of life) are associated more with factors in the newborn's environment.

Common causes of neonatal mortality

1. **Prematurity:** Premature infants come early into the world, and they are born fragile, small, and weighing less than full term infants. Many of the babies who survive face greater risks of significant health problems and disability throughout their lives (I.e. learning disabilities, visual and hearing problems, chronic lung disease and other long-term diseases).
2. **Neonatal infections:** Neonatal infections are a major cause of death worldwide. It is estimated that approximately 4 million deaths occur annually in developing countries in the neonatal period.
3. **Birth Asphyxia:** It is estimated that in developing countries, asphyxia causes around seven deaths per 1000 births, whereas in developed countries, this proportion is less than one death per 1000 births **.**
4. **Respiratory Distress Syndrome (RDS) or Hyaline Membrane Disease (HMD):** RDS is one of the most common causes of neonatal respiratory failure. According to the National Neonatal Perinatal Database 2003, HMD was found to affect 1.2% of total live births and contributed to 13.5% of total neonatal deaths**.**

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5. **Congenital anomalies:** Congenital malformation such as congenital heart diseases and metabolic disorders are common causes of infant mortality.

As birth and death are the two most important events in life, any person has legal existence between the recorded timings of those two events. In addition to the legal importance of recording births and deaths, there is importance relevant to vital basic data about the population group. Any planned activity in concern to the population, including health care needs, such statistical information collected from the registration of births and deaths. Also, the magnitude of specific diseases can be assessed using registered deaths relevant to diseases listed in medical certifications of death. This makes the registration of deaths of paramount importance epidemiologically (Kotabagi, Chaturvedi, & Banerjee, 2004). In an effort to reduce infant and child mortality, massive investment has been made to improve access to health-care, nutrition, hygiene and sanitation, and promote exclusive breastfeeding. As a result, world regions have shown reductions in IMR and under-five mortality rates. However, these achievements are challenged by disparities that persist among regions and within countries (Kumar et al., 2019). Therefore, this paper aimed to study mortality in newborns and identify the direct causes of neonatal deaths to achieve the goal of reducing neonatal deaths via policy efforts to promote infant health and under-five children in Benghazi – Libya**.**

Objectives of the study: To study mortality and identify the direct causes of neonatal deaths among newborn babies.

MATERIALS AND METHOD

Design, sample size, and settings of the study: A descriptive case series hospital-based study was conducted from registration files in the neonatal intensive care unit and death certificates in the statistical department in Benghazi Pediatric Hospital.

Study duration and variables of the study: The study was conducted during the period between January and December 2015. Out of 1610 newborn babies admitted to neonatal intensive care in Benghazi Pediatric Hospital in the year (2015), the total number of deaths was 122. The study's focus was on death certificates. Variables studied include the following; birth weight, gender, residency, date of hospital admission, duration of stay in the hospital, age of neonates at death, and causes of death.

Ethical Considerations: Verbal consent was taken from the head of the Intensive Care Unit and the head of the Statistical Department at Benghazi Pediatric Hospital (Teaching Hospital). Confidentiality of data was guaranteed.

Statistical methods: Statistical analysis of study results was performed by the application of the statistical package social science software version 17 (SPSS). Data was collected, analyzed, and expressed as frequency distributions and then computed in percentages in tables and figures. Simple descriptive statistical parameters such as ratio, mean, standard deviation, minimum, and maximum were done. For categorical variables, a chi-square test was applied to test for association. A P-value of less than 0.05 was considered statistically significant in all statistical analyses.

RESULTS

Out of 1610 neonatal admissions reviewed, the total number of deaths at Benghazi Pediatric Hospital was 122 (7.5%) of total neonatal admissions to the hospital during the year 2015. The male and female represent 62.3% and 37.7% respectively. The male to female ratio M:F=1.7**:**1.The vast majority of neonatal mortality cases 91.8%, were residing in Benghazi, whereas the minority 8.2%, were from outside Benghazi**.**

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The minimum birth weight of neonate mortality was 0.7 mg, and the maximum was 4.7kg. Whereas the mean birth weight was 2.63 and the standard deviation of birth weight 0.821. Neonatal mortality according to hospital stay was classified into four categories as following: Stay at the hospital from 0-1 week (78%), more than 1week - 2 weeks (13.1%), more than 2 weeks -3 weeks (2.6%) and stay at the hospital more than 3 weeks was (6.1%). Regarding the distribution of newborn mortality according to maturity, there were full-term case in more than half of newborns (54.1%), (21.3%) were preterm, and data was missing in (24.5%) of newborn mortality cases.

Table (1): Descriptive statistic birth weight of neonate mortality in the Neonatal Intensive Care Unit at Benghazi Pediatric Hospital.

Birth weight	Number	%
0.7 - 0.9 mg	2	1.6
1- 1.9 kg	21	17.2
2- 2.9 kg	42	34.4
3- 3.9 kg	32	26.2
4 kg or more	5	4.0
Missed	20	16.4
Total	102	100

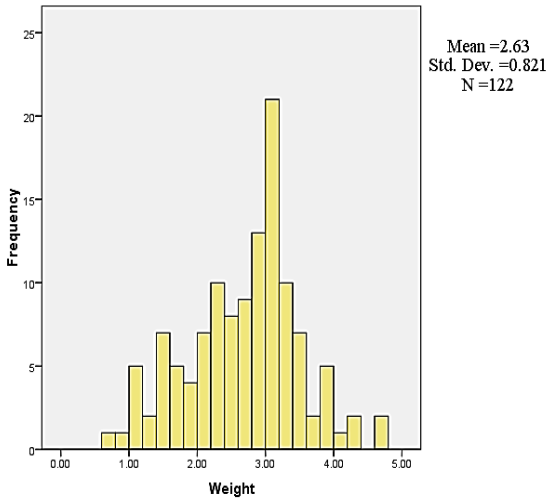

Figure (1): Distribution of mortality among newborn babies according to birth weight.

Table (2): Distribution of age of neonate mortality at Benghazi Pediatric Hospital.

Characteristics/Parameters	Details of age	No.	%
Death according to age	One day-<1week	63	51.6%
	1week-<2weeks	20	16.39%
	2weeks-<3weeks	19	15.57%
	3weeks-1month	18	14.7%

Table (3): The causes of admission of newborns to Benghazi Pediatric Hospital**.**

	Diagnosis at admission	Frequency	%
Admission Causes	Jaundice	550	34.16
	Neonatal sepsis	240	14.9
	Respiratory diseases	234	14.5
	Prematurity (Birth weight < = 2.4 Kg)	263	16.3
	Convulsion	77	4.8
	Congenital heart diseases	52	3.2
	Multiple congenital anomaly	38	2.4
	Birth asphyxia	25	1.6
	Meningitis	41	2.5
	Insulin dependent diabetes	35	2.2
	Others	45	2.8
	Total admissions	1610	100

The above table shows the diseases or morbid conditions which either resulted in a direct cause of death or contributed to death.

Table (4): Causes of death of newborns.

Causes of death	Number	%
Congenital heart diseases	16	13.11
Neonatal sepsis	23	18.85
Respiratory disorders* (respiratory distress syndrome, pneumothorax, aspiration pneumonia)	27	22.13
Prematurity	32	26.23
Multiple congenital anomaly	14	11.48
Birth asphyxia	4	3.30
Metabolic disorders	2	1.64
Renal impairment	1	0.82
Bleeding disorders	1	0.82
Necrotizing enterocolitis (NEC)	2	1.64
Total	122	100%

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Among respiratory disorders, there were (Respiratory distress syndrome in fifteen neonates, six neonates had Pneumothorax, Brnchopneumia & Aspiration pneumonia in five & one neonate had Muconium aspiration**)**. The other causes that contributed to death included one case of dehydration, one case of intestinal obstruction, two cases died due to disseminated intravascular coagulation, and two had Neuroblastoma. Multiple causes of death and cardiopulmonary arrest were mentioned on 37 (30%) death certificates of newborns.

Table (6): Cross-tabulation of neonatal sepsis and congenital heart diseases' related mortality distribution according to gender.

Gender	Neonatal sepsis		Total
	Number of effected	Number of free from disease	
Male	18	58	76 (100%)
Female	5	41	46 (100%)
Total	23	99	122(100%)
Pearson Chi square = 3.076, df=1, *P* value = 0.079 (non-statistically significant).			
Gender	Congenital heart disease		Total
	Number of effected	Number of free from disease	
Male	11	41	52(42.6%)
Female	5	65	70(57.3%)
Total	16	106	122(100%)
Pearson Chi square = 0. 327, df=1, *P* value =0.568 (non-significant because, p value higher than 0.05. No statistical significant difference was observed.			
None of the neonates' mortality due to sepsis or due to congenital heart diseases was related with gender, either male or female.			

DISSCUSSION

Out of 1610 neonatal admissions to the Benghazi Children Hospital during 2015, there were 122 neonatal deaths (7.5%). The remaining 1488 (92.4%) neonates were discharged after improvement. In this study, the male gender was predominant. Nearly 52 % occurred in the first week of life (early neonatal death at one day - <1 week). These results are similar to the data reported by Fituri *et al*. 2014-2016, which recorded 28930 newborn babies admitted to the neonatal intensive care unit. In the Tripoli medical center, reported neonatal deaths were at 3.2%, and the neonatal mortality rate (NMR) calculated was 10.1/1000, where 250 of the babies died in the neonatal period, and 38 babies died in the post-neonatal period. 65.3% of the neonatal deaths occurred in the first week of life, while 21.5% died in the late neonatal period (Sherlala, Sabei, & Fituri, 2017). Likewise, a study conducted by Minyahil (2014) showed that most neonatal deaths occur in the 1st week of life (Woldu et al., 2014).

In this study, more than half of the deaths were full-term babies (54%). Most of them had a birth weight ranged between 2 -2.9 Kg and 3- 3.9 Kg. A limited number of babies were below 2.5Kg. Regarding the maturity of newborns with neonatal deaths, a fair amount of data was missing, nearly 25% of the sample size (not written in the medical records whether the babies were delivered full-term or premature). This makes an error in the findings that affects the results. The neonatal deaths in full-term babies with normal weight in this study were explained based on missing data, and these results were inconsistent with the literature.

The present study demonstrated that the vast majority of the neonates died in the first week of life compared with other studies (Bashir M. *et al*. 2018; Gebremedhin, Berhe, & Gebrekirstos, 2016; Warren & Anderson, 2009)

The common causes of admission to the ICU at Benghazi Children Hospital were Jaundice followed by prematurity. Whereas Rakesh's study in 2019 revealed that neonatal jaundice, birth asphyxia, and sepsis are the most common causes of admission (Kumar et al., 2019). Another study conducted by Homa and his colleagues in Kermanshah in Iran

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2014-2016 found that understanding the causes of death in neonatal intensive care units and the modifiable factors associated with death could possibly reduce infant mortality. It is necessary to identify the causes of mortality in each country or country regions in order to minimize it. The study also demonstrated that the most common causes of neonatal death were prematurity (gestational age below 37 weeks), and its related complications, for example, respiratory distress syndrome and sepsis. The highest death rate occurred in the first week of birth and during the night shift. Also, the highest number of infant deaths was of boys, and lowest number was of those resuscitated in the delivery room. Considering the high prevalence of neonatal mortality with lower gestational age, more care in preventing preterm delivery, as the most important cause of neonatal mortality, can be of particular importance in reducing neonatal mortality (Babaei & Dehghan, 2018).

Another similar study in Misurata - Libya reported that the infant mortality rate and neonatal mortality rate, which plays an important role in health planning and neonatal outcome, is a major indicator of obstetrics and health care, where it has an important role in providing the information needed to improve the health status of pregnant women and newborns (Bashir et al. 2014).

The missed data can lead to errors in the results.(Angus, Linde-Zwirble, Clermont, Griffin, & Clark, 2001). The study findings indicated that the most frequent direct single cause of death in neonates was prematurity (26.2%), then neonatal sepsis, and congenital heart disease (18.8% and 13.1%) respectively. Also, a multiple congenital anomaly was on (11.4 %) of death certificates and cardiopulmonary arrest was mentioned on 37 of the death certificates of newborns.

Another study in Egypt in 2000 showed that prematurity was the primary cause of death in Egyptian neonates, while the WHO estimates gave infections, including tetanus, as the main cause (Campbell et al., 2004).
A retrospective study was conducted by Dulal *et al*. in Tezpur- India the finding were a decreasing trend of neonatal mortality rates (NMR) in Tezpur. Birth asphyxia, low birth weight, and sepsis are the leading causes of neonatal mortality. This neonatal mortality can be brought down by providing adequate antenatal care, improving maternal nutritional status, close monitoring of fetal wellbeing in pregnancy, the timely intervention of delivery, good neonatal resuscitation care, and early referral of sick newborns to neonatal intensive care units (Kalita et al., 2019).

While, a study in Jimma-Ethiopia also represented the major factors that affect the survival time of preterm were prenatal Asphyxia, Sepsis, Hyaline membrane disease, jaundice, gestational age, temperature, and respiratory distress syndrome for time to death of premature infants. Furthermore, a previous study found the same findings (Wang et al., 2013; Wesenu, Kulkarni, & Tilahun, 2017). A previous study reported that with advances in diagnostic and treatment modalities as well as government initiatives to decrease neonatal mortality, significant achievements have been made. Common causes of mortality were birth asphyxia, sepsis, and prematurity (Kumar et al., 2019).

Furthermore**,** (Jain et al., 2019) performed a study that reported that the causes of neonatal deaths were prematurity-related complications followed by intrapartum-related events. Birth asphyxia and sepsis accounted for most neonatal deaths, 80% of which are preventable with simple interventions. Understanding the cause and timing of neonatal deaths is critical for forming public health policies targeted at reduce the neonatal mortality rate (Jain et al., 2019).

Whereas a Tripoli-Libya study recorded that prematurity and its complications were the

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main cause of death (Sherlala et al., 2017). Similarly, deaths due to respiratory distress syndrome were common in preterm and male neonates (Iyer, Naveen, Suma, Kumarguru, & Sweta, 2018). Finally, a study in Indonesia found that hyaline membrane disease, neonatal infection, and prematurity are responsible for high morbidity and mortality rates among neonates (Sastroasmoro, 1998). In addition, the current study showed that the M:F ratio was 1.7:1. However, the association between congenital heart disease, neonatal sepsis, and gender in deceased newborns was insignificant (No statistically significant difference was observed). The common cause of neonatal admission to Benghazi Pediatric Hospital was Jaundice, followed by respiratory disorders and neonatal sepsis. These findings are in agreement with the respiratory disorders reported in literature, as neonatal sepsis is the most frequent cause of admission for neonatal intensive care in both term and preterm (Ezeh, 2017; Goldenberg, Culhane, Iams, & Romero, 2008; Kliegman, 2016; Moise, 2018 ; Amorim, et al, 2018).

Limitation of the study: The data collected in this study only reflected a percentage of Benghazi Pediatric Hospital cases and not all cities in the country. The results may lack generalizability due to the short period of time at which the study was conducted. Important missing information not recorded in medical records was significant in some variables such as mothers' age, parity, and maternal complications. Also important data for the neonates were missing such as birth weight and maturity. Therefore, lack of information on the death certificates creates errors. Unfortunately, with regard to the total live births in 2015, no data was collected due to legal issues. Consequently, the neonatal mortality rate could not be calculated.

CONCLUSION

Based on the current study's results, the male gender was predominant. The vast majority of neonatal mortalities were admitted to the Hospital from Benghazi city. Most newborns had a normal delivery. Few newborns were delivered by caesarean section. There were 122 neonatal deaths, where nearly half of them died before the first week, which is a warning sign for health services. Most newborns stay in hospital from one to ten days. Also, the current study concluded that the most frequent causes of neonatal-related deaths were prematurity, then neonatal sepsis, and congenital heart disease. Also, multiple congenital anomalies were recorded on death certificates. In addition, among multiple causes of death, cardiopulmonary arrest was mentioned on newborns' death certificates.

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وفيات الأطفال حديثي الولادة في وحدة العناية المركزة لحديثي الولادة بمستشفى بنغازي للأطفال – ليبيا.

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المستخلص: يهدف البحث إلى دراسة معدلات الوفيات، وتحديد الأسباب المباشرة لوفيات الأطفال حديثي الولادة في مستشفى بنغازي للأطفال. وأجريت دراسة وصفية لسلسلة الحالات خلال عام 2015. حيث تشمل البيانات؛ الوزن عند الولادة، والجنس، والإقامة، ومدة الإقامة في المستشفى، وعمر حديثي الولادة عند الوفاة، وأسباب الوفاة. من أصل 1610 حالة تم مراجعتها لحديثي الولادة تم قبولهم بالمستشفى، كان العدد الإجمالي للوفيات 122 خلال عام 2015. ركزت البيانات على شهادات وفاة المواليد وأظهرت أن الذكور هم الغالب (62.3٪). تراوح وزن معظمهم عند الولادة بين 2 – 2.9 كجم. ما يقارب من 52٪ من وفيات المواليد في يوم واحد كانت لحديثي الولادة أعمارهم أقل من أسبوع، و 54٪ أطفال مكتملو المدة. كان السبب الوحيد المباشر الأكثر شيوعًا للوفاة عند الأطفال حديثي الولادة هو الإنتان الخداجي، ثم الإنتان الوليدي (التهابات المواليد)، ثم أمراض القلب الخلقية على التوالي. خلصت الدراسة إلى أن الأسباب الأكثر شيوعا والمرتبطة بحالات الوفاة لحديثي الولادة كانت الإنتان الخداجي، ثم الإنتان الوليدي. كذلك توصى بالبحوث المستقبلية وحساب معدل وفيات المواليد المبكرة والمتأخرة مع توفر إجمالي المواليد الأحياء.

الكلمات المفتاحية: حديثو الولادة، الوفيات، المسببات.

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Early Hospital Discharge and Early Puerperal Complications

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Abstract: The study aimed to evaluate the association between the time of postpartum discharge and symptoms indicative of complications during the first postpartum week. The cross-sectional study included 753 women with vaginal delivery at Al-Jamhorya teaching public hospital without complications were interviewed before the hospital discharge and seven days after. The time of postpartum discharge was classified as early (≤24hours) or late (>24hours). A total of 753 mothers were enrolled in the study. The majority (94.3%) of the mothers stayed in the hospital ≤24hours, 4.1% >24hours, and 1.6 % were discharged against medical advice. The mean duration of hospital stay was 12.1±6.1 hours, with a minimum hospital stay of 2 hours and a maximum stay of 46 hours. The prenatal care was satisfactory in 91.2%. Prenatal care was satisfactory in 91% of early discharge mothers and 93.5% in the late group. This slight difference was not statistically significant. After delivery, 8.4% had urinary tract infections. Urinary tract infection after delivery occurred in 8.2% of mothers with early discharge and 12.9 % in mothers with late discharge. This difference was not statistically significant. Complications of episiotomy were recorded in 79.9% of mothers with early discharge and 61.3% in late discharge. This difference was statistically significant. The study's conclusions indicated that late discharge mothers had received anesthesia and performed episiotomy more than early discharge mothers. Complications of episiotomy were recorded more in mothers with early discharge than in late discharged mothers. It is recommended that a randomized clinical trial is best to evaluate the association between the time of discharge postpartum and the presence of complications, also to attain safety and possible benefits of shorter hospital stay.

Keywords: Early Hospital Discharge, Vaginal Delivery, Puerperal Complications

INTRODUCTION

Maternal morbidity refers to complications that have arisen during the pregnancy, delivery, or postpartum period. Every year an estimated 50 million women are affected by maternal morbidity. Defining, interpreting, and measuring maternal morbidity, however, is recognized to be difficult, and the prevalence of such morbidity (both general and specific) has been poorly described.(Fortney & Smith, 1999; Organization, 1998). Over the past decade, the nature and extent of postpartum maternal morbidity have received increasing interest in both developed and developing countries, with a range of research methods of varying sophistication being used to identify long and short-term and acute and chronic morbidity following childbirth. (Fikree et al., 2004; M. Chama, 2000;

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Organization, 1998; Silverton, 1993; Waterstone et al., 2003).

The WHO (1998) defines the postpartum period, or puerperium, as beginning one hour after the delivery of the placenta and continuing until 6 weeks (42 days) after the birth of the infant.(Organization, 1998). As the woman recovers from labour, adapts to her new role, and reverts physically to her non-pregnant state, it is an exceptional but critical time for both the mother and her infant (Cunningham F, 2001).

Many of the complications leading to postpartum maternal morbidity arise during labor and delivery and in the first 1–2 weeks following delivery; for at least 18 million women, these morbidities become long-term and are often debilitating. Major acute obstetric morbidities include haemorrhage, sepsis, and pregnancy-related hypertension. Longer-term morbidities include uterine prolapse, vesicovaginal fistulae, incontinence, dyspareunia, and infertility (Koblinsky & Tinker, 1994).

Fortney & Smith have described six dimensions to maternal morbidity: etiology, severity, duration, time of onset, accumulation, and sequelae. However, in many developing countries, health services data on postpartum morbidity remains extremely limited. In recent years, there has been growing interest to determine the ideal time for postpartum discharge for optimal maternal and child outcomes. (Fikree et al., 2004; M. Chama, 2000; Organization, 1998; Silverton, 1993; Waterstone et al., 2003). Hospital length of stay after childbirth has decreased progressively during the past 60 years. (Braveman et al., 1996; Koblinsky & Tinker, 1994; Madden et al., 2002). In the early 1980s in Mexico, the Mexican Social Security Institute developed the program Atención de Parto de Bajo Riesgo (Care for Low-Risk Delivery), which resulted in a six-hour reduction in postpartum hospital stays. (Britton et al., 1994; Yaffe et al., 2001).

For women who have uncomplicated vaginal deliveries, the American College of Obstetrics and Gynecology (ACOG) defines early discharge as a hospital stay lasting 48 hours or less and considers a stay of 24 hours or less as very early discharge (VED). (Hellman et al., 1962; Lieu et al., 2000; Norr & Nacion, 1987). This study hypothesizes that shorter postpartum stays are associated with poor health outcomes because of the decreased probability of detecting postpartum complications, as has been found in studies with other populations (Norr & Nacion, 1987).

Objective: To evaluate the association between the time of postpartum discharge and symptoms indicative of complications during the first postpartum week.

MATERIAL AND METHODS

Study Subjects and Setting*:* 753 women with vaginal delivery at Al-Jamhorya teaching public hospital without complication were interviewed before the hospital discharge, and seven days after the Time of postpartum discharge, which was classified as early (≤24 hours) or late (>24hours).

Study sample*:* (A convenient sample of 753 Women).

Study duration*:* The study was conducted during a period of 6 months, from January 2014 to June 2014**.**

Inclusion criteria: a) vaginal delivery of a live singleton term infant (gestational age 37 to 41 weeks); b) uncomplicated pregnancy without concomitant diseases such as diabetes, hypertension, preeclampsia, cardiopathy, epilepsy, or evident infections; and c) residence in Benghazi City.

The exclusion criteria were refusal to participate, and residing outside the city. The withdrawal criteria were failure to locate the patient after three attempts.

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Four trained interviewers evaluated medical records to select subjects who fulfilled the inclusion criteria and then invited eligible mothers to participate in the study.

To collect the following baseline data, selected mothers were asked to participate in a face-to-face interview before leaving the hospital: a) socio-demographic characteristics; b) gynecologic and obstetric history; c) prenatal care assessed; d) delivery events, including vaginal lacerations; and e) clinical characteristics of the immediate puerperium, (considered as the 24 hours following delivery). A chart review was performed for all cases to corroborate questionnaire data and obtain clinical information. Information about the time of discharge was retrieved from medical records after discharge. Mothers were invited for a medical visit seven days after delivery, at this visit, mothers underwent another face-to-face interview to obtain information related to maternal postpartum health. Mothers who failed to attend the 7-day follow-up appointment, would be considered as lost to follow up.

The study outcome variable was the presence of self-reported symptoms in early puerperium. This variable was measured using symptoms reported by the mother during an interview conducted seven days after hospital discharge. Symptoms were categorized as suggestive of a) urinary tract infection (dysuria, frequent urination, bladder tenesmus); b) episiotomy complications (local pain or discomfort, bleeding, separation of sutures, c) episiotomy infection (purulent discharge, pain, warmth, and redness in the area); d) endometritis: (uterine pain, foul-smelling lochia, and fever or shivering); f) mastitis and/or mammary abscess (pain, heat, and redness or cracking of nipples); and g) other reported symptoms or hospital readmission.

Statistical analysis*:* Data were analyzed using a statistical package for social science (SPSS) version 18. Descriptive statistics, such as mean, standard deviation, median and mode were used. Inferential statistics were used when needed, as Chi-square(x^2) to find the difference in the distribution of the variables between the two groups, P-value was considered significant when ≤ 0.05. Data were presented in tables and figures, which were the figures done by Microsoft Excel 2003.

RESULTS

The majority of women (54%) were in the age group between 21-30 years followed by 31-40 years old, as shown in figure 1.

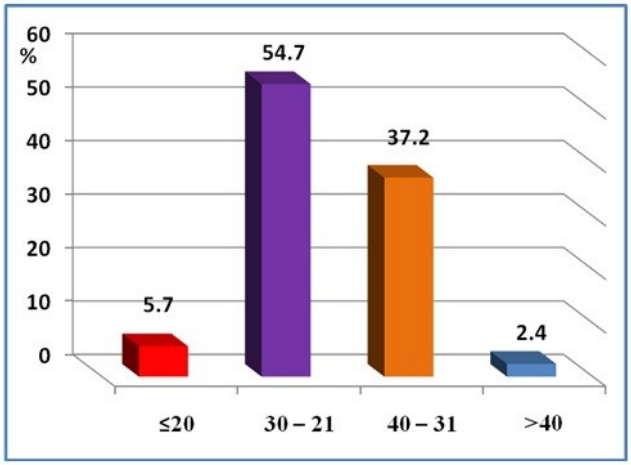

Figure (1): Distribution of mothers according to age (years).

Table (1): Distribution of mothers according to their level of education.

Level of education	No.	%
Illiterate	14	1.9
Primary School	85	11.3
Preparatory School	399	53
Secondary School	251	33.3
University	4	0.5
Total	753	100

The Relationship between duration of hospital stay (hours) and type of anesthesia $X^2=8.906$ df=2; p=0.012 (Significant) according to (table 2).

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Table (2): Distribution of mothers according to time of postpartum hospital discharge and type of anesthesia.

Type of anesthesia	Duration of hospital stay (hours)				Total	
	≤24		>24			
	No.	%	No.	%	No.	%
Local	485	68.4	29	93.5	514	69.4
Not given	224	31.5	2	6.5	226	30.5
Epidural	1	0.1	0	0	1	0.1
Total	710	100	31	100	741	100

The relationship between the time of postpartum hospital discharge and prenatal care: (Prenatal care was satisfactory in 91.2%, where only 8.8% of the cases were unsatisfactory). Prenatal care was satisfactory in 91% of early discharge and 93.5% in the late group: e. X^2=0.240 df=1; p=0.624, and this slight difference was not statistically significant (Not Significant). The relationship between time of postpartum hospital discharge and vaginal laceration: p= 0.174 (Not significant) according to information as shown in (table 3).

Table (3): Distribution of mothers according to complications.

Complications	Details	No.	Percent%
Vaginal laceration	Yes	113	15%
	No	640	85%
Urinary tract infection (after delivery)	Yes	63	8.4%
	No	620	82.3%
	Not known	70	9.3%
History of Thromboembolic complication(after delivery)	Yes	6	0.8%
	No	675	89.6%
	Not known	72	9.6

After delivery, 8.4% had urinary tract infections. Urinary tract infection after delivery has occurred in 8.2% of mothers with early discharge and 12.9 % in mothers with late discharge, this difference was not statistically significant. Late discharge mothers had received anesthesia and performed episiotomy more than early discharge mothers. A complication of episiotomy was recorded more in mothers with late discharge than in early discharged mothers as shown in (figure 2).

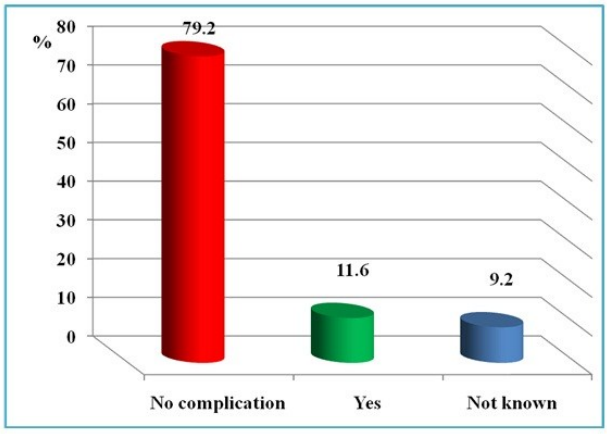

Figure (2): Distribution of mothers according to complications of episiotomy.

From this study, it was observed that pain and infection were recorded in mothers with late discharge more than early discharge. The pain constituted 62.5% in the late group, as shown in (table 4), and 45.9% in the early group. The infection was recorded in 25% of the late group and only 8.1 % of the early group, as observed in (table 4).

Table (4): Relationship of mothers according to time of postpartum hospital discharge and type of complications of episiotomy.

Types of episiotomy complications	No.				Total	
	≤24		>24			
	No.	%	No.	%	No.	%
Pain	34	45.9	5	62.5	39	47.6
Pain & redness	25	33.8	1	12.5	26	31.7
Infection	6	8.1	2	25	8	9.8
Separation of suture	6	8.1	0	0	6	7.3
Redness in the area	3	4.1	0	0	3	3.6
Total	74	100	8	100	82	100

X^2= 7.236 df=2; p= 0.027 (Significant).

Complications of episiotomy were recorded in 79.9% of mothers with early discharge and 61.3% in late discharge. This difference was statistically significant. Relationship between time of postpartum hospital discharge and mastitis after delivery: X^2=1.468 df=2; p=0.480. (Not significant) according to the

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information from (figure 3).

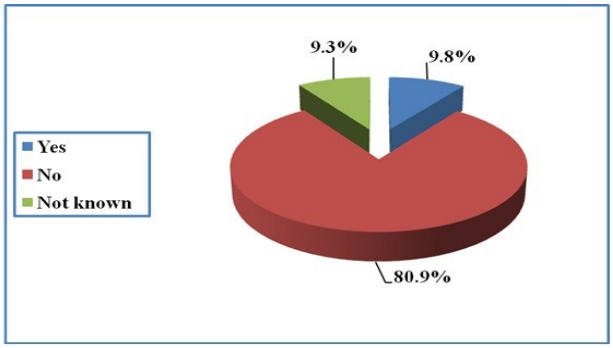

Figure (3): Distribution of mothers according to the history of mastitis after delivery.

Furthermore, in the following table, we demonstrate the difference in early and late discharge according to many variables with mean and standard deviation all of which are recorded in table 5.

Table (5): Characteristics describing mothers studied according to time of postpartum hospital discharge, Al-Jamhorya Hospital, Benghazi.

Variable	Early discharge (≤24hrs) n(%)	Late discharge (>24hrs) n(%)
Duration of hospital stay	Mean±St.Dev. 11.4±5.2	Mean±St.Dev. 27±4.5
Obstetric history		
Satisfactory	646(91)	29(93.5)
Unsatisfactory	64(9)	2(6.5)
Status of the patient at the time of admission	97(13.7)	3(9.7)
Second stage	189(26.6)	8(25.8)
Ruptured membranes		
Procedures		
Labour induction	189(26.6)	8(25.8)
Application of enema	0(0)	0 (0)
Episiotomy	406(57.2)	27(87.1)
Bladder catheter at the time of delivery	412(58)	21(67.7)
Yes		
Type of anesthesia		
None	224(31.5)	2(6.50
Local	485(68.4)	28(93.5)
Epidural	1(0.1)	0(0)

DISCUSSIONS

A total of 753 mothers were enrolled in the study. The majority (94.3%) of the mothers stayed in the hospital ≤24hour, 4.1% >24hours, and 1.6 % were discharged against medical advice.

The mean duration of hospital stay was 12.1±6.1 hours, with a minimum hospital stay of two hours and a maximum stay of 46hours. Another study conducted by Dolores RV in Mexico 2009 recorded that 68.6% had early postpartum discharge, with a mean hospital stay of 21.5± 8.5hours. The study also showed that although there was no association between early discharge and the severity of complications during early puerperium for all mothers, the presence of symptoms decreased among women who received indications to have a medical checkup one week later. Symptoms also decreased among women with early discharge and satisfactory prenatal care, compared with those with early discharge and unsatisfactory prenatal care, suggesting a positive effect of adequate prenatal care even with an early discharge. This correlation deserves further study to better understand its importance. Consequently, the researchers concluded that there was no association between early discharge and symptoms of complications during the first postpartum week; the odds of complications were lower for mothers with early discharge and satisfactory prenatal care (Ramírez-Villalobos et al., 2009).

The results of the current study showed that prenatal care was satisfactory in 91.2%. Prenatal care was satisfactory in 91% of early discharge and 93.5% in the late group and this slight difference was not statistically significant p=0.624, and the mean age of mothers was 29.4± 5.8years, with a minimum age of 15years and a maximum of 43years. A majority (91.9%) was in the age group between 21years to 40years. Furthermore, the age of mothers with an early discharge was similar to those with a late discharge, and there was no statistical difference between the two groups p=0.838. This result was similar to

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other studies. (Ramírez-Villalobos et al., 2009)

In this study, the complications of episiotomy were recorded in 11.6% of the patients. The complication of episiotomy was recorded in 79.9% of mothers with early discharge and 61.3% in late discharge. This difference was statistically significant p= 0.027.

Furthermore, readmission to the hospital after delivery was recorded in 4 mothers (0.5%), and all of them were in the early discharge group. In other studies, no significant differences were found in the rates of maternal re-hospitalization (1.9% in the early discharge group vs. 2.3% in the control group) (Bueno et al., 2005).

In this study, an episiotomy was done in 57.2% of early discharge cases and 87.1% in those with a late discharge. This difference was statistically significant p = 0.001. A bladder catheter was done during labour to 58% of mothers with early discharge and 67.7% in late discharge. This difference was not statistically different (p = 0.283).

Whereas, a case-control study in India 2015 reported that: the younger mothers who had first time accessed antenatal services and who had less than three ANC visits during the antenatal period, and mothers delivering in government hospitals in addition to not having any complications during delivery, and those who requested early discharge, and were discharged within 48h of delivery, were more likely to have discharged early from hospitals, in addition to lack of insistence by doctors against early discharge.

The normal condition of mothers, babies, and multiparous mothers were the main reasons for early discharge as perceived by the health care providers. It is important to design appropriate strategies to ensure timely discharge, and they should have local level acceptance. (Nipte et al., 2015)

The current study's findings demonstrated that 8.4% of mothers after delivery had urinary tract infections. Urinary tract infection after delivery has occurred in 8.2% of mothers with early discharge and 12.9 % in mothers with late discharge. This difference was not statistically significant, p=0.483, this result was similar to the result of other studies (Ramírez-Villalobos et al., 2009). The complication of episiotomy was recorded in 11.6% of the patients. A complication of episiotomy was recorded in 79.9% of mothers with early discharge and 61.3% in late discharge, this difference was statistically significant p= 0.027.

Pain at the episiotomy site was recorded in 46% of the mothers, pain, and redness in 32.2%, infection in 10.3%, separation of the suture in 8%, and redness in 3.5%. Pain and infection were recorded in mothers with late discharge more than early discharge. The pain constituted 62.5% in the late group, and 45.5% in the early group. The infection was recorded in 25% of the late group and only 9.1 % of the early group.

History of mastitis was positive in 9.8% of the patients. Mastitis after delivery was recorded in 9.7% of mothers with early discharge and 16.1% in mothers with late discharge. This difference was not statistically significant p= 0.480.

History of thromboembolic complication after delivery was positive in six mothers (0.8%), and all of them were in the early discharge group. The causes of early discharge of mothers from hospital after delivery could be explained by various reasons such as dissatisfaction about hospital accommodation or care, need to take care of other children at home, feeling more comfortable at home, and no beds in the hospital. The results of the Indian study of early discharge among mothers who delivered in government hospitals, are similar when compared to observations in some studies from overseas. This probably

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results from a high caseload and lack of adequate space for hospitalization in the wards. Even though the national guidelines recommend retention of mothers after delivery in the hospitals for 48 h or more, bed availability can become an issue in the case of busy health facilities. Hence, infrastructural expansion in terms of providing more beds, and making the hospital stay more comfortable at primary health care levels, becomes critical. The absence of maternal complications is associated with early discharge, and women with complications are retained in hospitals for longer periods (Nipte et al., 2015).

Similar findings were reported in studies from New Delhi, India, and the United States. Relatives, family members, and mothers who had no complications during delivery need to be motivated to agree to stay in the hospitals after delivery for a minimum of 48 h to ensure an uneventful postpartum period. Additionally, the issue of early discharge is also decided by other socio-cultural factors. Elderly females in the family or close relatives or spouses of mothers need to be educated on delivery-related complications and the need for a 48 h hospital stay after the delivery. Various other reasons for seeking early discharge from hospitals may be: dissatisfaction about hospital accommodation or care, need to take care of other children at home, feeling more comfortable at home, reducing out of pocket expenditure due to longer hospitalization, perception of getting to know the baby better at home, preventing disturbance due to hospital routines, and desire to be close to the family. These reasons can be addressed through improving the hospital environment and allowing better and easy contact between the mothers and their families (Nipte et al., 2015).

It is important to emphasize that the medical risks to mothers and babies excessively outweigh the perceived benefits of early discharge, and Information Education Communication (IEC) strategies need to focus on this. The mothers' level of education, income, parity, gestational age, and birth weight of babies, were not observed to be associated with early discharge. Similar observations concerning gestational age, infant birth weight, and parity were made in a study from the United States of America. 24 However, some other studies have reported contradictory observations (Nipte et al., 2015).

A systematic literature review similar to our study entitled vaginal delivery: how does early hospital discharge affect mother and child outcomes? Conducted by (Benahmed et al., 2017) concluded that the currently available literature provides little scientific evidence to guide postpartum discharge policy planning. The evidence-based randomized control trials (RCTs) are old, with the most recent trial published 10 years ago, and the quality of evidence of these trials is poor. The more recent evidence is based only on two very poor quality non-randomized studies (Benahmed et al., 2017)

Moreover, the concept of the early discharge itself is very variable across studies, leading to health outcomes being measured at variable times after delivery.

Despite these limitations, early discharge seems to be safe for both mother and newborn. Breastfeeding did not seem to be affected. Because of the lack of robust clinical evidence and full economic evaluations, the current data neither support nor discourage the widespread use of early postpartum discharge. Before implementing an early discharge policy, Western countries with longer lengths of hospital stays, such as France and Belgium, may benefit from testing shorter lengths of stay in studies with an appropriate design (e.g. randomized) (Benahmed et al., 2017; Brown et al., 2002).

In our study, the mothers who fail to attend the 7-day follow-up appointment, were con-

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sidered as lost to follow up. Whereas the México study recorded missed women as lost due to change of residence, failure to locate the place of residence after three attempts, or incorrect address. No significant differences were found between women who completed the study and those who were lost to follow-up, regarding the length of hospital stay, age, and the number of live-born children (Ramírez-Villalobos et al., 2009).

In another study in Sweden (Intrapartum and postpartum care in Sweden: women's opinions and risk factors for not being satisfied). The researchers found the following risk factors for not being satisfied were: age<25 years (intrapartum care only) elementary school (intrapartum and postpartum care), lack of support from a partner (intrapartum care); suffering from many physical symptoms (intrapartum and postpartum care); lack of support by a midwife (intrapartum care, only), dissatisfaction with the birth environment (intrapartum care only), insufficient time for breastfeeding support, encouragement and personal questions in postpartum care (Waldenström et al., 2006).

CONCLUSIONS

Late discharge mothers had received anesthesia and performed an episiotomy more than early discharge mothers. A complication of episiotomy was recorded more in mothers with early discharge than in late discharged mothers. History of thromboembolic complication after delivery and readmission to hospital after delivery was recorded only in mothers with an early discharge. A qualitative study for understanding the socio-cultural grounding for early discharge is needed. Early discharge should be decided by senior physicians.

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الخروج المبكر من المستشفى ومضاعفات النفاس المبكرة

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المستخلص : تهدف الدراسة إلى تقييم العلاقة بين وقت الخروج بعد الولادة، والأعراض التي تدل على حدوث مضاعفات خلال الأسبوع الأول بعد الولادة. وقد شملت الدراسة المقطعية 753 سيدة مع ولادة مهبلية بمستشفى الجمهورية التعليمي العام بدون مضاعفات قبل الخروج من المستشفى وتمت مقابلتهم قبل خروجهم من المستشفى وكذلك بعد سبعة أيام. تم تصنيف وقت التفريغ بعد الولادة على أنه مبكر (≥24 ساعة) أو متأخر (<24 ساعة). وقد تم تسجيل ما مجموعه 753 من الأمهات في الدراسة ، ومعظم الأمهات (94.3٪) يبقين في المستشفى ≥24 ساعة ، 4.1٪ <24 ساعة و1.6٪ خرجن من المستشفى مخالفة للمشورة الطبية. كان متوسط مدة الإقامة في المستشفى 12.1 ± 6.1 ساعة ، مع حد أدنى للإقامة في المستشفى لمدة ساعتين وحد الأقصى للإقامة لمدة 46 ساعة. كانت رعاية ما قبل الولادة مرضية في 91.2٪. كانت رعاية ما قبل الولادة مرضية في 91٪ من التخريج المبكر، و 93.5٪ في المجموعة المتأخرة، وهذا الاختلاف الطفيف لم يكن ذا دلالة إحصائية. بعد الولادة أصيب 8.4٪ بعدوى في المسالك البولية. حدثت عدوى المسالك البولية بعد الولادة في 8.2٪ من الأمهات اللائي خرجن مبكرًا، و 12.9٪ في الأمهات اللائي لديهن خروج متأخر، ولم يكن هذا الاختلاف ذا دلالة إحصائية. تم تسجيل مضاعفات بضع الفرج في 79.9٪ من الأمهات اللائي خرجن مبكرًا، و 61.3٪ في أواخر التخريج، وكان هذا الاختلاف ذا دلالة إحصائية. استنتجت الدراسة أن الأمهات المتأخرات تلقين التخدير وأجرين بضع الفرج (شق العجان) أكثر من الأمهات الخريجات مبكرا، و تم تسجيل مضاعفات بضع الفرج(شق العجان) في الأمهات اللائي لديهن خروج مبكر منه في الأمهات المتأخرات. وتوصي الدراسة بالتجارب السريرية العشوائية كونها الأفضل لتقييم العلاقة بين وقت الخروج بعد الولادة، ووجود المضاعفات ، وأيضًا لإيجاد الأمان والفوائد المحتملة للإقامة القصيرة في المستشفى.

الكلمات المفتاحية: الخروج المبكر من المستشفى ، الولادة المهبلية ، مضاعفات النفاس.

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Clinical Profile and CT-Chest Patterns of 56 Patients with Covid-19 Pneumonia

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Abstract: Since the COVID-19 pandemic was announced, the concern of radiologists and physicians regarding its diagnosis has been profoundly raised. The primary reference for confirming COVID-19 pneumonia relies on reverse transcriptase-polymerase chain reaction (RT-PCR) testing, where the subject of availability, false negative-rates, practice dependency, and time-consumption, made computed tomography (CT) more superior in Covid-19 pneumonia diagnosis, which was the situation in Al-Bayda-city\Libya. The first local case in Al-Bayda-city was reported on 30 July 2020, followed by a dramatic surge in the number of cases, which necessitated the recognition of main clinical features and CT-patterns of COVID-19 to facilitate rapid diagnosis. The aim of study: Describe the clinical features and the CT-chest patterns of COVID-19 pneumonia among the studied population. A descriptive case series study was conducted in the central hospital of Al-Bayda city /Libya from 11 August to 21 September 2020, which involved 56 patients (31 females and 25 males). Patients' ages ranged from 28-88 years (62.79± 11.3). Non-contrast CT-chest was performed on all patients. The main patients' complaints were fever 94.6%, dyspnea 89.3%, and cough 85.7%. The most common CT pattern among the studied cases was ground-glass opacities found in 100% of patients, followed by vascular thickening 88%, consolidative lesion 71.4%, crazy-paving pattern 57%, vacuolar sign 57.1%, architecture distortion 40%, halo sign 34%, reverse halo sign 34.5%, and traction-bronchiectasis 16% of the studied cases. Finally, recognition of CT-chest patterns of Covid-19 pneumonia plays a significant role in early detection, and therefore isolation and management of the disease. The findings of this study can be used as a baseline for further research in the future.

Keywords: Covid19 Pneumonia; Covid-19; Covid-19 Libya; Chest CT; Ground-Glass Opacity (GOO).

INTRODUCTION

COVID-19 is an emerging global health problem caused by a novel coronavirus named severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). It is the seventh known coronavirus to infect humans, first noticed in December 2019 Wuhan\China. The World Health Organization (WHO) declared COVID-19 to be pandemic in March 2020. (Zheng 2020; Kim et al. 2020; Bernheim et al. 2020). As of 17th November 2020, a total of 54,771,888 cases of COVID-19 have been confirmed, including 1,324,249 deaths (WHO, 2020a). Since diagnosing the first documented local transmission case of COVID-19 in Al Bayda city\Libya on 30th July 2020, the radiology department was overwhelmed by patients with typical COVID-19 symptoms with peculiar patterns in computerized tomography (CT) scans of the chest with an increased

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death toll for cases with chest infections mainly due to viral pneumonia (Ibrahim, 2020). The clinical symptoms of COVID-19 range from asymptomatic to mild (low-grade\high fever, fatigue, dry cough, nasal congestion, diarrhea, and slight weakness with or without pneumonia), rarely a runny nose; to a severe form, characterized by dyspnea and/or hypoxemia that can quickly progress to respiratory distress, septic shock, uncorrectable metabolic acidosis, and coagulation disorders (Carotti et al.2020). The standard of reference for confirming COVID-19 pneumonia relies on reverse transcriptase polymerase chain reaction (RT-PCR) tests. However, availability of (RT-PCR) in an emergency setting, a high rate of false-negatives, low sensitivity (only 30–60%), reliance on viral loads, time of sampling, and time consumption, made CT chest complementary and even superior in diagnosing COVID-19 in asymptomatic patients and symptomatic patients with an average of 5 days before an (RT-PCR) test becomes positive. In addition, some literature emphasizes the pivotal role of CT in the diagnosis of Covid-19 with 98% sensitivity (Hani et al .2020; Carotti et al. 2020, Fang et al. 2020). Furthermore, some studies have recommended the usage of chest CT scans as a primary screening or diagnostic tool in epidemic areas (Ai et al. 2020).

Chest CT has high precision and can be used as a standard technique for COVID-19 diagnosis. The usage of chest CT for the diagnosis of viral pneumonia enables patients with suspected infection of COVID-19 to be isolated and managed in time for improvement, and therefore, optimize patient management (Li & Xia 2020). The most common feature of covid-19 is bilateral ground-glass opacities (GGO), typically with a peripheral and subpleural distribution, consolidation, crazy-paving pattern, vascular thickening, traction bronchiectasis, and reticular pattern (Zheng et al 2020; Bernheim et al 2020; Sabri et al 2020).

According to WHO guideline (2020b) "For symptomatic patients with suspected COVID-19, using chest imaging for the diagnostic workup of COVID-19 when: (1) RT-PCR testing is not available; (2) RT-PCR testing is available, but results are delayed; and (3) initial RT-PCR testing is negative, but with high clinical suspicion of COVID-19" which is the situation in Al-Bayda city, RT-PCR is not available. Therefore, CT is used in the diagnostic workup.

This paper aims to describe the common CT patterns of covid-19 in Albayda as there is a growing need for local radiologists and physicians to be familiar with the covid-19 features in CT. In addition, comparing the result of this research with other regional and international findings.

MATERIAL AND METHODS

This descriptive case series study was conducted from 11th August 2020 to 21st September 2020. The ethical approval form to conduct the study was obtained from the radiology department at the central hospital Al Bayda city. The number of participants reviewed was 56. Patients who met the inclusion criteria based on the WHO criteria for covid-19 diagnosis by CT were included (WHO 2020b). The scans were performed using an FCT Speedia HD Fujifilm 64-MDCT scanner. The scout was taken in the supine position during holding of breath in full inspiration. The following parameters were used; 120 kV, 5mm beam collimation, 1.58 pitch, 0 gantry tilt, and the FOV (347-500) depending on the patient's size. The scans covered the whole thorax from the root of the neck to below the diaphragm. No intravenous contrast had been administered. Following acquisition, the images were reported by two radiologists.

Data regarding symptoms were collected either directly from patients or medical records during the scan. Data was filled manually in

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special paper forms; then entered into the computer system and analyzed using the Statistical Package of Social Science Software program, version 24 (IBM Corp).

RESULTS

This is a descriptive case series study that involved 56 patients, 31 (55.4%) females, and 25 (44.6%) males. Their ages range from 28-88 years (62.79± 11.3). 31(55.4%) were in-patient, while 25(44.6%) were out-patient.

The mean duration of symptoms was 8.6±19 days. The most common symptoms among the studied patients were fever, dyspnea and cough, with 94.6%, 89.3%, and 85.7% respectively. While headaches happened in two-thirds of them, and only 10% of complaints were vomiting and diarrhea (Table-1).

Table-(1): The percentage of symptoms among the studied population

Symptoms	Number of patients	Percentage
Fever	53	94.6
Dyspnea	50	89.3
Cough	48	85.7
Headache	32	57.1
Sweating	30	53.3
Sore throat	25	44.6
Vomiting & Diarrhea	10	17.9

The majority of patients (80%) had different comorbidities. 69.6% were diabetic, and 53.6% were hypertensive. Interestingly, nearly a quarter were both diabetic and hypertensive, which is the same fraction for those who were diagnosed with triple diseases (diabetes, hypertension, and heart disease). 20% of patients had no chronic illness (Table-2).

Table(2): The percentages of comorbidities among the studied patient.

Comorbidity	Number of Patients	Percentage
No chronic illness	11	19.6
Diabetes	39	69.9
Hypertension	30	53.6
Heart Disease	13	23.3
Others	2	7.1

The CT pattern of the studied cases: Regarding lobe involvements, all lobes were involved in 76.8% (43\56) of participants, while 10% (6\56) of patients showed the involvement of all lobes with sparing of lingula segment. In addition, in 98.2% (55\56) both lungs were affected.

In regard to the pattern of lung lesions among the studied patients, ground-glass opacities were found in 100% (56\56) of patients, followed by vascular thickening detected in almost 88% (49\56). While Crazy paving pattern was found in more than half (57%) of the studied population. Consolidative lesions appeared in the majority of studied cases 71.4%. Vacuolar sign, halo sign, and reverse halo sign found in 57.1% (32\56), 34% (19\56), and 34.5% (19\56) of studied patients respectively (Table-3).

Table (3): The percentages of the different patterns of lung lesions among studied population

CT-pattern	Number of patients	Percentage (%)
Ground-glass opacity	56	100
Vascular thickening	49	87.5
Consolidation	40	71.4
Crazy paving	32	57.1
Vacuolar sign	32	57.1
Halo sign	19	34
Revers halo sign	19	34
Architecture distortion	19	34
Tractional-bronchiectasis	9	16

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The percentages of architecture distortion and tractional-bronchiectasis were found in 40% (19\56), and 16% (9\56) respectively. Some examples of common CT patterns are shown in (figures: 1, 2, and 3).

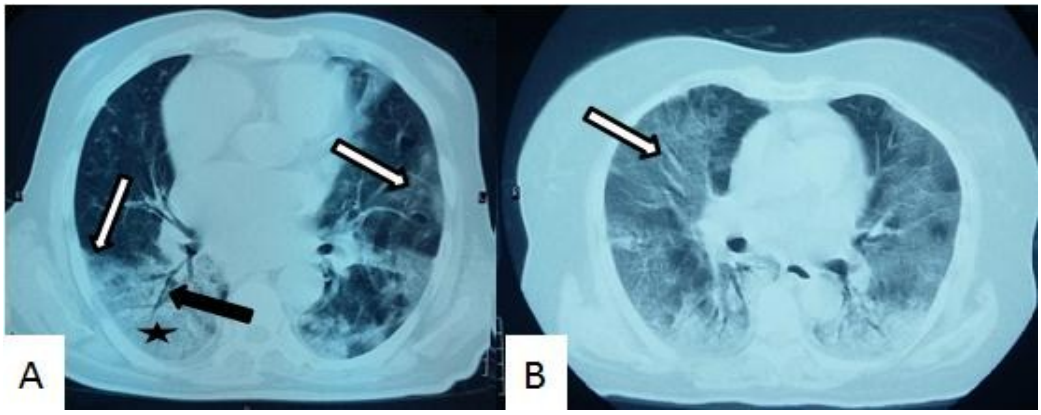

Figure (1): Axial CT chest; (A) showing Ground-glass opacity (white arrow), air Broncho-gram (black arrow), consolidation (black star); (B) diffuse areas of ground-glass opacity (white arrow).

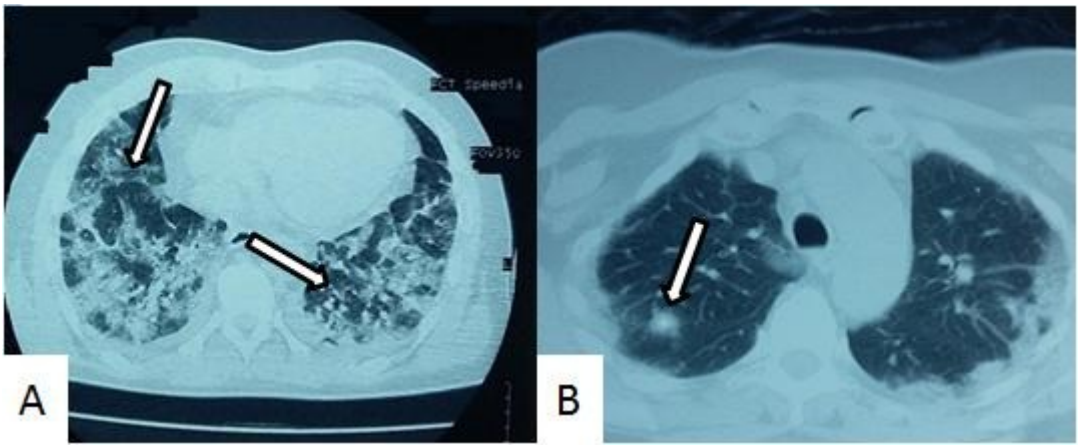

Figure (2): Axial CT chest; (A) showing Crazy paving pattern (white arrows); (B) halo sign (white arrow).

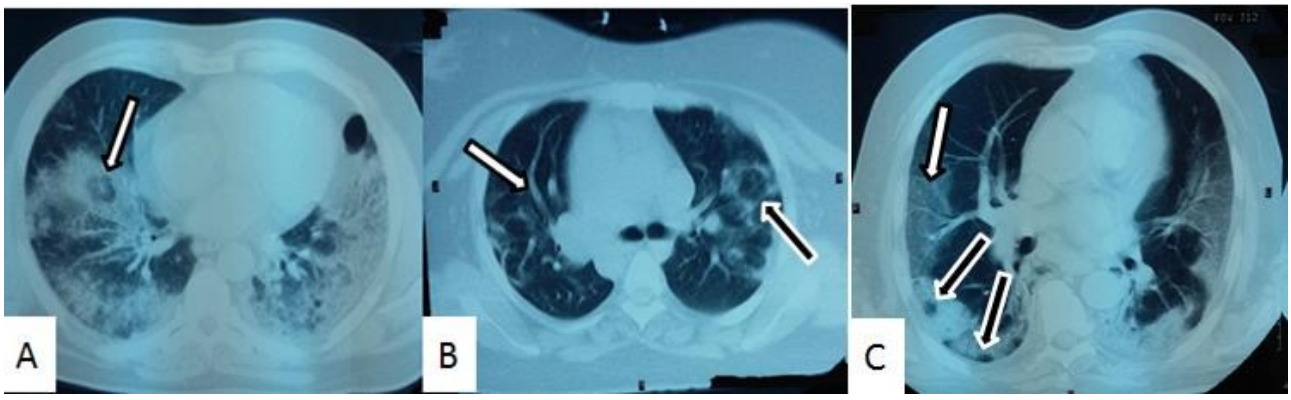

Figure (3): Axial CT chest; (A) Revers halo sign (white arrow); (B) Revers halo sign (black arrow), vascular thickening (white arrow); (C) ground-glass opacity (white arrow), Rt subpleural opacity with vacuoles (black arrows)

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DISCUSSION

This is a descriptive, case series study that has been carried out on 56 patients, 31 (55.4%) females and 25 (44.6%) males. Their ages range from 28-88 years (62.79± 11.3). 31 (55.4%) were in-patient, while 23(41.1%) were out-patient. Non-contrast chest CT was performed for all patients. In this study, clinical manifestations and chest-CT findings of patients were studied. Most clinical presentations were similar to other studies (Mohamed et al., 2020; Heshui et al., 2020). The current study's results were fever 94.6%, dyspnea 89.3%, and cough 85.7%. Two-thirds of patients complained of headaches, and about 45% declared a sore throat. Other symptoms, including nausea and vomiting, occurred only in 10% of the studied population.

In the present study, about 80% of patients had a comorbid disease, where diabetes was the more frequent comorbidity 69.6%, 53.6% were hypertensive, and approximately a quarter of the studied population had a triple disease (diabetes, hypertensive, and heart disease). Only 20% of patients had no chronic disease. This result is similar to a study by (Mohamed et al., 2020), where the most frequent comorbidity was diabetes, followed by hypertension. Heshui et al., (2020) concluded that; the risk factors for COVID-19 were old age and comorbid diseases such as diabetes, chronic pulmonary disease, and other chronic illness.

Non-contrast chest-CT plays an important role in the diagnosis of suspected cases of COVID-19 infection. Some studies revealed that the sensitivity of chest CT in diagnosing COVID-19 was 98% (Hani et al., 2020; Carotti et al., 2020; pan et al., 2020). In addition, some literature has advised chest CT scan as an initial diagnostic investigation in epidemic areas (Ai et al., 2020; Xie et al., 2020; Heshui et al., 2020). The early control of a possible spread of the disease can be achieved by quick diagnosis, with the use of chest CT for the diagnosis of viral pneumonia, and thus the timely isolation and treatment of suspected cases (Li and Xia 2020). A study by Li and Xia (2020) demonstrated that chest CT had a low rate of missed cases of COVID-19 (3.9%), and therefore can be used as a standard technique for COVID-19 diagnosis. Even though CT features of COVID-19 are non-specific, the presence of these findings in patients with no symptoms or patients with mild respiratory symptoms is alarming in the setting of a pandemic, especially if there is no superior alternative for diagnosis (Rubin et al., 2020).

The common findings observed on chest-CT imaging of patients with COVID-19 were: ground-glass opacity GGO, consolidation, vascular enlargement, interlobular septal thickening, air bronchogram, and air trapping. These patterns are similar to CT patterns of Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) and caused by interstitial and alveolar pulmonary edema and injury (Li and Xia 2020).

In the current study, ground-glass opacities were present in all studied patients 100%, vascular thickening noted in 88%, consolidation was found in 71.4% of the studied population. Interestingly, crazy paving patterns and vascular signs were found in an almost equal percentage of studied cases, 57%, and 57.1% respectively. The study of (Li and Xia 2020) had shown CT findings of COVID-19 that are different from CT findings of SARS and MERS which are reversed halo signs and halo signs. In this study reverse halo signs were observed in 34.5% and halo sign were found in 34% of studied patients.

In previous studies, multifocal involvement was more frequent than uni-focal involvement (Li and Xia 2020; Heshui et al., 2020). In the current study, bilateral affection was found in 98.2%, while in 76.8% of patients, all lobes involvement was noted.

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The results of this study suggest that the percentage of female patients is greater than male patients and patients with comorbidity are more likely to develop symptoms. Clinical presentation and chest CT manifestation are similar to those mentioned in the literature.

For positive COVID-19 patients, imaging sets up baseline pulmonary conditions and assists recognize primary cardiopulmonary pathologies that can help in determining the degree of risk for clinical deterioration (Rubin et al., 2020). Imaging is recommended to evaluate the progression of COVID-19 or secondary cardiopulmonary pathologies such as heart failure or pulmonary embolism that could be due to myocardial injury secondary to COVID-19 (Rubin et al., 2020). CT-chest may potentially have new roles by launching the response of treatments or differentiate patients who are more likely to respond to new forms of treatment (Rubin et al., 2020).

In the current study, there are several limitations. Firstly, the study had a relatively small number of patients (56 patients), all studied participants were symptomatic, and all of them were adults, and no children were involved. Further studies are required involving a larger number of patients, an asymptomatic population, and all age groups.

Secondly, the study only analysed the clinical manifestation and chest CT findings at first presentation, follow-up images are recommended in further researches to study disease progression and recovery signs. Finally, due to the unavailability of (RT-PCR), it is not included in this study, and WHO guidelines regarding diagnosis in the absence of (RT-PCR) are followed.

CONCLUSION

Covid-19 is an emerging global health problem; rapid diagnosis is an important issue for tackling the spread of the disease. CT chest along with symptoms play an important role in Covid-19 diagnosis in the event of RT-CRP unavailability. This case serial study describes the common symptoms and CT- pattern among 56 patients in Al-Bayda city\Libya, the findings are similar to some regional and international findings. This paper might help raise awareness among local physicians and radiologists, and possibly be used as a baseline for future related research.

ABBREVIATIONS

CT: Computerized Tomography**.**
COVID-19: Coronavirus Disease-2019.
GGO: Ground-Glass Opacities
MERS: Middle East Respiratory Syndrome.
RT-PCR: Reverse Transcriptase Polymerase Chain Reaction.
SARS-Cov-2: Severe Acute Respiratory Syndrome Coronavirus.
WHO: World Health Organization

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العلامات السريرية وانماط الاشعة المقطعية الصدرية ل 56 مريض بذات الرئة الناتجة عن كوفيد-19

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المستخلص : منذ إعلان جائحة كوفيد المستجد-19، ازداد اهتمام أطباء الأشعة والباطنة بشأن كيفية تشخيصه بشكل كبير. تعتبر مسحة الأنف المرجع الرئيسي لتشخيص الالتهاب الرئوي الناتج عن فيروس كوفيد-19، لكن توفرها والمعدل السلبي الخاطئ واعتمادها علي خبرة الممارس والوقت المستقطع حتى ظهور النتيجة ،جعل التصوير المقطعي أكثر تفوقًا في تشخيص الالتهاب الرئوي الناتج عن كوفيد المستجد-19، و هذا ما أتبع في مدينة البيضاء- ليبيا، حيث تم الإبلاغ عن أول حالة انتشار محلية في 30 يوليو 2020، تلاها ارتفاع كبير في عدد الحالات، الذي تطلب التعرف على السمات السريرية الرئيسية ونمط التصوير المقطعي للالتهاب الرئوي بسبب كوفيد-19 لزيادة الوعي بين الممارسين وأخصائي الأشعة المحليين وتسهيل التشخيص السريع، وهذا هو الهدف الرئيسي لهذه الدراسة. أجريت هذه الدراسة الوصفية لسلسلة الحالات في المستشفى المركزي لمدينة البيضاء في ليبيا في الفترة ما بين 11 أغسطس إلى 21 سبتمبر 2020، وشملت 56 مريضًا (31 أنثى و25 ذكرًا). تتراوح أعمارهم بين 28-88 سنة (62.79 ± 11.3) خضعوا جميعهم لصورة مقطعية للصدر بدون صبغة. كانت الشكاوى الرئيسية للمرضى: الحمى 94.6٪ وضيق التنفس 89.3٪ والسعال 85.7٪. كان النمط الأكثر شيوعًا للتصوير المقطعي بين الحالات المدروسة: عتامة الزجاج المصنفر بنسبة 100٪، يليه سماكة الأوعية الدموية 88٪، التصلد الرئوي 71.4٪، نمط الرصف الفسيفسائي 57٪، العلامة الفجوية 57.1٪، التشوه المعماري 40٪، علامة الهالة 34٪، علامة الهالة العكسية 34.5٪، توسع القصبات الجر 16٪. أخيرًا، يلعب التعرف على أنماط التصوير المقطعي للالتهاب الرئوي بسبب كوفيد-19 دورًا مهمًا في الاكتشاف المبكر وبالتالي تطبيق احترازات العزل والعلاج. كما يمكن استخدام نتائج هذه الدراسة كلبنة أساس لمزيد من الابحاث في المستقبل.

الكلمات المفتاحية: التهاب رئوي بسبب كوفيد المستجد-19، كوفيد المستجد-19، كوفيد المستجد-19 ليبيا ،التصوير المقطعي للصدر، عتامه الزجاج المصنفر.

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Normal Mode Analysis of Generalized Magneto-Thermoelastic Medium with Initial Stress Under Green-Naghdi Theory

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Abstract: The normal mode analysis method was used to study the effect of both the initial stress and the magnetic field on a thermally elastic body. This method is used to obtain the exact expressions for the considered variables. Some particular cases are also discussed in the context of the problem. The generalized thermal elasticity equations were reviewed under the influence of the basic initial stress and the magnetic field using the theory (Green-Naghdi) of the second and third types (the second type with no energy dispersion and the third type with energy dispersion). The different physical quantities were illustrated in the presence and absence of both the initial stress and the magnetic field. The results of this research show the extent of difference between the second and third types of Green and Naghdi's theory. All results and figures were obtained using (MATLAB R2013a) program.

Keywords: Generalized Thermo-Elasticity; Magnetic Field; Initial Stress; Normal Mode Analysis; Green and Naghdi Theory.

INTRODUCTION

The generalized theory of thermoelasticity is one of the modified versions of the classical uncoupled and coupled theory of thermoelasticity and has been developed in order to remove the paradox of physical impossible phenomena of the infinite velocity of thermal signals in the classical coupled thermoelasticity. (Hetnarski & Ignaczak, 1999) examined five generalizations of the coupled theory of thermoelasticity. The first generalization was proposed by (Lord & Shulman, 1967), which involves one relaxation time for a thermoelastic process. The second generalization is due to (Green & Lindsay, 1972) which takes into account two relaxation times. The third generalization of the coupled theory of thermoelasticity was introduced by (Green & Naghdi, 1993), who developed different theories labeled type I, type II, and type III. The (G-N I) theory in the linearized theory is equivalent to the classical coupled thermoelasticity theory. The (G-N II) theory does not admit energy dissipation, while the third (G-N III) theory admits dissipation of energy. The heat flux is a combination of type I and type II. Both type II and type III theories imply a finite speed of propagation for heat waves. (Bargmann & Steinmann, 2006) investigated the (G-N) approach for modeling the phenomenon of second sound.(Othman & Atwa, 2011; Othman & Atwa, 2012; Othman et al., 2013b; Othman & Kumar, 2009), has discussed different problems for various materials with different effects using the (G-N) theory. The fourth generalization of the coupled theory of thermoelasticity was developed by (Chandrasekharaiah, 1998; Tzou, 1995).

Initial stress in solids has a significant influence on the mechanical response of the material from an initially stressed configuration and has applications in geophysics, engineering structures, and the behavior of soft biological tissues. Initial stress arises from pro-

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cesses, such as manufacturing or growth, and is present in the absence of applied loads. (Montanaro, 1999) formulated the isotropic thermoelasticity with hydrostatic initial stress. (Ailawalia et al., 2009; Othman & Song, 2007; Singh, 2008; Singh et al., 2006), and many others have applied (Montanaro, 1999) theory to study the plane harmonic waves in the context of generalized thermoelasticity. (Othman & Atwa, 2012) investigate the effect of initial stress under the Green-Naghdi (G-N) theory for different cases in thermoelasticity. (Ailawalia & Narah, 2009) studied the effect of hydrostatic initial stress and rotation in a generalized thermoelastic medium. (Othman & Edeeb, 2016) studied the Effect of Initial Stress on Generalized Magneto-thermoelasticity Medium with Voids: A Comparison of Different Theories. (Abd-Elaziz et al., 2019) studied the On the Effect of Thomson and Initial Stress in a Thermo-Porous Elastic Solid under G-N Electromagnetic Theory.

The theory of magneto-thermoelasticity is concerned with the interacting effects of the applied magnetic field on the elastic and thermoelastic deformations of a solid body. This theory has aroused much interest in many industrial appliances, particularly in nuclear devices where there exists a primary magnetic field; various investigations are to be carried out by considering the interaction between magnetic, thermal, and strain fields. Analyses of such problems also influence various applications in biomedical engineering as well as in different geomagnetic studies. The development of the interaction of electromagnetic field, the thermal field, and the elastic field is available in many works such as (Abd-Alla et al., 2003; Choudhuri & Debnath, 1985; Othman & Song, 2006; Paria, 1966; Sherief & Helmy, 2002) studied the effect of rotation on the reflection of magneto-thermoelastic waves under thermoelasticity without energy dissipation with the (G-N) theory of type II. (Othman & Kumar, 2009) studied the reflection of magneto-thermoelastic waves with temperature-dependent properties in the context of generalized thermoelasticity with (G-N) theory of type II, i.e. without energy dissipation, and other models of thermoelasticity. (Othman & Atwa, 2011) studied the effect of the magnetic field on the two-dimensional problem of generalized thermoelasticity without energy dissipation. (Othman et al., 2013a) studied the generalized magneto-thermo-microstretch elastic solid under a gravitational field with energy dissipation. Recently (Othman et al., 2013b) studied the effect of magnetic field and rotation on generalized thermo-microstretch elastic solid for a mode-I crack using (G-N) theory. (Atwa, 2014) studied the generalized magneto-thermoelasticity with two temperatures and initial stress under Green–Naghdi theory. (Abo-Dahab et al., 2017) studied A Two-Dimensional Problem with Rotation and Magnetic Field in the Context of Four Thermoelastic Theories, the normal-mode analysis method was applied to obtain the exact solutions for the physical problem.

FORMULATION OF THE PROBLEM AND BASIC EQUATIONS

Consider an isotropic, homogeneous, linear, thermally, and electrically conducting thermoelastic half-space $(x \geq 0,\ -\infty \leq y \leq \infty)$. The rectangular Cartesian coordinate system (x, y, z), having originated on the surface $z = 0$, for the two dimensional problem assume the dynamic displacement vector as $u = (u, v, 0)$. The surface $(x = 0)$ of the half-space is taken to be traction-free and subjected to mechanical and thermal loads. All the considered functions are assumed to be bounded as $x \to \infty$.. The whole body is at a constant temperature T_0.. Consider also that the orientation of the primary magnetic field $\boldsymbol{H} = (0, 0, H_0)$ is towards the positive direction of $z-$ axis. Due to the application of this magnetic field, an induced magnetic field $\boldsymbol{h}$ and an induced electric field $\boldsymbol{E}$. arise in the medium .All the considered functions will

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depend on time t and the coordinates x and y. So the displacement vector $\boldsymbol{u}$ has the components

$$u_x = u(x,z,t), \quad u_y = v(x,z,t), \quad u_z = 0. \quad (1)$$

The variation of the magnetic and electric fields are a perfectly conducting slowly moving medium and are given by Maxwell's equations:

$$\operatorname{curl} \boldsymbol{h} = \boldsymbol{J} + \varepsilon_0 \dot{\boldsymbol{E}}, \quad (2)$$

$$\operatorname{curl} \boldsymbol{E} = -\mu_0 \dot{\boldsymbol{h}}, \quad (3)$$

$$\boldsymbol{E} = -\mu_0 (\dot{\boldsymbol{u}} \quad \boldsymbol{H} \quad (4)$$

$$\operatorname{div} \boldsymbol{h} = 0. \quad (5)$$

From the above equations, one can obtain

$$\boldsymbol{E} = \mu_0 H_0 (\dot{v}, 0, -\dot{u} \quad (6)$$

$$\boldsymbol{h} = (0, 0, -H_0 e), \quad (7)$$

$$\boldsymbol{J} = (-h_{,y} - \varepsilon_0 \mu_0 H_0 \ddot{v}, 0, h_{,x} + \varepsilon_0 \mu_0 H_0 \ddot{u} \quad (8)$$

The constitutive relations are given by

$$\sigma_{ij} = 2\mu e_{ij} + \delta_{ij}[\lambda e_{kk} - \beta \frac{\partial T}{\partial x}] - P(\delta_{ij} + \omega_{ij}) \quad (9)$$

$$e_{ij} = \frac{1}{2}(u_{i,j} + u_{j,i}), \quad \omega_{ij} = \frac{1}{2}(u_{j,i} - u_{i,j}), \quad (10)$$

The equation of motion has the form

$$\sigma_{ji,j} + F_i = \rho \ddot{u} \qquad i, j = 1,2,3. \quad (11)$$

Where F_i is the Lorentz force and is given by: $F_i = \mu_0 (\boldsymbol{J} \times \boldsymbol{H})_i$. (12)

From equations (8) and (11), Lorentz force is obtained

$$\boldsymbol{F} = (F_x, F_y, F_z) = (\mu_0 H_0^2 e_{,x} - \varepsilon_0 \mu_0^2 H_0^2 \ddot{u} \quad {}_0^2 e_{,y} - \varepsilon_0 \mu_0^2 H_0^2 \ddot{v}, 0). \quad (13)$$

Substituting from equations (9) and (13) into equation (11), the equations of motion can be written as follows

$$(\mu - \frac{P}{2})\nabla^2 u + (\lambda + \mu + \mu_0 H_0^2 + \frac{P}{2}) e_{,x} - \beta T_{,x} = \rho(1 + \frac{\varepsilon_0 \mu_0^2 H_0^2}{\rho}) \ddot{u} \quad (14)$$

$$(\mu - \frac{P}{2})\nabla^2 v + (\lambda + \mu + \mu_0 H_0^2 + \frac{P}{2}) e_{,y} - \beta T_{,y} = \rho(1 + \frac{\varepsilon_0 \mu_0^2 H_0^2}{\rho}) \ddot{v}. \quad (15)$$

The equation of heat conduction has the form

$$K \nabla^2 T + k^* \nabla^2 \dot{T} \quad {}_{r-E}^{\ddot{}} \quad {}_{r-0}^{\ddot{}} \quad (16)$$

Where, σ_{ij} are the stress tensor components, e_{ij} are the strain tensor components, ω_{ij} is the rotation tensor, $e = e_{kk}$ is the cubic dilatation, δ_{ij} is Kronecker's delta, u_i is the displacement vector, λ, μ are the elastic constants, T is the absolute temperature, T_0 is the temperature of medium in its natural state assumed to be such that $|(T - T_0)/T_0| < 1$,

ε_0, μ_0 are the electric and magnetic permeability respectively, $\boldsymbol{J}$ is the current density vector, $\boldsymbol{E}$ is the induced electric field vector, $\boldsymbol{h}$ is the induced magnetic field vector, H_0 is a constant magnetic field, P is the initial stress, λ, μ are Lame's constants,

$\beta = (3\lambda + 2\mu)\alpha_t$, α_t is the coefficient of linear thermal expansion, ρ is the density, C_E is the specific heat at constant strain, k is the coefficient of thermal conductivity, k^* is the material constant characteristic of the theory, and

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}.$$

When $k^* \to 0$ then equation (16) reduces to the heat conduction equation in (G-N) theory (of type II),

$$\nabla = \frac{\partial}{\partial x} i + \frac{\partial}{\partial y} j. \quad \text{and} \quad \nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}.$$

The components of stress tensor are

$$\sigma_{xx} = \lambda(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}) + 2\mu \frac{\partial u}{\partial x} - \beta T - p, \quad (17)$$

$$\sigma_{yy} = \lambda(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}) + 2\mu \frac{\partial v}{\partial y} - \beta T - p, \quad (18)$$

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$$\sigma_{zz} = \lambda(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}) - \beta T - p, \quad (19)$$

$$\sigma_{xy} = \mu(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}) - \frac{p}{2}(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}). \quad (20)$$

The basic governing equations of linear magnetic thermoelastic materials under influence of the initial stress become

$$(\mu - \frac{p}{2})\nabla^2 u + (\lambda + \mu + \frac{p}{2})\frac{\partial e}{\partial x} - \beta\frac{\partial T}{\partial x} + \mu_0 H_0^2 \frac{\partial e}{\partial x} - \mu_0^2 H_0^2 \varepsilon_0 \frac{\partial^2 u}{\partial t^2} = \rho\frac{\partial^2 u}{\partial t^2}, \quad (21)$$

$$(\mu - \frac{p}{2})\nabla^2 v + (\lambda + \mu + \frac{p}{2})\frac{\partial e}{\partial y} - \beta\frac{\partial T}{\partial y} + \mu_0 H_0^2 \frac{\partial e}{\partial y} - \mu_0^2 H_0^2 \varepsilon_0 \frac{\partial^2 v}{\partial t^2} = \rho\frac{\partial^2 v}{\partial t^2}, \quad (22)$$

$$K\nabla^2 T + k^* \frac{\partial}{\partial t}\nabla^2 T = \rho C_E \frac{\partial^2 T}{\partial t^2} + \beta T_0 \frac{\partial^2 e}{\partial t^2}. \quad (23)$$

Where, $h = -H_0 e$

For the purpose of numerical evaluation, dimension variables are introduced.

$$(u', v') = \frac{\omega_1^*}{c_1}(u, v),\ T' = \frac{T}{T_0},$$

$$(x', y') = \frac{\omega_1^*}{c_0}(x, y),\ \sigma'_{xx} = \frac{\sigma_{xx}}{\mu},$$

$$\sigma'_{xy} = \frac{\sigma_{xy}}{\mu},\ ,\sigma'_{ij} = \frac{\sigma_{ij}}{\mu_0}\sigma_{ij},$$

$$t' = \omega_1^* t,\ \ c_1^2 = \frac{\lambda + 2\mu}{\rho},$$

$$\omega_1^* = \frac{\rho C_E c_1^2}{k},\ h' = \frac{h}{H_0},$$

$$\beta = (3\lambda + 2\mu)\alpha_t,\ \ p' = \frac{p}{\mu}. \quad (24)$$

Equations (21) - (23), with the help of non-dimensional variables (24) may be recast into the dimensionless form after dropping primes for convenience as:

$$\nabla^2 u + E_1 \frac{\partial e}{\partial x} - E_2 \frac{\partial T}{\partial x} = E_3 \frac{\partial^2 u}{\partial t^2}, \quad (25)$$

$$\nabla^2 v + E_1 \frac{\partial e}{\partial y} E_2 \frac{\partial T}{\partial y} = E_3 \frac{\partial^2 v}{\partial t^2}, \quad (26)$$

$$\varepsilon_1 \nabla^2 T + \varepsilon_2 \frac{\partial}{\partial t}\nabla^2 T = \frac{\partial^2 T}{\partial t^2} + \varepsilon_3 \frac{\partial^2 e}{\partial t^2}. \quad (27)$$

Here,

$$E_1 = \frac{2\lambda + \mu(2 + p) + 2\mu_0 H_0^2}{\mu(2 - p)},$$

$$E_2 = \frac{2\beta T_0}{\mu(2 - p)},\qquad E_3 = \frac{2\mu_0 H_0^2 \varepsilon_0 c_1^2 + 2\rho c_1^2}{\mu(2 - p)},$$

$$\varepsilon_1 = \frac{K}{c_1^2 \rho c e},\qquad \varepsilon_2 = \frac{K\omega_1^*}{c_1^2 \rho c e},\quad \varepsilon_3 = \frac{\beta}{\rho c e}.$$

Where $\varepsilon_1, \varepsilon_2$, and ε_3 are the coupling constants. Using the expression relating displacement components u(x , y ,t) and v (x , y ,t) to the scalar potential functions ψ_1 (x , y ,t) and ψ_2 (x , y ,t) in dimensionless form.

$$u = \frac{\partial \psi_1}{\partial x} + \frac{\partial \psi_2}{\partial y},\ \text{and}\ v = \frac{\partial \psi_1}{\partial y} - \frac{\partial \psi_2}{\partial x}, \quad (28)$$

$$e = \nabla^2 \psi_1,\ \text{and}\ \ (\frac{\partial u}{\partial y} - \frac{\partial v}{\partial x}) = \nabla^2 \psi_2. \quad (29)$$

By substituting from Eq. (29) in Eqs. (25)-(27), this yields

$$(1 + E_1)\nabla^2 \psi_1 - E_2 T = E_3 \frac{\partial^2}{\partial t^2}\psi_1, \quad (30)$$

$$[\nabla^2 - E_3 \frac{\partial^2}{\partial t^2}]\psi_2 = 0, \quad (31)$$

$$\varepsilon_1 \nabla^2 T + \varepsilon_2 \frac{\partial}{\partial t}\nabla^2 T = \frac{\partial^2 T}{\partial t^2} + \varepsilon_3 \frac{\partial^2 e}{\partial t^2}\nabla^2 \psi_1. \quad (32)$$

Then the components of stress tensor will be

$$\sigma_{xx} = E_4(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}) + 2\frac{\partial u}{\partial x} - E_2 T - p, \quad (33)$$

$$\sigma_{yy} = E_4(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}) + 2\frac{\partial v}{\partial y} - E_2 T - p, \quad (34)$$

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$$\sigma_{zz} = E_4(\frac{\partial u}{\partial x}+\frac{\partial \nu}{\partial y}) - E_2 T - p, \quad (35)$$

$$\sigma_{xy} = (\frac{\partial u}{\partial y}+\frac{\partial \nu}{\partial x}) - \frac{p}{2}(\frac{\partial \nu}{\partial x}-\frac{\partial u}{\partial y}). \quad (36)$$

Where $E4 = \frac{\lambda}{\mu}$,

NORMAL MODE ANALYSIS

The applied methodology to the system was the normal mode analysis to obtain the exact expressions for the used physical variables. The solution of the considered physical variables can be decomposed in terms of the normal mode as the following form

$$[u,\nu,T,\psi_1,\psi_2,,\sigma_{ij}](x,y,t) = [u^*,\nu^*,T^*,\psi_1^*,\psi_2^*,\sigma_{ij}^*](y)\exp[i(\omega t+\alpha x)], \quad (37)$$

Where $[u^*,\nu^*,T^*,\psi_1^*,\psi_2^*,\sigma_{ij}^*](y)$ are the amplitudes of the function, ω is the complex time constant, $i=\sqrt{-1}$ and a is the wave number in x-direction.

Using Eq. (37) into Eqs. (30)-(32), yields the following,

$$(D^2-F_2)\psi_1^* - F_3 T^* = 0, \quad (38)$$

$$(D^2-F_4)\psi_2^* = 0, \quad (39)$$

$$F_5(D^2-a^2)\psi_1^* + (D^2-F_6)T^* = 0. \quad (40)$$

Where,

$$D=\frac{d}{dy}, \quad F_1 = 1+E_1, \quad F_2 = \frac{F_1 a^2 - E_3\omega^2}{F_1},$$

$$F_3 = \frac{E_2}{F_1}, \quad F_4 = a^2 - E_3\omega^2, \quad F_5 = \frac{\varepsilon_3\omega^2}{\varepsilon_1+\varepsilon_2\omega},$$

Eliminating $\psi_1^*(y)$ and $T^*(y)$ between Eqs. (38) - (40), yields the following fourth order ordinary differential equations for $\psi_1^*(y)$ and $T^*(y)$:

$$[D^4 - AD^2 + B]\{\psi_1^*(y), T^*(y)\} = 0. \quad (41)$$

Equation (41) can be factored as

$$(D^2-k_1^2)(D^2-k_2^2)\{\psi_1^*(y), T^*(y)\} = 0. \quad (42)$$

Where $k_n^2 (n=1,2)$ are the roots of the characteristic equation of Eq. (41),

$$A = F_2 + F_6 + -F_3F_5,$$

$$B = F_2F_6 - F_3F_5a^2, \quad m^2 = F_4 = a^2 - E_3\omega^2.$$

The solution of Eqs. (41) and (39) have the form

$$\psi_1^*(y) = \sum_{n=1}^{2} G_n e^{-k_n y}, \quad (43)$$

$$T^*(y) = \sum_{n=1}^{2} L_{1n} G_n e^{-k_n y}, \quad (44)$$

$$\psi_2^* = G_3 e^{-my}. \quad (45)$$

Where $G_n (n=1,2,3)$ are some parameters and

$$L_{1n} = \frac{k_n^2 - F_2}{F_3}.$$

Substituting from Eqs. (43)-(45) and (37) in Eqs. (28), (33)-(35) respectively, the displacement and stress components take the form

$$u^* = (\sum_{n=1}^{2} i\,a G_n e^{-k_n y} - m\,G_3 e^{-my})e^{(\omega t+i\alpha x)}, \quad (46)$$

$$\nu^* = (\sum_{n=1}^{2} -k_n G_n e^{-k_n y} - i\,a G_3 e^{-my})e^{(\omega t+i\alpha x)}, \quad (47)$$

$$\sigma_{xx}^* = (\sum_{n=1}^{2} L_{2n} G_n e^{-k_n y} - b_1 G_3 e^{-my})e^{i(\omega t+\alpha x)} - p, \quad (48)$$

$$\sigma_{yy}^* = (\sum_{n=1}^{2} L_{3n} G_n e^{-k_n y} + b_1 G_3 e^{-my})e^{(\omega t+i\alpha x)} - p, \quad (49)$$

$$\sigma_{xy}^* = (\sum_{n=1}^{2} L_{4n} G_n e^{-k_n y} + b_2 G_3 e^{-my})e^{(\omega t+i\alpha x)}, \quad (50)$$

Where,

$$L_{2n} = (k_n^2 - a^2)E_4 + 2k_n^2 - E_2 L_{1n},$$

$$L_{3n} = L_{2n} = (k_n^2 - a^2)E_4 - 2a^2 - E_2 L_{1n},$$

$$L_{4n} = 2ia k_n, \quad b_1 = 2iam,$$

$$b_2 = (a^2+m^2) - \frac{p}{2}(m^2-a^2).$$

THE BOUNDARY CONDITIONS

In this section, the boundary conditions at $y=0$, needs to be considered, in order to determine the constants G_n $(n=1,2,3)$:

(1) The mechanical boundary conditions

$$\sigma_{yy} = -P_1 e^{(\omega t + i\alpha x)}, \quad \sigma_{xy} = 0, \quad (51)$$

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(2) The thermal boundary condition that the surface of the half-space is subjected to

$$T = P_2 e^{(\omega t + \mathrm{i} a x)}. \quad (52)$$

Where P_1 is the magnitude of the applied force on the half-space and P_2 is the applied constant temperature to the boundary.

Using the expressions of the variables into the above boundary conditions (51), (52) produces,

$$\sum_{n=1}^{2} L_{3\,\mathrm{n}} G_{\mathrm{n}} + b_1 G_3 = -p_1, \quad (53)$$

$$\sum_{n=1}^{2} L_{4\,\mathrm{n}} G_{\mathrm{n}} + b_1 G_3 = 0, \quad (54)$$

$$\sum_{\mathrm{n}=1}^{3} L_{1\mathrm{n}} G_{\mathrm{n}} = P_2. \quad (55)$$

Invoking boundary conditions (53)-(55) at the surface $y = 0$ of the plate, yields a system of three equations. After applying the inverse of the matrix method, one can get the values of the three constants G_{n} $(\mathrm{n} = 1, 2, 3)$.

$$\begin{pmatrix} G_1 \\ G_2 \\ G_3 \end{pmatrix} = \begin{pmatrix} L_{31} & L_{32} & b_1 \\ L_{41} & L_{42} & b_2 \\ L_{11} & L_{12} & 0 \end{pmatrix}^{-1} = \begin{pmatrix} -P_1 \\ 0 \\ P_2 \end{pmatrix}. \quad (56)$$

Hence, obtaining the expressions for the displacements, the temperature distribution, and the other physical quantities of the plate surface.

$\lambda = 2.17 \times 10^{10}\ N/m^2$,
$\mu = 3.278 \times 10^{10}\ N/m^2$
$K = 1.7 \times 10^2\ W/m$ deg,
$\alpha_t = 1.78 \times 10^{-5} N/m^2$,
$\rho = 1.74 \times 10^3\ kg/m^3$,
$C_E = 1.04 \times 10^3\ J/kg$ deg, $T_0 = 298\ K$,
$\beta = 2.68 \times 10^6 N/m^2$ deg, $\omega_1^* = 3.58 \times 10^{11}/s$.

The Magnetic field parameters were

$H_0 = 10^8$, $\mu_0 = 4\pi \times 10^{-7}\ H/M$,
$\varepsilon_0 = 8.85418717 \times 10^{-12} F/M$.

The comparisons were carried out for

$x = 0.5$, $t = 0.3$, $\omega = \zeta_0 + i\zeta_1$, $\zeta_0 = -0.7$, $\xi_1 = 0.1$, $p_1 = -0.1$, $\mathrm{p}_2 = 0.2$, $a = 0.5$, $0 \le y \le 25$.

The comparisons have established for two cases

(i) With and without magnetic field

$[(H_0 = 10^8, 0),\quad p = 1,\quad t = 0.3]$.

(ii) With and without initial stress

$[(p = 1, 0),\quad H_0 = 10^8,\quad t = 0.3]$.

The above numerical technique, was used for the distribution of the real parts of the displacement components u and v, the temperature distribution T, the stress components σ_{xx}, σ_{yy} and σ_{xy} with the distance for (G-N) theory of both types II and III with and without the magnetic field ($H_0 = 0, 10^8$) during $p = 1$, and $t = 0.3$ in figures (1-6).

Figures (7-12) clarify the distribution of the real parts of the displacement components u and v, the temperature T, the stress components with the distance y for (G-N) theory of both types II and III with and without the initial stress ($p = 1, 0$) during $H_0 = 10^8$, and $t = 0.3$. Figures (1-12) are graphically represented changes in the behavior of the physical quantities against distance y in 2D.

Fig. 1 depicts that the distribution of the vertical displacement u, in the context of both types II and III, always begins from positive values for $H_0 = 10^8, 0$ and begins from negative values for $H_0 = 10^8$ of type III. It was observed that the displacement u increases with the increase of the magnetic field for $y > 0$. The distributions of u is directly proportional to the magnetic field.

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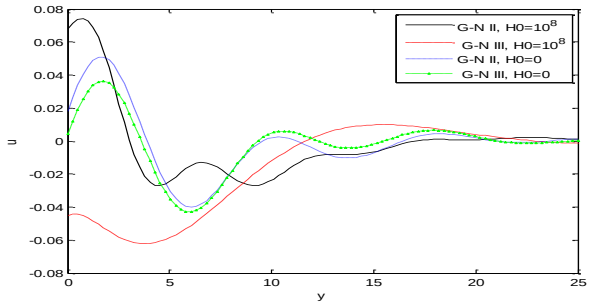

Fig.(1) Horizontal displacement distribution u in the absence and presence of the magnetic field.

Fig. 2 depicts the displacement distribution v, in the context of both types II and III for $H_0 = 10^8, 0$ it was observed that the distributions of v decrease with the increase of the magnetic field for $y > 0$. The distributions of v are inversely proportional to the magnetic field.

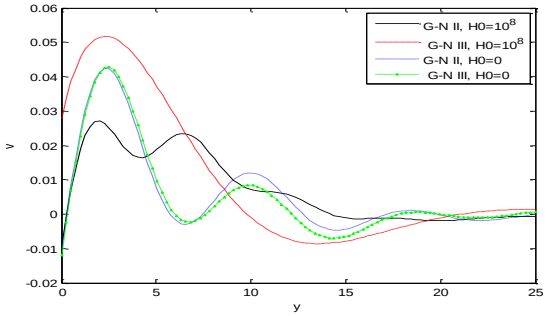

Fig.(2) Vertical displacement distribution v in the absence and presence of the magnetic field.

Fig. 3 explains that the distribution of temperature T begins from a positive value (which is the same point) in case of $H_0 = 0, 10^8$, in the context of both types II and III of (G-N), and takes the form of a wave until it develops to zero.

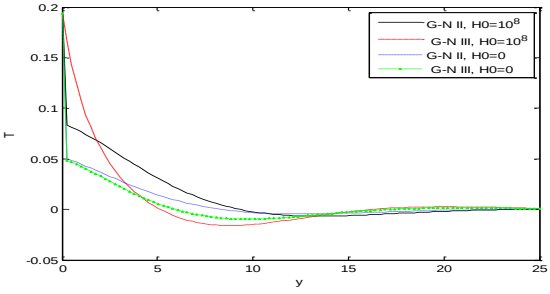

Fig. (3) Thermodynamic temperature distribution T in the absence and presence of magnetic field.

Fig. 4 determines the distribution of the stress component σ_{xx} in the case of $H_0 = 10^8$, and $H_0 = 0$, in the context of both types II and III. It was noted that the distribution of σ_{xx} decreases with the increase of the magnetic field value for $y > 0$.

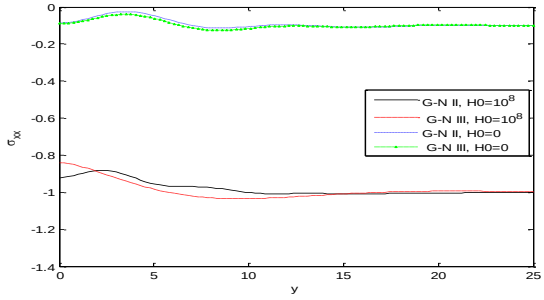

Fig. (4) Distribution of stress component σ_{xx} in the absence and presence of the magnetic field.

Fig. 5 shows the distribution of the stress component σ_{yy} in the case of $H_0 = 10^8, 0$, in the context of both types II and III. It was observed that the distribution of σ_{yy} decreases with the increase of the magnetic field value for $y > 0$.

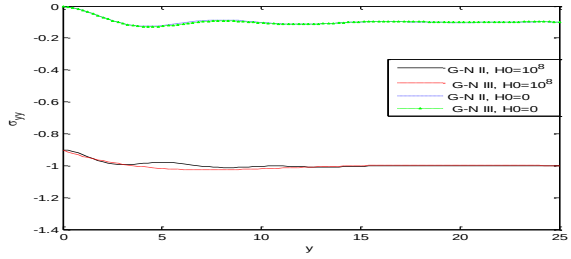

Fig. (5) Distribution of stress component σ_{xy} in the absence and presence of the magnetic field.

Fig. 6 explains the distribution of stress component σ_{xy} which begins from zero in the case of $H_0 = 10^8$, $H_0 = 0$, in the context of both types II and III. It was observed that the magnetic field has an effect on σ_{xy}, while the distribution of σ_{xy} increases with the increase of the magnetic field value for $y > 0$.

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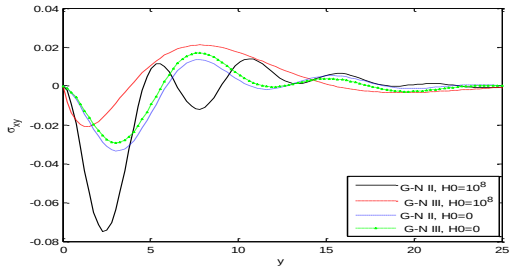

Fig. (6) Distribution of stress component σ_{xy} in the absence and presence of magnetic field.

Figs. 7 and 8 show the distribution of displacement components u and v in the case of $p=1$ and $p=0$, in the context of both types II and III. It was noted that the distributions of u and v respectively increase with the increase of the initial stress for $y>0$. The distributions of u and v are directly proportional to the initial stress.

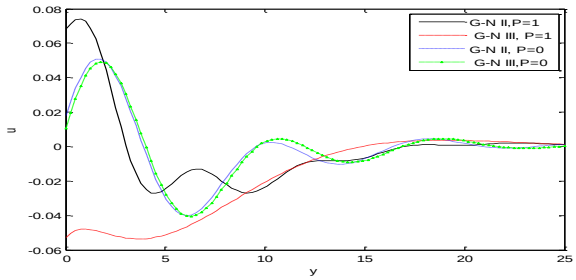

Fig. (7) Distribution of the displacement component u with and without initial stress.

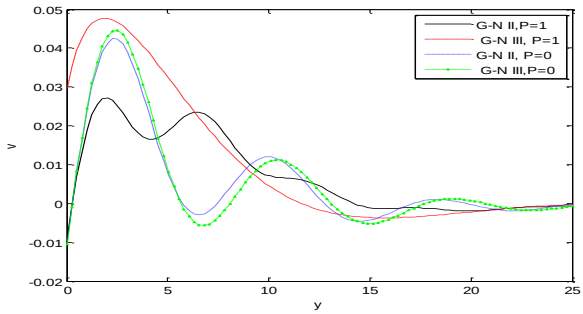

Fig. (8) Distribution of the displacement component v with and without initial stress.

Figs. 9 explains the distribution of temperature T which begins from zero in the case of $p=1$ and $p=0$, in the context of both types II and III. It was noticed that T decreases with the increase of the initial stress for $y>0$.

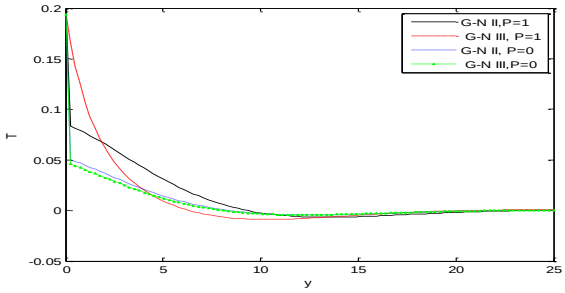

Fig. (9) Temperature distribution T with and without initial stress.

Figs. 10 and 11 depict the behavior of σ_{xx} and σ_{yy} in the context of both types II and III which always begin from positive values for $p=1,\ 0$, and begin from negative for $p=1$ in type II. It was observed that stress components σ_{xx} and σ_{yy} increase with the increase of the initial stress for $y>0$.

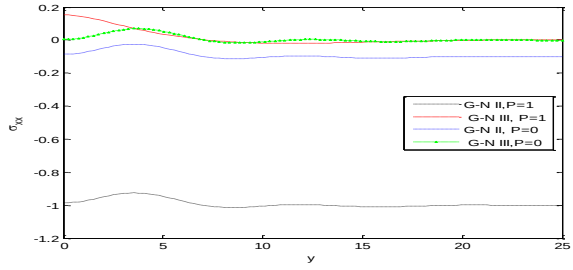

Fig. (10) Distribution of the stress component σ_{xx} with and without initial stress.

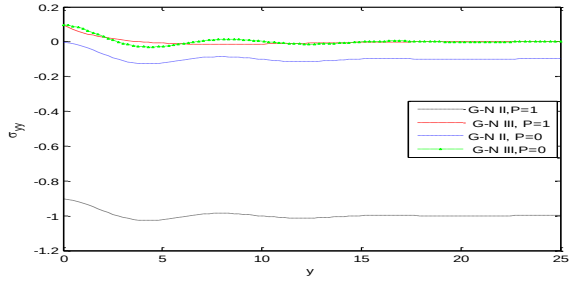

Fig. (11) Distribution of the stress component σ_{yy} with and without initial stress.

Figs. 12 demonstrates that the distribution of the stress component σ_{xy}, in the context of both types II and III begins from zero and satisfies the boundary conditions at $p=1$, and $p=0$. In the context of both types II and III. It was noted that the stress component of σ_{xy},

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increases with the increase of the initial stress values for $y > 0$.

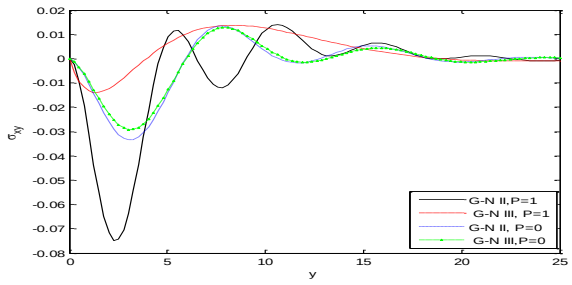

Fig. (12) Distribution of the stress component σ_{xy} with and without initial stress.

3D curves are representing $y = 0$ the complete relation between the physical variables and both of the components of the distance as shown in Figures (13-18) in the presence of the magnetic field $H_0 = 10^8$ and the initial stress proprieties $p = 1$, at $t = 0.3$ in the context of (G-N) theory of type III. These figures are very important in studying the dependence of these physical quantities on the vertical component of the distance. The obtained curves are highly dependent on the vertical distance from the origin, and all the physical quantities are moving in the wave propagation.

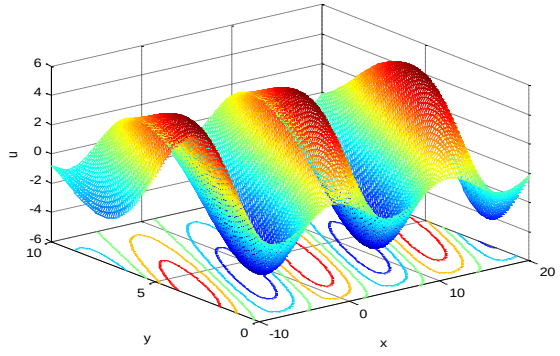

Fig. 13 (3D) Horizontal component of displacement u against both components of distance based on G-N type III at $H_0 = 10^8$ and $P = 1$.

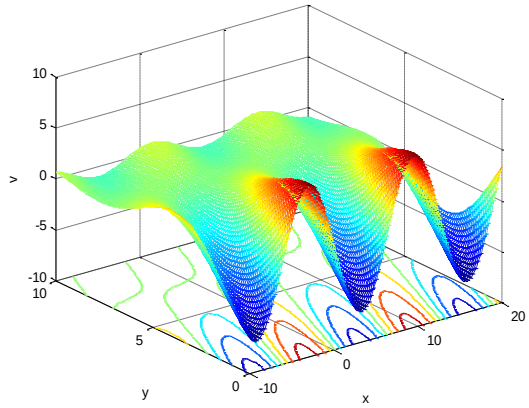

Fig. 14 (3D) Vertical component of displacement v against both components of distance based on G-N type III at $H_0 = 10^8$ and $P = 1$.

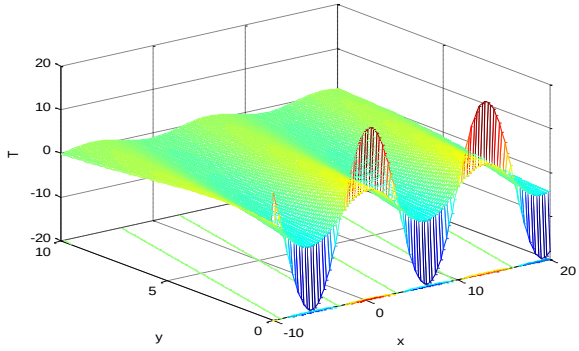

Fig. 15 (3D) Thermodynamic temperature distribution T against both components of distance based on G-N type III at $H_0 = 10^8$ and $P = 1$.

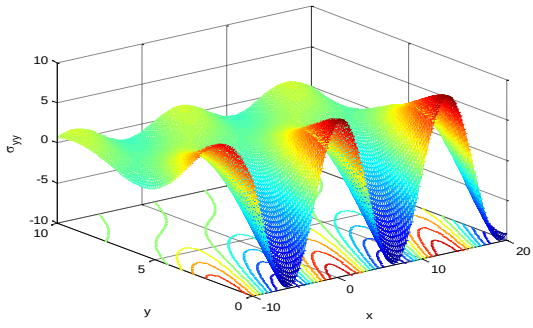

Fig. 16 (3D) Distribution of the stress component σ_{yy} against both components of distance based on G-N type III at $H_0 = 10^8$ and $P = 1$.

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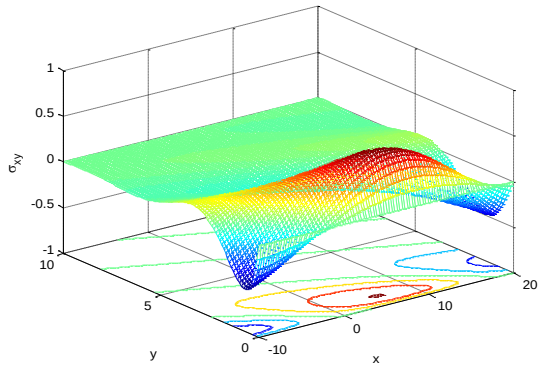

Fig. 17 (3D) Distribution of the stress component σ_{xy} against both components of distance based on G-N type III at $H_0 = 10^8$ and $P = 1$.

CONCLUDING REMARKS

By comparing the figures obtained under the (G-N) theory in the context of both types II and III, important phenomena are observed: the values of all physical quantities converge to zero with increasing distance y, all functions are continuous, and all physical quantities satisfy the boundary conditions. Also, analysis of the components of displacement, stresses, the temperature distribution due to the initial stress, and the magnetic field for thermoelastic solid with magnetic field under the initial stress is an interesting problem of mechanics. Normal mode analysis technique has been used, which applies to a wide range of problems in thermoelasticity. The value of all physical quantities converges to zero, with an increase in distance and all functions are continuous y. It was observed that the magnetic field and initial stress have a significant role in all considered physical quantities, as the amplitudes of these quantities vary (increasing or decreasing) with the increase of the initial stress and magnetic field.

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تحليل الوضع الطبيعي للوسط المغناطيسي الحراري المرن المعمم مع إجهاد أولي في ظل نظرية (جرين وناخدي)

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المستخلص: تم استخدام طريقة تحليل الوضع الطبيعي في دراسة تأثير كل من الإجهاد الأساسي الهيدروستاتيكي، والمجال المغناطيسي على جسم مرن حرارياً، وهذه الطريقة تستخدم للحصول على التعبيرات الدقيقة للمتغيرات المدروسة، وتناقش بعض الحالات الخاصة أيضا في سياق المشكلة . حيث تم استعراض معادلات المرونة الحرارية المعممة تحت تأثير الإجهاد الأساسي الهيدروستاتيكي، والمجال المغناطيسي باستخدام نظرية (جرين وناخدي) من النوعين الثاني والثالث (النوع الثاني مع عدم تشتت للطاقة والنوع الثالث مع تشتت للطاقة)، وتم رسم الكميات الفيزيائية المختلفة في حالة وجود، وعدم وجود كل من الضغط الهيدروستاتيكى، والمجال المغناطيسي. والنتائج التي خرج بها هذا البحث توضح مدى الفرق بين النوعين الثاني والثالث لنظرية جرين وناخدي. ويجب الإشارة إلي أن جميع الأشكال والنتائج التي تم الحصول عليها كانت باستخدام برنامج (MATLAB R2013a).

الكلمات المفتاحية: المرونة الحرارية المعممة. المجال المغناطيسي، الإجهاد الأساسي الهيدروستاتيكي، طريقة تحليل الوضع الطبيعي، نظرية (جرين وناخدي).

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تحديد مستويات بعض المعادن الثقيلة في بعض العيون والآبار الجوفية بالمنطقة الشمالية الشرقية من ليبيا

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المستخلص : في هذه الدراسة ، تم رصد المعادن الثقيلة (الزنك، الكاديوم، الرصاص، والنحاس) في بعض العيون والآبار الجوفية في المنطقة الشمالية الشرقية من ليبيا. جمعت العينات من مناطق مختلفة في فصلين (الجاف والرطب)، واستخدم جهاز الامتصاص الذري، وكان الحد الأقصى للكشف (LOD) يتراوح بين 0.008 إلى 0.03 ميكروغرام مل $^{-1}$، و الحد الكمي (LOQ) في حدود 0.02 إلى 0.09 ميكروغرام مل $^{-1}$. تراوحت نسبةRSD ٪ الانحرافات المعيارية النسبية بين 0.0001 و 0.329٪. أظهرت النتائج وجود متبقيات معادن الثقيلة في فصلين (الجاف والرطب) في المناطق أثناء الدراسة في بعض العيون والآبار الجوفية، وكانت قيم الزنك والكادميوم والنحاس أقل من الحدود المسموح بها، وفقًا لمنظمة الصحة العالمية (WHO)، ومنظمة الأغذية والزراعة (FAO)، والمواصفات القياسية الليبية(LNCSM). والرصاص في فصل الجاف أعلى من فصل الرطب وفقًا لمنظمة الصحة العالمية، والمواصفات القياسية الليبية، حيث كانت بقية القيم تحت الحدود المسموح بها عالميا، وفقًا لمنظمة الصحة العالمية، ومنظمة الأغذية والزراعة، والمواصفات القياسية الليبية. أظهرت نتائج هذه الدراسة وجود مستويات تنذر بالخطر من معدن الرصاص في فصل الجاف في الآبار الجوفية في سهل المرج I، الأبيار III. بشكل عام، يعتبر فحص الأسمدة الكيماوية، والزراعية وسيلة فعالة لمراقبة جودة مياه الشرب لتحديد مصادر التلوث المحتملة التي يمكن أن تكون في الخزانات، وخطوط الأنابيب لضمان وصول مياه شرب آمنة إلى المستخدمين.

الكلمات المفتاحية: المعادن الثقيلة، المنطقة الشمالية الشرقية، بعض العيون والآبار الجوفية

المقدمة

أصبح التلوث المعدني للأنظمة البيئية مشكلة خطيرة تهدد صحة الإنسان والحيوان وكذلك النبات(Boran و Altınok, ، 2010؛ Gaur وآخرون،2005؛ Suthar وآخرون، 2009). تشكل الملوثات المعدنية بسبب التخلص من النفايات الصناعية غير المعالجة والمعالجة جزئيا والمحتوية على المعادن السامة على المدى الطويل، والاستخدام العشوائي للأسمدة، والمبيدات الحشرية المحتوية على المعادن في الحقول الزراعية في تلوث بعض العيون والآبار الجوفية (Macklin وآخرون، 2006؛ Reza و Singh ، 2010؛ Martin ، 2000؛Dike وآخرون، 2004).

لوحظ أن الزيادة السريعة في عدد السكان مقترنة بعوامل مثل التنمية الصناعية، والزراعة، والتي تؤدي إلى تراكم ضخم للملوثات المعدنية وتنتهي في نهاية المطاف إلى تلوث المياه. و الملوثات المعدنية سبب رئيسي للقلق على البيئة المائية بسبب سميتها، ووفرتها، واستمرارها، وتراكمها في المصادر المائية (Deniseger وآخرون، 1990؛ Sin وآخرون،2001). يشكل تلوث المياه بالمعادن الثقيلة تهديدًا متزايدًا لمنتجات المحاصيل في العالم ، ومن المحتمل أن

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تسبب المعادن تدهورا في نوعية المياه، وحدوث تأثيرات سامة على المحاصيل(Roy وآخرون، 2015). المعادن الثقيلة لديها خصائص سامة، ولها آثار ضارة على صحة الإنسان حتى في الجرعات الصغيرة، كما أنها تسبب أمراضا خطيرة، وأضرارا على النبات (Ferner، 2001؛ Kabata-Pendias، 2010).

لوحظ وجود بعض المعادن الثقيلة في مياه ري المحاصيل والخضروات (Phuong وآخرون، 2010؛ Yadav وآخرون، 2013؛ Prabu، 2009؛ Benti، 2014؛ Rahman وآخرون، 2015). و امتصاص بعض المعادن الثقيلة (Cu و Zn, Pb, Cr, Cd) من قبل النباتات ينتج عنها تثبيط النمو، تلف الهيكل، وانخفاض الأنشطة الفسيولوجية والبيوكيميائية وكذلك يقلل من خصوبة التربة والإنتاج الزراعي (Bhaskar وآخرون، 2010؛Ahmad و Goni، 2010). أشارت نتائج الأبحاث السابقة في ليبيا إلى وجود معادن ثقيلة في بعض الخضروات والفواكه (الجراري، 2015).أجري Tarla وآخرون في مارس 2013 تحديد تركيز بعض المعادن الثقيلة مثل (Pb، Cd، Cu، Fe و Mn) في العيون حيث أظهرت النتائج أن بعض المعادن الثقيلة (Pb، Fe و Mn) كانت أعلى من الحدود المسموح بها حسب منظمة الصحة العالمية بينما Cd تم اكتشافه ضمن الحدود الآمنة، وأن وجود المعادن الثقيلة في المياه يشكل مخاطر صحية على المستهلكين (Tarla وآخرون،2018).

تهدف هذه الدراسة لكشف متبقيات بعض المعادن الثقيلة في بعض العيون والآبار الجوفية لبعض المناطق في المنطقة الشمالية الشرقية من ليبيا، ومقارنة مستوى تلوث هذه المعادن في المياه قيد الدراسة مع الحدود المسموح بها عالميا، وكذلك حسب المواصفات القياسية الليبية ومنظمة الصحة العالمية، ومنظمة الأغذية والزراعة، وتوجيه نظر المستهلكين إلى مواطن الخطورة إن وجدت.

المواد وطرق البحث

موقع الدراسة : تقع منطقة الدراسة بين وادي درنة (E 22.619346° N 32.727701°) شرقا والأبيار (E 20.522419° N 32.257841°) غربا كما هو موضح في الشكل (1) و تم استخدام جهاز تحديد المواقع الجغرافي (GPS) لتحديد مواقع جمع العينات .

جمع عينات المياه : جمعت 30عينة مياه عشوائية مرة من كل موقع (1 لتر) علي فصلين (جاف–رطب) 2016 متكونة من تسعة العيون و21الآبار الجوفية من مناطق مختلفة في المنطقة الشمالية الشرقية من ليبيا، هي وادي درنة، كرسه، الدبوسية ، عين أبولوينا شحات I، شحاتII، شحات III، مسة I، مسة II، عين سليون مسة III، ستلونة I، لشبو ستلونة II، تكنانة ستلونة III، قندولة I،قندولة II،قندولة III، مراوة I ، مراوة مراوة III ،وسيطة I ، وسيطة II، وسيطة III، سهل المرج I ، سهل المرج II ،سهل المرج III ،طلميثة I ،طلميثة II، طلميثة III،الأبيار I ،الأبيار II ،الأبيار III). تم جمع عينات العيون من مياه مباشرة، والآبار الجوفية بواسطة مضخات، بواسطة قنينة زجاجية معتمة بعد غسلها بنفس الماء 3–4 مرات وكتب عليها اسم المنطقة وتاريخ أخذ العينة، ثم نقلت العينات داخل حافظة مبردة إلى المعمل مباشرة، و تم تخزين عينات المياه التي تم جمعها في تلاجة علي درجة الحرارة 4°م إلى حين تحليلها (APHA, 1995; Hunt و Wilson، 1986)

شكل (1) مواقع الدراسة

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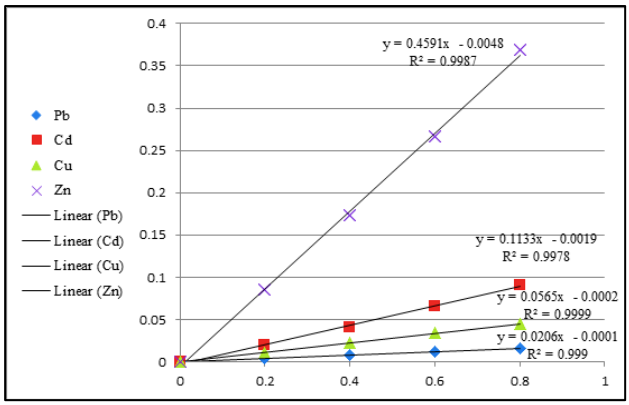
المواد الكيميائية المستخدمة : تم استخدام حمض النيتريك بنسبة 69٪ (درجة تحليلية ، BDH Ltd. Pool England) وحمض الهيدروكلوريك 37٪ (درجة تحليلية ، Riedelde Haen AG ألمانيا).و استخدام الماء منزوع الأيونات من تنقية مياه (Millipore Milli-Q، Bedford، MA، USA) لإعداد العينات والمعايير. و تحضير المحاليل المعيارية للعناصر من النحاس، والزنك، والكادميوم، والرصاص المستخدمة للمعايرة عن طريق تخفيف محاليل المخزون البالغة 1000 ملغ من كل عنصر تم توفيره من BDH. نقعت جميع الحاويات والأواني الزجاجية في حامض النتريك بنسبة 20٪ لمدة 16 ساعة على الأقل وشطفت بالماء المقطر ومزيل الأيونات قبل الاستخدام .

إعداد المعادن الثقيلة لـامتصاص الذري : تم تقدير تركيز المعادن بثلاثة مكررات بواسطة جهاز الامتصاص الذري المجهز بالمصيدة الذرية للأنبوب المشقوق (STAT) (مطياف الامتصاص الذري Philips PU 9100X). كان الحد الأقصى للكشف 0.030 ميكروغرام/مل للرصاص، 0.023 ملغم / لتر للكاديميوم ، ميكروغرام/مل ، 0.008 للنحاس ميكروغرام/مل، 0.028 ميكروغرام /مل للزنك من أجل التحديد الكمي الدقيق للمعادن الثقيلة في عينات المياه ، استخدمت (4 معادن قياسية (Cd 10 ppm، Cu 10، 100و Zn 10 جزء في المليون ، مصفوفة 5 ٪ HNO3).
تم تحضير العينات عن طريق التخفيف من 1.0 مل من عينات المياه إلى 10.0 مل مع حمض النتريك عالي النقاء بنسبة 0.3 ٪ وتحليله بواسطة جهاز الامتصاص الذري. تم إعداد أربع مجموعات قياسية باستخدام طريقة التخفيف المتسلسل لـ Zn، Pb و Cu و Cd كان الحد الكمي 0.091 ميكروغرام /مل للرصاص، 0.072 ميكروغرام للكادميوم، ميكروغرام/مل، 0.026 للنحاس ميكروغرام/مل ، 0.085 ميكروغرام /مل للزنك.

الهضم: أعدت عينات المياه بواسطة (Abdolgader وآخرون،2013)

حساب تركيز المعادن الثقيلة في المياة المجمعة : تم حساب تركيز العينة المحتوية على المعدن بواسطة معادلة الخط المستقيم لمنحى المعايرة كل المعدن الذي تمت قسمته على الحجم الذي تم استخلاص العينة منه للحصول على التركيز الفعلي للمعدن.

منحنيات المعادن الثقيلة القياسي : تظهر هذه المنحنيات مدي خطية كل المعدن علي حده كما هو موضح في الشكل (2).



الشكل (2) يوضح تركيز كل معدن مع مساحة المنحي المقابل له لكل تركيز

تحليل إحصائي : حللت البيانات ببرنامج SPSS إصدار 25.تم تحليل المواقع والمواسم باستخدام two way ANOVA عند فرق معنوية أقل P <0.05 .تم إجراء اختبار t-test لمعرفة الفروق المعنوية بين بعض العيون والآبار الجوفية، وكذلك الفروق المعنوية بين الفصل الجاف والفصل الرطب عند P <0.05 Nie)وآخرون(1970.

النتائج والمناقشة

تحديد مستويات بعض المعادن الثقيلة في بعض العيون والآبار الجوفية بالمنطقة الشمالية الشرقية من ليبيا: في هذه الدراسة ، عثر على متبقيات المعادن الثقيلة في عينات بعض العيون، والآبار الجوفية ، وقياسها بواسطة جهاز الامتصاص الذري.أظهرت النتائج العثور على متبقيات المعادن الثقيلة في الفصلين (الجاف–الشتاء) في المناطق قيد الدراسة ، و تم

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الكشف عن المعادن الثقيلة في جميع المناطق في عينات المياه خلال فصل الجاف كما هو موضح في الجدول (1و2).

وتراوحت قيمة الزنك للعيون من مسة I إلى عين لشبو ستلونه II بين 0.0107 إلى 0.0236 ميكروغرام مل $^{-1}$ وفي الآبار الجوفية من مسة II إلى الأبيار II بين 0.0143 إلى 0.0863 ميكروغرام مل $^{-1}$ ، و كانت القيم تحت الحدود المسموح بها عالميا حسب منظمة الصحة العالمية، ومنظمة الأغذية، والزراعة(Jamshaid وآخرون،2018 ؛ Ahmed وآخرون2019) و تراوحت قيمة النحاس للعيون من دبوسية إلى عين لشبو ستلونه II بين 0.007 إلى 0.0018 ميكروغرام مل $^{-1}$ ، وفي الآبار الجوفية من مسة II إلى الأبيار II بين 0.006 إلى 0.0165 ميكروغرام مل $^{-1}$ ، و كانت قيم الزنك تحت الحدود المسموح بها عالميا. أظهرت النتائج أن قيمة الكادميوم للعيون من دبوسية إلى أبولوينا شحاتI تراوحت بين 0.001 إلى 0.006 ميكروغرام مل $^{-1}$ وفي الآبار الجوفية من قندولة II إلى الأبيار III بين 0.001 إلى 0.006 ميكروغرام مل $^{-1}$ ، و كانت قيم الزنك تحت الحدود المسموح بها عالميا. أوضحت النتائج أن قيمة الرصاص للعيون من كرسة إلى طلميثة II تراوحت بين 0.0015 إلى 0.0057 ميكروغرام مل $^{-1}$ ، وفي الآبار الجوفية من شحات III إلى سهل المرج I كانت بين 0.0028 إلى 0.0657 ميكروغرام مل $^{-1}$ ، وجدير بالذكر أن قيمة الرصاص في فصل الجاف أعلى من فصل الرطب حسب منظمة الصحة العالمية ، حيث كانت بقية القيم تحت الحدود المسموح بها عالميا حسب منظمة الصحة العالمية، ومنظمة الأغذية والزراعة.أظهرت النتائج أن الآبار الجوفية كانت أكثر تلوثا بالمعادن الثقيلة (Zn-Cu-Cd-Pb) من العيون ، و أوضحت نتائج هذه الدراسة مستويات مقلقة عن معدن الرصاص في فصل الجاف في الآبار الجوفية في سهل المرج I والأبيار III.

جدول (1) متبقيات بعض المعادن الثقيلة في العيون التي تم جمعها من مناطق مختلفة خلال فصل الجاف 2016

المواقع		Pb	Cd	Cu	Zn
		$\mu g\ mL^{-1}$	$\mu g\ mL^{-1}$	$\mu g\ mL^{-1}$	$\mu g\ mL^{1}$
وادي درنة		0.0032	0.0004	0.0012	0.0177
كرسة		0.0015	0.0002	0.0012	0.0118
دبوسية		0.0025	0.0001	0.0007	0.0111
عين أبولوينا شحات I		0.0072	0.0006	0.0009	0.0171
مسةI		0.036	0.0002	0.0011	0.0107
سليون مسة III		0.0048	0.0002	0.0015	0.0130
لشبو ستلونةII		0.0040	0.0003	0.0018	0.0236
تكنانة ستلونة III		0.0039	0.0004	0.0011	0.0170
طلميثةII		0.0057	0.0002	0.0009	0.0230
الحدود المسموح	WHO&LNCSM	0.05	0.005	1	3
	FAO	5.00	0.01	0.2	2.00

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جدول (2) متبقيات بعض المعادن الثقيلة في الآبار الجوفية التي تم جمعها من مناطق مختلفة خلال فصل الجاف 2016

المواقع		Pb	Cd	Cu	Zn
		µg mL^{-1}	µg mL^{-1}	µg mL^{-1}	µg mL^{-1}
شحات II		0.0149	0.0006	0.0008	0.0494
شحات III		0.0107	0.0007	0.0006	0.0178
مسة II		0.0108	0.0002	0.0011	0.0163
ستلونة I		0.0103	0.0005	0.0012	0.0215
قندولة I		0.0092	0.0008	0.0002	0.0342
قندولة II		0.0100	0.0003	0.0008	0.0145
قندولة III		0.0104	0.0007	0.0010	0.0298
مراوة I		0.0124	0.0003	0.0008	0.0298
مراوة II		0.0140	0.0006	0.0005	0.1265
مراوة III		0.0092	0.0007	0.0011	0.0102
وسيطة I		0.0096	0.0007	0.0003	0.0154
وسيطة II		0.0095	0.0007	0.0004	0.0207
وسيطة III		0.0109	0.0007	0.0007	0.0402
طلميثة I		0.0129	0.0011	0.0020	0.0163
طلميثة III		0.0102	0.0008	0.0006	0.0133
سهل المرج I		0.0109	0.0009	0.0006	0.0266
سهل المرج II		0.0120	0.0007	0.0010	0.0238
سهل المرج III		0.0107	0.0007	0.0020	0.1526
الأبيار I		0.0114	0.0007	0.0017	0.0143
الأبيار II		0.0114	0.0007	0.0013	0.1385
الأبيار III		0.0119	0.0007	0.0014	0.0223
الحدود المسموح	WHO&LNCSM	0.05	0.005	1	3
	FAO	5.00	0.01	0.2	2.00

كما في الجدول (3و4) أظهرت نتائج التحليل في بعض العيون والآبار الجوفية التي تم جمعها من مناطق مختلفة خلال فصل الرطب 2016 احتواءها على المعادن الثقيلة ، ومعظم تركيز المعادن الثقيلة في هذا الفصل في مصادر العيون والآبار الجوفية كان تحت الحدود المسموح بها حسب منظمة الصحة العالمية، ومنظمة الأغذية، والزراعة، والمواصفات القياسية الليبية. وتراوحت قيمة الزنك للعيون من سليون مسة III إلى طلميثة II بين 0.005 إلى 0.0013 ميكروغرام مل $^{-1}$ وفي الآبار الجوفية من مراوة II إلى الأبيار III تراوحت 0.0010 إلى 0.0014 ميكروغرام مل $^{-1}$ و كانت قيم الزنك تحت الحدود المسموح بها عالميا حسب المنظمة الصحة العالمية، ومنظمة الأغذية، والزراعة، والمواصفات القياسية الليبية، وتراوحت قيمة النحاس للعيون من دبوسية إلى طلميثة II بين 0.003 إلى 0.0013 ميكروغرام مل $^{-1}$ وفي الآبار الجوفية من مراوة II إلى ستلونه I تراوحت 0.005 إلى 0.0012 ميكروغرام مل $^{-1}$ وتراوحت قيمة الكادميوم للعيون من دبوسية إلى طلميثة II بين 0.001 إلى 0.008 ميكروغرام مل $^{-1}$ وفي الآبار الجوفية من مسة II إلى العويلية II تراوحت بين 0.002 إلى 0.009 ميكروغرام مل $^{-1}$، وتراوحت قيمة الرصاص للعيون من سليون مسة III إلى دبوسية بين 0.0100 إلى 0.0143 ميكروغرام مل $^{-1}$ وفي الآبار الجوفية من قندولة I إلى شحات III تراوحت بين 0.0092 إلى 0.0149 ميكروغرام مل $^{-1}$.

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جدول (3) متبقيات بعض المعادن الثقيلة في العيون التي تم جمعها من مناطق مختلفة خلال فصل الرطب 2016

المواقع	Pb	Cd	Cu	Zn
	µg mL^{-1}	µg mL^{-1}	µg mL^{-1}	µg mL^{1}
وادي درنة	0.0032	0.0106	0.0003	0.0013
كرسة	0.0015	0.0126	0.0002	0.0008
دبوسية	0.0025	0.0143	0.0006	0.0003
عين ابولوينا شحات I	0.0072	0.0125	0.0001	0.0007
مسةI	0.036	0.0128	0.0002	0.0006
سليون مسة III	0.0048	0.0100	0.0001	0.0005
لشبو ستلونةII	0.0040	0.0101	0.0003	0.0005
تكنانة ستلونة III	0.0039	0.0121	0.0003	0.0011
طلميثةII	0.0057	0.0106	0.0008	0.0013
الحدود المسموح				
WHO&LNCSM	0.05	0.005	1	3
FAO	5.00	0.01	0.2	2.00

جدول (4) متبقيات بعض المعادن الثقيلة في الآبار الجوفية التي تم جمعها من مناطق مختلفة خلال فصل الرطب 2016

المواقع	Pb	Cd	Cu	Zn
	µg mL^{-1}	µg mL^{-1}	µg mL^{-1}	µg mL^{1}
شحات II	0.0149	0.0149	0.0006	0.0008
شحات III	0.0107	0.0107	0.0007	0.0006
مسة II	0.0108	0.0108	0.0002	0.0011
ستلونة I	0.0103	0.0103	0.0005	0.0012
قندولة I	0.0092	0.0092	0.0008	0.0002
قندولة II	0.0100	0.0100	0.0003	0.0008
قندولة III	0.0104	0.0104	0.0007	0.0010
مراوة I	0.0124	0.0124	0.0003	0.0008
مراوة II	0.0140	0.0140	0.0006	0.0005
مراوة III	0.0092	0.0092	0.0007	0.0011
وسيطة I	0.0096	0.0096	0.0007	0.0003
وسيطة II	0.0095	0.0095	0.0007	0.0004
وسيطة III	0.0109	0.0109	0.0007	0.0007
طلميثة I	0.0129	0.0129	0.0011	0.0020
طلميثة III	0.0102	0.0102	0.0008	0.0006
سهل المرج I	0.0109	0.0109	0.0009	0.0006
سهل المرج II	0.0120	0.0120	0.0007	0.0010
سهل المرج III	0.0107	0.0107	0.0007	0.0020
الأبيار I	0.0114	0.0114	0.0007	0.0017
الأبيار II	0.0114	0.0114	0.0007	0.0013
الأبيار III	0.0119	0.0119	0.0007	0.0014
الحدود المسموح				
WHO&LNCSM	0.05	0.005	1	3
FAO	5.00	0.01	0.2	2.00

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بشكل عام ، يوضح شكل (3) عينات بعض العيون والآبار الجوفية التي تم تحليلها، و كانت ملوثة بالزنك (Zn) ، والنحاس (Cu) ،والرصاص (Pb) ،والكادميوم (Cd) خلال فصلين (الجاف–الرطب).

في اختبار t في المستويات المتوسطة للمعادن الثقيلة لوحظ اختلافات معنوية بين الفصلين (الجاف –الرطب)عند ($p < 0.05$) كما في جدول (5). وجود فروق معنوية بين العيون، والآبار الجوفية عند تركيز كل معدن بين مناطق الدراسة عند ($p < 0.05$) كما موضح في جدول (6).

جدول (5) تحليل تباين تراكيز المعادن الثقيلة بين فصل الجاف والرطب باستخدام اختبار T-test

$\mu g\ mL^{-1}$	مجموعات	متوسط		الانحراف المعياري	احتمالية	اختبار ت
Zn	فصل جاف	0.0023*	±	0.0003	0.00*	2.892
	فصل رطب	0.0009	±	0.00005		
Cu	فصل جاف	0.0002	±	0.00001	0.00*	4.099
	فصل رطب	0.0004*	±	0.00002		
Cd	فصل جاف	0.0249	±	0.00197	0.00*	6.471
	فصل رطب	0.0394*	±	0.00459		
Pb	فصل جاف	0.0086	±	0.00145	0.01*	2.187
	فصل رطب	0.01197*	±	0.00035		

*توجد فروق معنوية بين بعض العيون والآبار الجوفية عند أقل من 0.05

جدول (6) تحليل تباين تراكيز المعادن الثقيلة بين بعض العيون والآبار الجوفية باستخدام اختبار T-test

$\mu g\ mL^{-1}$	مجموعات	متوسط		الانحراف المعياري	احتمالية	اختبار ت
Zn	العيون	0.019	±	0.0026	0.005*	4.054
	الآبار الجوفية	0.036*	±	0.0032		
Cu	العيون	0.0009	±	0.0003	0.00*	3.774
	الآبار الجوفية	0.0022*	±	0.0037		
Cd	العيون	0.0003	±	0.00002	0.00*	5.302
	الآبار الجوفية	0.0004*	±	0.00002		
Pb	العيون	0.0078	±	0.0005	0.03*	2.587
	الآبار الجوفية	0.0108*	±	0.0010		

*توجد فروق معنوية بين بعض العيون والآبار الجوفية عند أقل من 0.05

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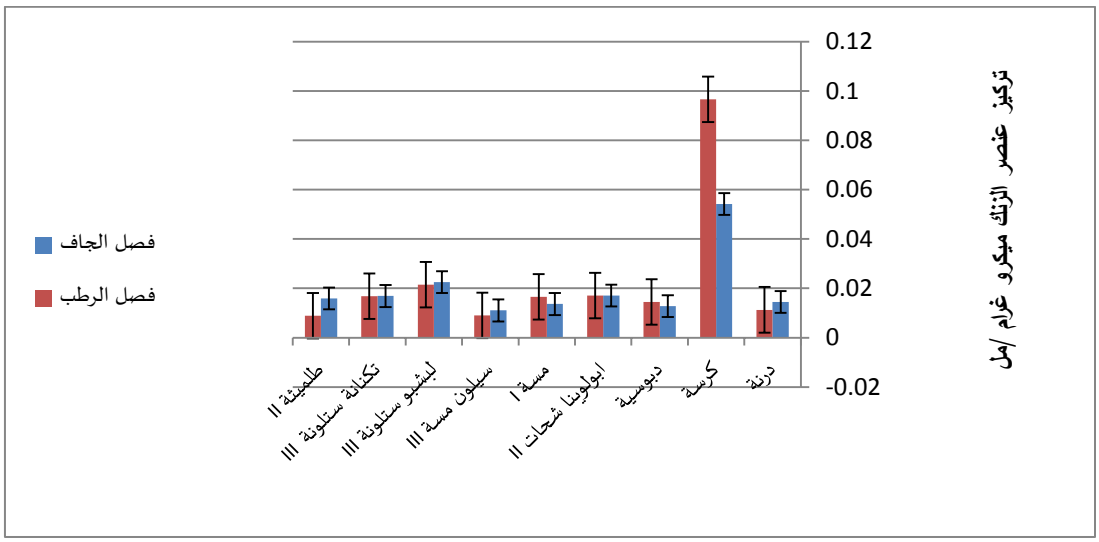
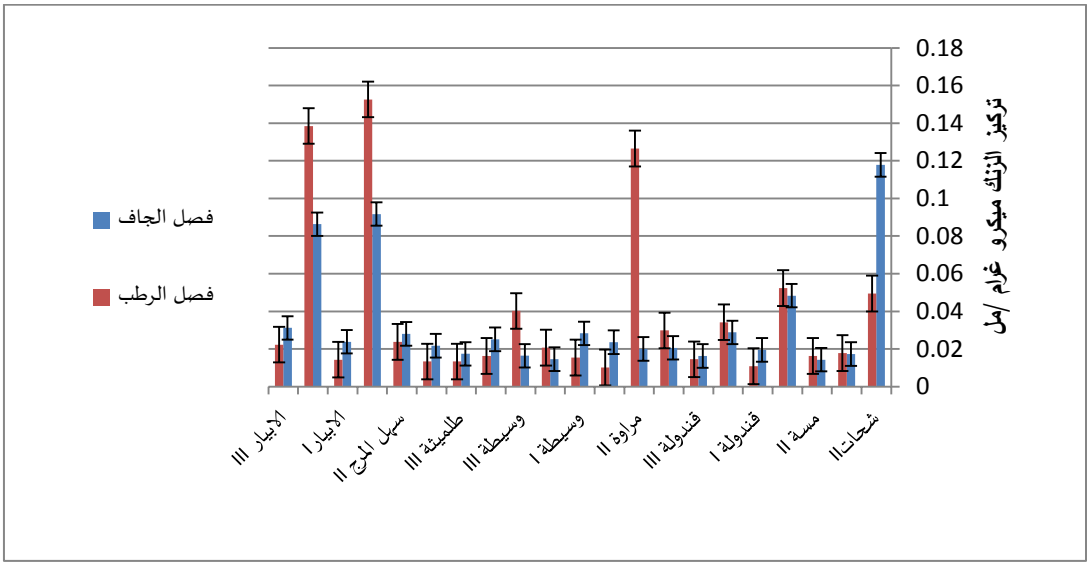
تم تحليل التباين في معدن الزنك في المناطق المختلفة وكانت هناك فروق معنوية بين سهل المرج III ،والمناطق المختلفة في فصل الرطب عن فصل الجاف كما هو موضح في الشكل (3 و4). أيضا ، في معدن النحاس هناك فروق معنوية في سهل المرج II في فصل الجاف عن فصل الرطب بين المناطق المختلفة عند($P <0.05$)كما هو موضح في الشكل (5و6).

أظهر تركيز المعدن الكادميوم في طلميثة I وجود فروق معنوية بين فصل الرطب مقارنة بفصل الجاف في المناطق المختلفة كما هو موضح في الشكل عند($P <0.05$) (7و8) ، ومن ناحية أخرى كانت هناك فروق معنوية لمعدن الرصاص بين سهل المرج II في فصل الجاف عن فصل الرطب بين المناطق المختلفة عند ($p <0.05$) كما الموضح في شكل (9و10).



شكل (3) متوسط تركيز معدن الزنك في العيون في مناطق مختلفة خلال فصلين 2016



شكل (4) متوسط تركيز معدن الزنك في الآبار الجوفية في مناطق مختلفة خلال فصلين 2016

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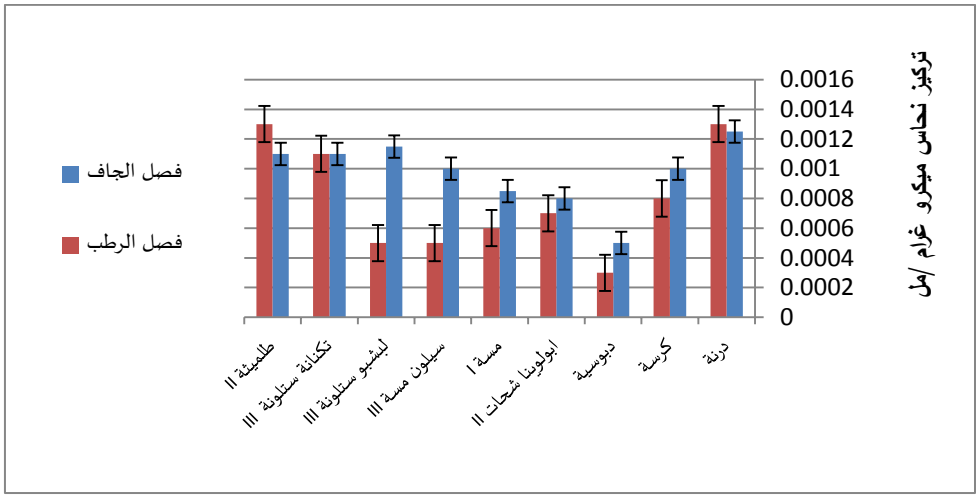
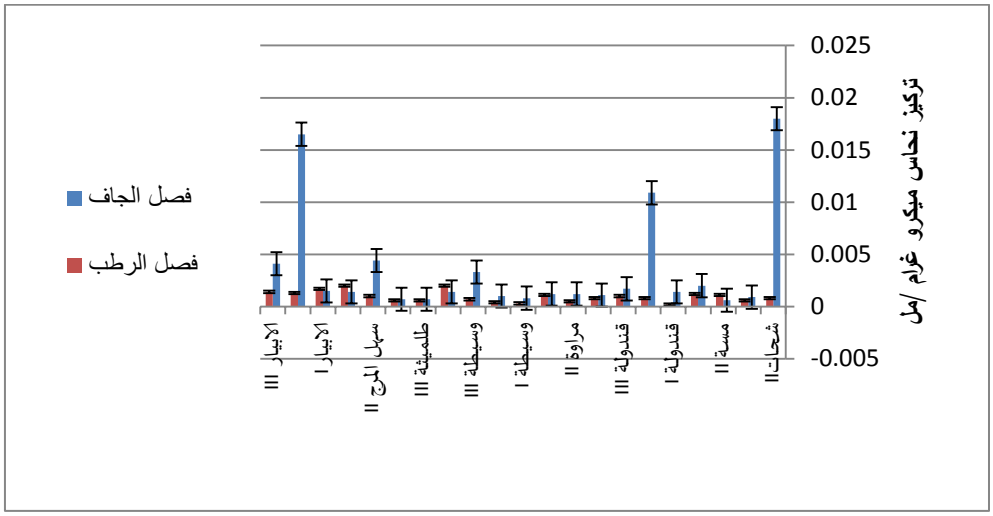
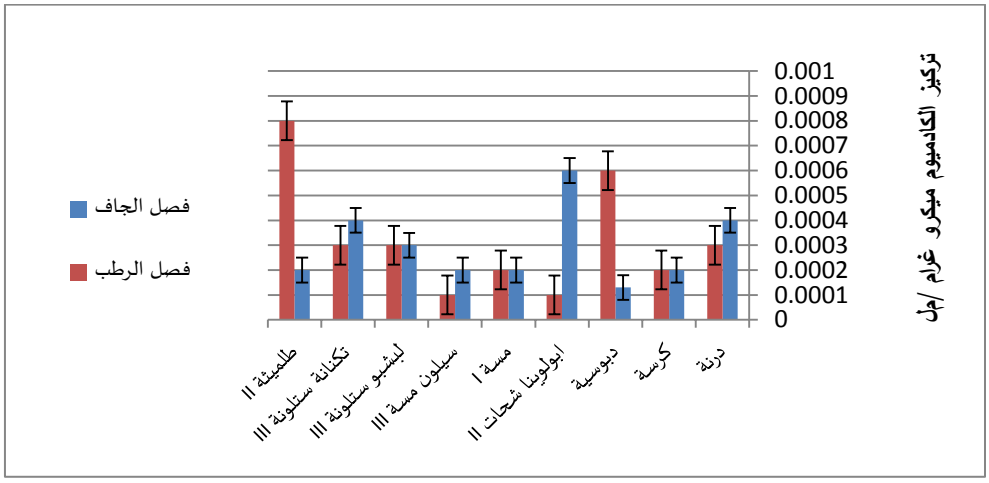


شكل (5) متوسط تركيز معدن النحاس في العيون في مناطق مختلفة خلال فصلين 2016



شكل (6) متوسط تركيز معدن النحاس في الآبار الجوفية في مناطق مختلفة خلال فصلين 2016



شكل (7) متوسط تركيز معدن الكادميوم في العيون في مناطق مختلفة خلال فصلين 2016

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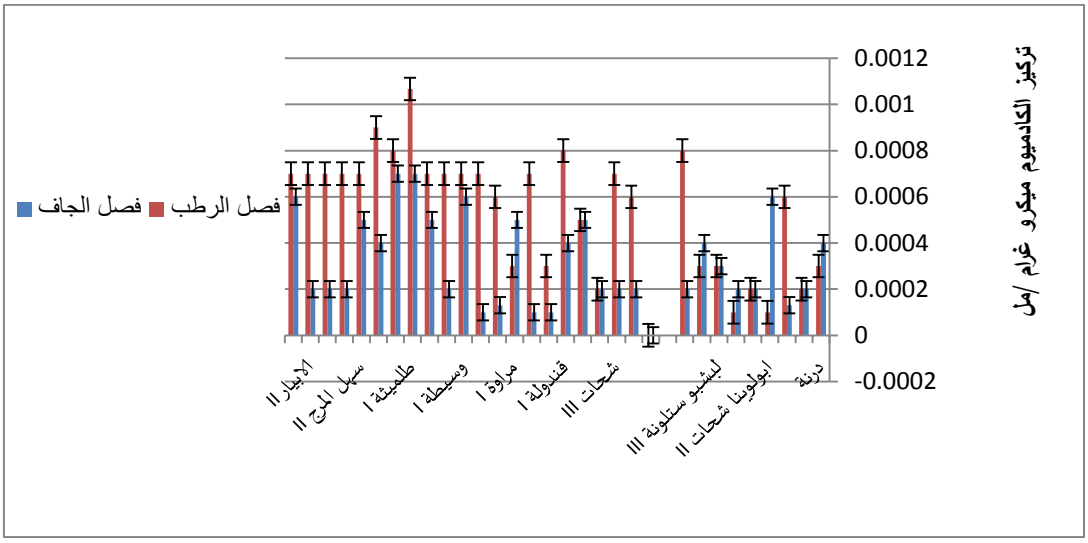
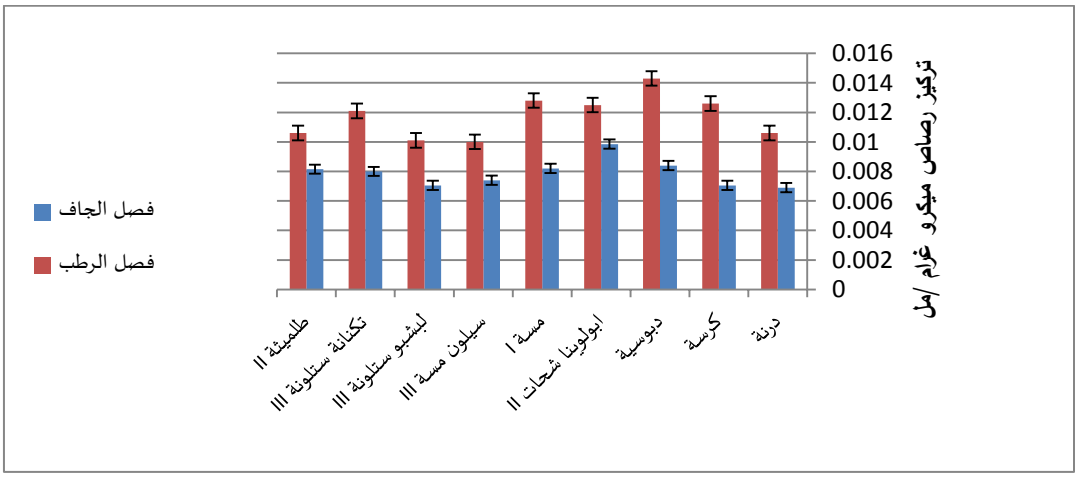
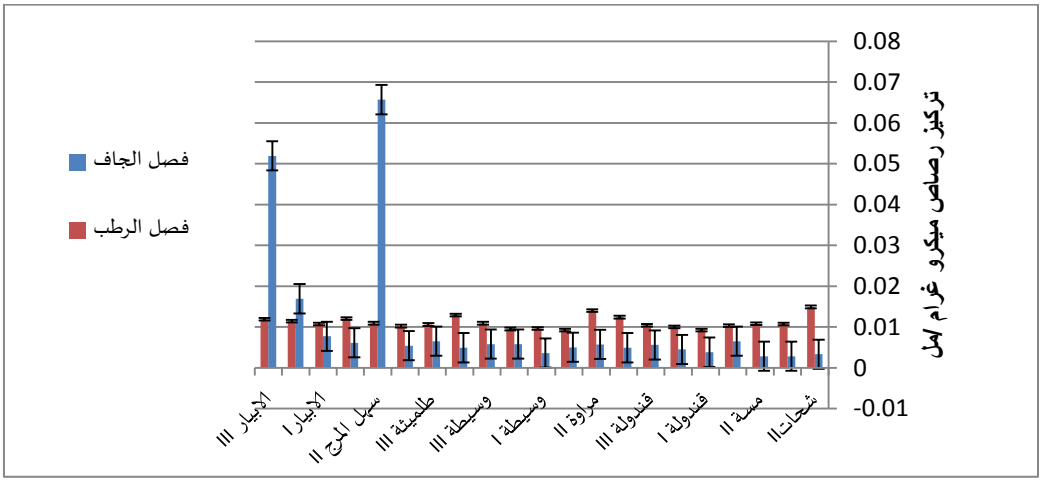


شكل (8) متوسط تركيز معدن الكاديميوم في الآبار الجوفية في مناطق مختلفة خلال فصلين 2016



شكل (9) متوسط تركيز معدن الرصاص في العيون في مناطق مختلفة خلال فصلين 2016



شكل (10) متوسط تركيز معدن الرصاص في الآبار الجوفية في مناطق مختلفة خلال فصلين 2016

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وكانت هذه النتيجة متفقة مع (Ghanemوآخرون، 2010) حيث تأثرت إدارة بعض العيون، والآبار الجوفية في المناطق الشرقية بمواقع الإلقاء الموزعة عشوائيًا ، ومكبات النفايات الصلبة ، والحفارات ، لا سيما في المجتمعات الريفية ، وكذلك الممارسات الزراعية والصناعية. وفقا لذلك ، وبعض العيون والآبار الجوفية ؛ يمكن أن ينعكس هذا في إمدادات المياه لهذه المجتمعات لأن مصادر المياه هذه هي المصادر الرئيسية للشرب والأغراض الزراعية تبعا لذلك ، يمكن أن تعزى مصادر المعادن المكتشفة في الآبار الجوفية في منطقة الدراسة والتي تستخدم في الشرب إلى العديد من المصادر بما في ذلك، مواقع الإلقاء، ومدفن النفايات للتخلص من النفايات الصلبة ، والحفارات ، والصناعات ، وحركة المرور ، وكذلك الأسمدة للأغراض الزراعية. حيث يتم نقل المادة المترشحة من خلال النفايات ومدافن النفايات المحتوية على المعادن الثقيلة والتي تتسرب إلى الآبار الجوفية عبر التربة. بالإضافة إلى حرق النفايات الصلبة في مواقع دفن النفايات ما يؤدي إلى تلوث الآبار الجوفية بالمعادن الثقيلة. إن أكثر ما يثير قلق دعاة وكالة حماية البيئة بشأن حرق النفايات الصلبة الخوف من أن ينتج عنها كميات كبيرة من الانبعاثات في غازات الرماد والمداخن المحتوية علي المعادن الثقيلة (Changوآخرون،2003) عادة ما يكون تلوث بعض العيون والآبار الجوفية الناتج من الرماد المتطاير عن حرق النفايات بالمعادن الثقيلة والمواد الخطرة الأخرى ويجب معالجته. بحرق النفايات الصلبة ، تتشكل ملوثات مختلفة، تنبعث في غاز المداخن بما في ذلك المعادن الثقيلة على سبيل المثال Cd، Pb، Zn ، ... ، خاصة عندما تحتوي النفايات على بطاريات، أو جلود، أو أصباغ، أو علب. يمكن أن تصل المعادن الثقيلة المنبعثة من حرق النفايات الصلبة إلى المياه (السطحية ، الجوفية ، مياه الأمطار..الخ) وبالتالي تؤدي إلى وتلوثها. لقد التزمت أوروبا منذ أوائل السبعينيات بحماية البيئة من الهواء والماء في هذا المجال ، تجدر الإشارة إلى التوجيه 2000/ EC/76 (Quina وآخرون،2008).

وفي النهاية ، في شرق ليبيا ، إن إفراغ معظم هذه الحفارات بواسطة صهاريج التفريغ والتخلص منها في الوديان، أو في مواقع الإغراق غير المناسبة التي تقع في الأراضي الزراعية دون أي اعتبار لخصائص التربة والطوبوغرافيا والمناخ، وكذلك الحفر العشوائي والذي يعد من مصادر التلوث الرئيسية للآبار الجوفية . نظرًا لعدم تصميم أي من مواقع الإلقاء الحالية لجمع المادة المترشحة من تدهور النفايات الصلبة ، فإن المادة المترشحة تجد طريقها دائمًا من خلال التربة إلى الآبار الجوفية ، مما يزيد من تركيز الملوثات بما في ذلك المعادن الثقيلة إلى الماء. بالإضافة إلى النفايات وحفر الآبار ، كما أن الأنشطة الحضرية، والزراعية، والصناعية في منطقة الدراسة قد تسهم في تلوث الآبار الجوفية بالمعادن الثقيلة (Malassa وآخرون، 2013).

الشكر والتقدير

نتقدم بجزيل الشكر والتقدير لهيئة أبحاث العلوم الطبيعة والتكنولوجيا الليبية لدعمها المادي لهذا البحث

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Determining the Levels of Some Heavy Metals in Springs and Groundwater Wells in the Northeastern Region of Libya

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Abstract: This study was designed to detect heavy metals (Zn, Cd, Pb, and Cu) in several springs and groundwater wells in the northeastern region of Libya. Samples were collected from different regions in both seasons (dry and wet). An atomic absorption spectrophotometry equipped with Slotted Tube Atomic Trap (STAT) was used. The limit of detection (LOD) was in the range of 0.008 to 0.03 µg mL^{-1}, and the limit of quantification (LOQ) was in the range of 0.02 to 0.09 µg mL^{-1}. % RSD (relative standard deviations) ranged between 0.0001 to 0.329%. Results showed the presence of heavy metal residues in the regions in two seasons (dry-wet) during the study in some springs and groundwater wells. The zinc (Zn), cadmium (Cd), and Copper (Cu) values were below permitted limits, according to the World Health Organization (WHO), Libyan National Center for Standardization (LNCSM), and Food and Agriculture Organization (FAO). Lead (Pb) in the dry season was much higher than the wet season in accordance with WHO and LNCSM. The other values were below permissable limits according to WHO, LNCSM, and FAO. This study's results show the presence of dangerous levels of lead during the dry season in the groundwater wells on SahlAlmarj I, Alabyar III. Overall, the investigation of chemical and agricultural fertilizers is an effective method of monitoring the quality of drinking water. Such investigations are needed to identify possible sources of contamination of storage tanks and pipelines to ensure the delivery of safe drinking water to end-users.

Keywords: Heavy Metals; Northeastern Region; Springs and Groundwater Wells.

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التأثير الحيوي لأعشاب تبن البحر *Posidonia oceanica* على بعض أنواع من الميكروبات الممرضة

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المستخلص : : تمتاز السواحل الليبية مقارنة بغيرها بانخفاض مستويات التلوث مما جعلها بيئة جيدة للتنوع البحري، وخاصة الأعشاب البحرية، والتي قد تعد مصدراً لمركبات جديدة نشطة بيولوجياً في مقاومة الميكروبات، لذلك أجريت الدراسة الحالية بهدف اختبار التأثير الحيوي لمستخلصات أوراق وريزومات أعشاب تبن البحر *Posidonia oceanica* (المائي والايثانولي والأسيتوني) بعدة تراكيز (50، 100، 150) ملغم/ مل ضد ثلاثة أنواع من البكتيريا الممرضة (*Escherichia coli*، *Staphylococcus arueus*، *Pseudomonas aeruginosa*) وفطر (*Candida spp.*)، واختبار حساسيتها بطريقة الأقراص. بينت النتائج أن مستخلصات أعشاب تبن البحر تمتلك فاعلية تثبيطية جيدة ضد بكتيريا *S.aureus* وفطر *Candida spp.*، وأن التركيز 150 ملغم / مل هو الأكثر فاعلية للمستخلصات جميعها، كما أشارت النتائج أن مستخلصات الرايزومات أكثر كفاءة من مستخلصات الأوراق، وأن المستخلص الأسيتوني هو الأفضل في تثبيط الميكروبات المختبرة، وأن بكتيريا *Escherichia coli* و *Pseudomonas aeruginosa* هي الأكثر مقاومة للمستخلصات بمختلف أنواعها وتراكيزها.

الكلمات المفتاحية : مكون التنسيق. قلم المدقة؛ التصميم. إدراج (كلمات رئيسية)

المقدمة

تعد ليبيا من الدول التي تعاني من ظاهرة سوء استخدام المضادات الحيوية مما أدى إلى ظهور سلالات ميكروبية مقاومة لهذه المضادات (Atia، 2018)، لذا تم البحث عن بدائل علاجية طبيعية (Abdulrraziq وSalih، 2020)، ونظراً لاستنفاد معظم الموارد البرية، وخاصة النباتات الطبية تم التوجه إلى استخدام الموارد البحرية بصفتها مصدر محتمل لمركبات علاجية جديدة (Mayer وآخرون، 2007).

تعد الأعشاب البحرية من ضمن الأنواع الأساسية في النظم البيئية الساحلية، حيث تلعب دوراً مهماً في دورة المغذيات وحماية الساحل من التآكل، كما أنها توفر بيئة لتكاثر الأسماك، واللافقاريات المائية، ويعد وجودها دليلاً على انخفاض نسبة التلوث (Ettinger وEisen، 2019 ; Lamb وآخرون، 2017)، وتحتوي على مركبات نشطة تعمل كمضادات للأكسدة، والالتهابات، ومانعة للتخثر، وعلاج للقرحة (Valentina وآخرون، 2015)، ولها قيمة غذائية عالية حيث تسوق بعض أنواعها كمنتجات عالمية بالإضافة لاستخدامها كمواد حافظة للأطعمة (McHugh، 2003)، وتصنف أعشاب تبن البحر *Posidonia oceanica* من ضمن الأعشاب البحرية المستوطنة في السواحل الليبية (Ezziany وآخرون، 2015)، تنتمي إلى عائلة Posidoniaceae والتي تضم تسعة أنواع محصورة بالكامل في منطقة حوض البحر الأبيض المتوسط (Larkum، 2006)، وهي نباتات بحرية زهرية بطيئة النمو طويلة العمر تشكل مروجاً واسعة، وتفقد أوراقها خلال فصل الخريف، وتتراكم كمخلفات على الشواطئ (Piva وآخرون، 2017)، تنمو بعمق يصل إلى 45م، وتوجد في المياه النقية بسبب

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حساسيتها العالية للتلوث (Cozza وآخرون، 2004).

أجريت دراسات عديدة في مختلف أنحاء العالم عن الفاعلية التثبيطية للأعشاب البحرية في مجال المكافحة الحيوية، حيث أشارت دراسة في الهند إلى وجود فاعلية تثبيطية لسبعة أنواع من الأعشاب البحرية ضد البكتيريا السالبة (Shanmughapriya وآخرون، 2008)، كما أكدت دراسة أجريت في نيجيريا إلى إمكانية استخدام العديد من الأعشاب البحرية في القضاء على السلالات البكتيرية المقاومة للمضادات الحيوية (Agbaje-Daniels وآخرون، 2020)، ولم تحظَ عشبة تبن البحر *Posidonia oceanica* باهتمام كبير في هذا المجال، مع أنه تم الإشارة إليها من قبل Berfad وزملاؤه (2013) و(2014) بأنها تمتلك نشاطاً تثبيطياً ضد بكتيريا *Staphylococcus arueus*، *Pseudomonas aeruginosa*، وفطر *.Pythium spp*، *Aspergillus flavus*.

أجريت هذه الدراسة في معمل كلية التربية/جامعة عمر المختار/ البيضاء/ ليبيا بهدف اختبار تأثير مستخلصات أوراق وريزومات أعشاب تبن البحر *Posidonia oceanica* بتراكيز مختلفة على بعض الأنواع من الميكروبات الممرضة للإنسان.

المواد وطرق البحث

الجمع والإعداد: جمعت عينات أعشاب تبن البحر الطازجة (أوراق وريزومات) من شواطئ منطقة الحمامة شمال مدينة البيضاء/ الجبل الأخضر/ ليبيا، وصنفت في قسم الأحياء/ كلية التربية/ جامعة عمر المختار، ونظفت من الرمال والعوالق، وغسلت بالماء المقطر لإزالة آي أثر للملح، وجففت بشكل طبيعي لمدة 48 ساعة، وطحنت بواسطة مطحنة كهربائية وحفظت لحين الاستعمال.

تحضير المستخلصات: أذيبت 5 جرامات من مسحوق أعشاب تبن البحر (أوراق وريزمات) كل على حدة في 100مل من الماء المغلي بدرجة 100م°، ووضعت على حاضنة هزاز لمدة 24 ساعة، ثم رشحت بواسطة الشاش للتخلص من الأجزاء الكبيرة، ثم رشح المحلول بواسطة أوراق ترشيح (0.22 um)، بعدها بخر الراشح بواسطة جهاز المبخر الدوار للحصول على المسحوق الجاف للمستخلص، وحفظ في الثلاجة بدرجة حرارة 4م° لحين الاستعمال (Alshalmani وآخرون، 2014).

- ولتحضير المستخلص (الايثانولي – الأسيتوني) استخدمت الطريقة السابقة نفسها مع استبدال الماء الساخن بالايثانول والأسيتون كل على حدة.
- حضر المحلول الأساسي بتركيز 150 ملغم / مل بإذابة 1.5جم من المسحوق الجاف في 10 مل ماء مقطر، ومنه حضرت التراكيز الأخرى 50، 100 ملغم / مل باستخدام قانون التخفيف.

العزلات الميكروبية: تم الحصول على عزلات معرفة ومشخصة مسبقاً لإصابات مختلفة من مختبر الرازي للتحاليل الطبية / مدينة البيضاء هي (***Escherichia coli***، *Staphylococcus aureus*، *Pseudomonas aeruginosa*، *Candida spp.*).

اختبار حساسية الميكروبات لمستخلصات أعشاب تبن البحر: تم إجراء الاختبار بطريقة الأقراص Disk diffusion method، حيث زرعت الميكروبات على وسط Mueller-Hinton agar، ثم وضعت أقراص مشبعة بمستخلصات أعشاب تبن البحر بقطر 6ملم وبمسافات متساوية، واستخدمت أقراص مشبعة بالماء الساخن والايثانول والأسيتون كشاهد، وحضنت الأطباق لمدة 24 ساعة بدرجة حرارة 37م، وتم قياس أقطار مناطق التثبيط الخالية من النمو الميكروبي منقوصا منها أقطار الأقراص للمستخلصات.

تصميم وتحليل البيانات: تم تصميم تجارب الدراسة المعملية وفق التصميم كامل العشوائية Completely Randomized Design (CRD)، وأجريت عملية التحليل الإحصائي باستخدام برنامج (Minitab17) لتحليل تباين (ANOVA)،

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وتم إجراء المقارنة بين المتوسطات باستخدام اختبار (Tukey's) عند P<0.05.

النتائج

اختبرت فاعلية مستخلصات أوراق وريزومات أعشاب تبن البحر (المائية والايثانولية والأسيتونية) ضد بعض أنواع من الميكروبات الممرضة للإنسان المعزولة من إصابات مختلفة، وبعد قياس أقطار التثبيط، بينت النتائج أن هناك تبايناً واضحاً في الفاعلية التثبيطية لمستخلصات الأوراق والريزومات ضد هذه الميكروبات تبعاً لنوع الميكروب ونوع المستخلص والتركيز ونوع الجزء المستخدم.

مستخلصات الأوراق: أظهرت النتائج من الجدول (1) أن جميع مستخلصات الأوراق المستخدمة بكافة التراكيز لم يكن لها تأثير إيجابي ضد الأنواع البكتيرية المختبرة باستثناء بكتيريا *S.aureus*، حيث سجل التركيز 100ملغم/مل للمستخلص الأسيتوني قطر تثبيط (0.9) ملم، وأعطى التركيز 150ملغم/مل أقطار تثبيطية بمعدل (2.0، 3.3، 4.5) ملم للمستخلص المائي والايثانولي والأسيتوني على التوالي، أما فطر *Candida spp.* يلاحظ عدم وجود أي تأثير تثبيطي للتركيزين 50، 100ملغم/مل للمستخلص المائي والايثانولي، وسجل المستخلص الأسيتوني أقطار تثبيط (1.9، 2.6) ملم للتركيزين 50، 100ملغم/مل على التوالي، وازدادت الفاعلية التثبيطية للمستخلصات بزيادة التركيز حيث سجل التركيز 150ملغم/مل أعلى أقطار تثبيط بلغت (2.5، 3.7، 6.0) ملم للمستخلص المائي والايثانولي والأسيتوني على التوالي.

جدول(1): معدلات أقطار التثبيط مقاسة بالمليمتر لمستخلصات أوراق تبن البحر (المتوسط± الانحراف المعياري).

المستخلص / الميكروب		*E.coli*	*S.aureus*	*Ps.aeruginosa*	*Candida spp.*
الشاهد		-	-	-	-
المائي ملغم/مل	50	-	-	-	-
	100	-	-	-	-
	150	-	2.0±0.0c	-	2.5±0.2c
الايثانولي ملغم/مل	50	-	-	-	-
	100	-	-	-	-
	150	-	3.3±0.3b	-	3.7±0.5b
الأسيتوني ملغم/مل	50	-	-	-	1.9±0.0c
	100	-	0.9±0.1d	-	2.6±0.1c
	150	-	4.5±0.4a	-	6.0±0.7a

الأحرف المختلفة توجد بينها فروق معنوية ضمن نفس النوع البكتيري عند مستوى 0.05%.

مستخلصات الريزومات: أظهرت النتائج من الجدول (2) أن جميع مستخلصات الريزومات المستخدمة بكافة التراكيز لم يكن لها نشاط تثبيطي تجاه بكتيريا *E.coli* و*Ps.aerginosa* باستثناء التركيز 150ملغم/مل للمستخلص الأسيتوني بقطر تثبيط (1.6، 1.0) ملم على التوالي، ولوحظ تأثر بكتيريا *S.aureus* بجميع التراكيز فيما عدا التركيز 50ملغم/مل للمستخلصين المائي والايثانولي، وسجل المستخلص الأسيتوني لهذا التركيز قطر تثبيط (1.8) ملم، بينما سجل التركيز 100ملغم/مل فاعلية تثبيطية جيدة بأقطار (1.5، 2.0، 3.5) ملم للمستخلص المائي والايثانولي والأسيتوني على التوالي، في حين تفوق التركيز 150 ملغم / مل لمستخلصات الريزومات في إعطاء أفضل المعدلات

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التثبيطية على جميع التراكيز السابقة، حيث سجل أقطار تثبيط بمعدلات (3.7، 5.3. 6.5) ملم للمستخلص المائي والايثانولي والأسيتوني على التوالي، كما أشارت النتائج إلى الحساسية العالية لفطر *Candida spp.* لأغلب التراكيز لجميع المستخلصات بأقطار تثبيط تراوحت ما بين (2.6-7.5) ملم، كان أفضلها للمستخلص الأسيتوني بتركيز 150ملغم/مل.

جدول(2): معدلات أقطار التثبيط مقاسة بالمليمتر لمستخلصات ريزومات تبن البحر (المتوسط± الانحراف المعياري).

المستخلص / الميكروب		*E.coli*	*S.aureus*	*Ps.aeruginosa*	*Candida spp.*
الشاهد		-	-	-	-
المائي ملغم/مل	50	-	-	-	-
	100	-	1.5±0.0 d	-	d22.8±0.
	150	-	3.7±0.3 c	-	4.0±0.0 c
الايثانولي ملغم/مل	50	-	-	-	-
	100	-	2.0±0.1 d	-	3.0±0.3 d
	150	-	5.3±0.4 b	-	6.2±0.5 b
الأسيتوني ملغم/مل	50	-	1.8±0.2 d	-	2.6±0.1 d
	100	-	3.5±0.0 c	-	5.7±0.4 b
	150	1.6±0.1a	6.5±0.5 a	1.0±0.0 a	7.5±0.5 a

الأحرف المختلفة توجد بينها فروق معنوية ضمن النوع البكتيري نفسه عند مستوى 0.05%.

المناقشة

يعد التنوع البيولوجي البحري الليبي غير مستكشَف جزئياً من حيث أنشطته الحيوية (Alshalmani وآخرون، 2014)، ولقلة الأبحاث المتداولة حول الأنشطة الحيوية لأعشاب تبن البحر تم إجراء هذه الدراسة التي أظهرت أن مستخلصات أعشاب تبن البحر تمتلك نشاطاً تثبيطياً جيداً تجاه *S.aureus* وفطر *candida sp.* في حين لم يكن لها تأثير واضح تجاه بكتيريا *E.coli* و*Ps.aeruginosa* واتفقت هذه النتيجة مع (Berfad وAlnour، 2014 ; Benito-Gonzalez وآخرون، 2019 ; Berfad وآخرون، 2013)، بأن مستخلصات أعشاب تبن البحر تمتلك فاعلية تثبيطية عالية حالت دون نمو العديد من البكتيريا والفطريات، واختلفت هذه النتيجة مع ما وجده (Orhan وآخرون، 2003) بأن المستخلص الخام لأعشاب تبن البحر لا تمتلك أي تأثير تثبيطي ضد البكتيريا، كما اختلفت هذه النتائج مع ما أشار إليه (Berfad وAlnour، 2014) بأن بكتيريا *Ps.aeruginosa* كانت ذات حساسية عالية لأعشاب تبن البحر بأقطار تثبيط (12 و9) ملم لمستخلصي الكلوروهكسان والايثانول على التوالي، ويرجع سبب التباين في القدرة التثبيطية لمستخلصات أعشاب تبن البحر إلى اختلاف أنواع السلالات المختبرة، وطريقة الاستخلاص، والمركبات الفعالة المذابة (Alnamer وآخرون، 2013)، كما أظهرت النتائج أن مستخلصات الريزومات أكثر كفاءة من مستخلصات الأوراق واتفقت هذه النتيجة مع ما وجده (Lee وآخرون، 2016) عند استخدامه ريزومات، وأوراق نوع من الأعشاب البحرية *Zostera marina* ضد بعض الأنواع الميكروبية، وكان المستخلص الأسيتوني هو الأكثر فاعلية من المستخلص المائي والايثانولي في تثبيط الميكروبات المختبرة، وهذا يتفق مع ما أشار إليه (Berfad وAlnour، 2014) بأن الأسيتون من أفضل المذيبات في استخراج المركبات الكيميائية لأعشاب تبن البحر، وكان التركيز 150 ملغم / مل هو الأكثر فاعلية لجميع المستخلصات، وقد ترجع الفاعلية التثبيطية لأعشاب

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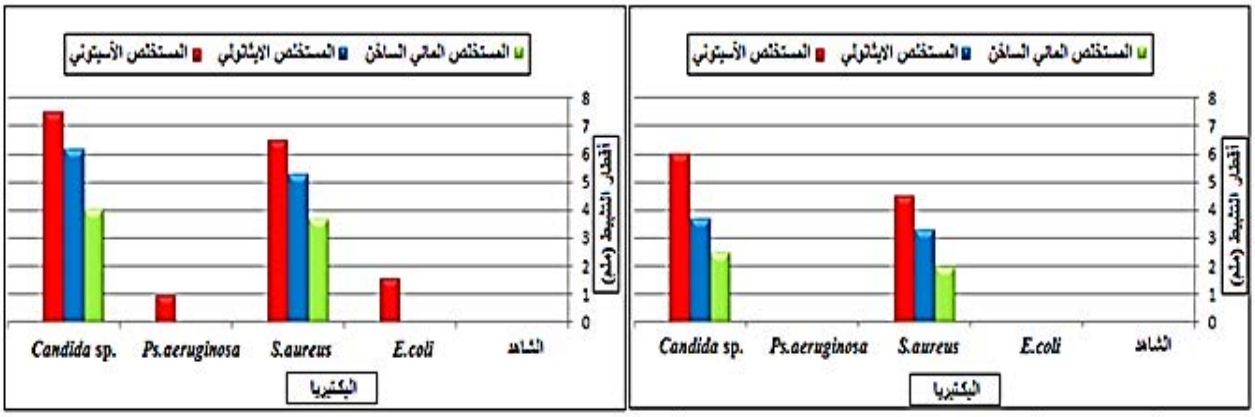
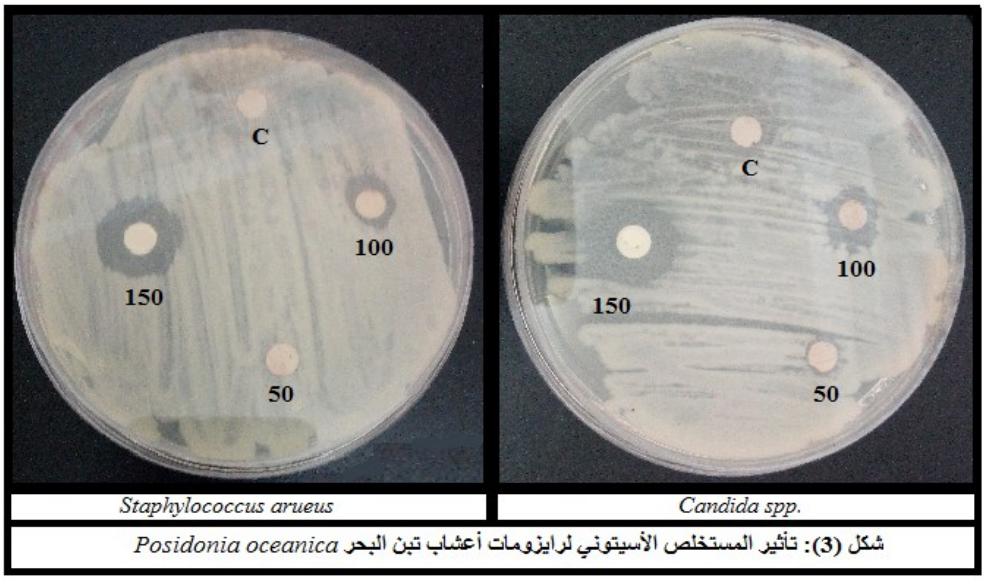
تبن البحر لاحتوائها على alkaloids، flavanoides، phenols، tannins، saponins، phlobatannins، sterols، resins، p-Coumaric acid، Chicoric acid، Ferulic acid، Gentisic acid، Cinnamic acid والتي لها نشاط في قمع النمو الميكروبي (Haznedaroglu وZeybek، 2007 ; Berfad و Alnour، 2014).



شكل (1): تأثير مستخلصات (أوراق) تبن البحر بتركيز 150 ملجم/مل على بعض أنواع من الميكروبات

شكل (2): تأثير مستخلصات (ريزومات) تبن البحر بتركيز 150 ملجم/مل على بعض أنواع من الميكروبات



شكل (3): تأثير المستخلص الأسيتوني لرايزومات أعشاب تبن البحر *Posidonia oceanica*

الخلاصة

نستنتج من هذه الدراسة أنه يمكن استخدام مستخلصات الأعشاب البحرية كمضادات للميكروبات وخاصة أعشاب تبن البحر لامتلاكها أنشطة فعالة ضد بكتيريا *S.aureus* وفطر *Candida spp.*، لذا يوصي البحث بإجراء المزيد من الدراسات على الأنواع المختلفة من الأعشاب البحرية الموجودة على الشواطئ الليبية، والاهتمام بإمكانية استخدامها كمصدر جديد للمركبات ذات الأنشطة البيولوجية المتنوعة، وخاصة في مجال المكافحة الحيوية.

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نتقدم بخالص الشكر والتقدير إلى العاملين بمعمل الرازي للتحاليل الطبية– البيضاء، وإلى قسم الأحياء بكلية التربية– جامعة عمر المختار.

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Biological Effect of *Posidonia oceanica* Seaweed on Some Pathogenic Microbes

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Abstract: Compared to other coasts, Libyan coasts are characterized by low levels of pollution. This makes them a suitable environment for marine diversity, especially seaweeds, which may be considered a source of new compounds that are biologically active in their resistance to microbes. Therefore, the present study was conducted with the aim of testing the bioactivity of leave and rhizome extracts of *Posidonia oceanica* seaweed (aqueous, ethanol, and acetone) at concentrations (50, 100, and 150) mg/ml against three types of pathogenic bacteria (*Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*), and fungus (*Candida spp.*), by a sensitivity test in the form of a disk diffusion method. The results showed that Posidonia oceanica seaweed extracts have good inhibitory activity against *S.aureus* and *Candida spp.*, and that the concentration of 150 mg/ml is the most effective for all extracts. The results also indicated that rhizome extracts are more efficient than leaf extracts, and the acetone extract is the best in inhibiting the tested microbes. Also, *Escherichia coli* and *Pseudomonas aeruginosa* are the most resistant to all extracts, regardless of type and concentration used.

Keywords: *Posidonia oceanica*, Biological Effect, Pathogenic Microbes.

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تطبيق أفضل التقنيات لخفض نسبة فطريات التخزين المحمولة في بذور الفول السوداني *Arachis hypogaea*

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المُسْتخلص : أُجريت الدراسة خلال الموسم 2019-2020 بهدف اختبار كفاءة بعض تقنيات المعالجة لإبادة أو خفض نسبة التكرار بفطريات التخزين *Aspergillus flavus*، و *A. niger*، و *Penicillium italicum* الملوثة طبيعياً لبذور الفول السوداني. عُوملت عينة البذور بالنقع في الماء الساخن (50م°، 60م°، 70م°)، والنقع في الماء المالح بتركيزات 10%، 15%، 20%، والتحميص بالفرن العادي عند 150م° لمدة 10، 20، 30 دقيقة، والتحميص بفرن الميكروويف عند 100م° لمدة 1، 3، 5، 7 دقائق، وقُدِرت نسبة تكرار ظهور الفطريات في البذور المُعالجة بالتحضين في الوسط المغذي آجار البطاطس والسكروز (PSA). أشارت النتائج إلى كفاءة كل التقنيات المُسْتخدمة في خفض تكرار الفطريات في البذور المُعَالجة، كما كان الفطر *P. italicum* أكثر الفطريات حساسية تحت التقنيات جميعها، وأثبتت الدراسة تفوق المُعَالجة بالتحميص في الميكروويف على باقي التقنيات، حيث قتلت كل الفطريات المحمولة في البذرة بنسبة 100% عند الزمن 5دقائق.

الكلمات المفتاحية: الماء الساخن، الماء المالح، الحرارة الجافة، الميكروويف، الفطريات المحمولة بالبذور، الفول السوداني.

المقدمة

تُعد كثير من المحاصيل الزراعية والمواد الغذائية والأعلاف أوساطا غذائية ملاءمة لنمو الفطريات التي تلوثها بالإضافة إلى قدرة بعضها على إنتاج السموم (Youssef وآخرون، 2012)، و بذور الفول السوداني (*Arachis hypogaea* L.) واحدة من المواد الغذائية المُعَرضة للإصابة بالفطريات المُنْتجة لهذه السموم، حيث يواجه الفول السوداني مشاكل كثيرة أثناء الجني وبعد التخزين، والنقل من أهمها الإصابة بمجاميع الفطريات *Aspergillus* و *Penicillium* و *Fusarium* المُنْتجة للسموم (القاضي والجالي، 2020)، ونظراً لما تشكله الفطريات المُنتجة للسموم من خطورة على صحة الإنسان والحيوان بسبب تأثيراتها المسرطنة، وانتقال سمومها عبر السلسلة الغذائية، أُجريت دراسات عديدة بهدف التقليل من التلوث الميكروبي في المحاصيل الزراعية ونواتجها الغذائية عن طريق تطبيق بعض المُعَالجات للقضاء على الميكروبات المحمولة بالبذرة سواء على سطحها أو بداخلها (Agrios, 2005 ؛ عبد العالي، 2016). تُعد المُعَالجة بالماء الساخن من الطُرق التي سجلت نجاحاً في دراسات عديدة، حيث ثبت بالتجربة كفاءة مُعَاملة النقع في الماء الساخن ضد *Alternaria* ، *Curvularia* spp. ، *Fusarium* spp. *Bipolaria* و *Colletotrichum graminicola* ، spp. spp. على بذور الذرة السكرية، وزاد في إنبات البذور وتطور النباتات الناتجة عنها (Masum وآخرون، 2009)، كما أوضح Farahani و Chaichi (2012) أن نقع بذور الشعير في الماء الساخن عند 50م° لمدة 30دقيقة خفض معنوياً spp *Penicillium*، spp *Alternaria* و *Fusarium* spp. نتائج واعدة تحصل عليها Agusti-Brisach وآخرون (2012) بخفض الفطر *Fusarium circinatum* في بذور الصنوبر *Pinus radiate* بعد نقعها في الماء الساخن 51-52°م لمدة 30دقيقة. عن استخدام المُعَالجة بالنقع في الماء المالح أُجريت عدة دراسات استندت

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على استخدام ملح الطعام أو ملح المائدة المعروف كيميائياً بكلوريد الصوديوم (NaCl) في خفض نسبة نقل الفطريات بالبذور، ففي دراسة عن الفطريات المُلوثة لبذور الفول السوداني المُمَلحة وغير المُمَلحة وجد Rostami وآخرون (2009) أن تمليح البذور خفض كثيراً من كثافة الفطريات المحمولة بالبذور وأنها يُمكن أن تُستعمل في وقاية البذور في المخزن، كما استخدم Enikuomehin (2010) ملح الطعام بتركيزات 2% ، 5% ، 10% و 15% في فرز البذور السليمة، والمصابة لصنفين من السمسم بالإضافة إلى خفض نسبة التلوث بالفطريات التي تحملها، وبينت التجربة أن البذور غير المنقوعة في محلول الملح احتوت نسبة عالية من الفطريات مُقارنةً بالبذور المُعَاملة.

التحميص بالفرن العادي أو التعريض للحرارة الجافة معروفة للقضاء على الميكروبات المحمولة داخل البذور، حيث تم تلقيح بذور القطن صناعياً بالفطر *Fusarium oxysporum visinfectum* وعُرِضت لدرجة حرارة 60°م ، 70°م ، 80°م لمدة 2- 14يوما، وأكدت النتائج نجاح درجات الحرارة المُرْتفعة في خفض الفطر داخل البذرة (Bennett و Colyer، 2010). كما تم القضاء على الفطر *Bipolars sorokiniana* عند تعريض بذور الشعير للحرارة الجافة 90م° لمدة ساعة (Couture و Sutton، 1980)، وأثبت Umechuruba وآخرون (2013) أنه بتعريض بذور *Solanum gil* لدرجات حرارة 90م° لمدة 20، 40، و60ثانية تم التخلص من الفطريات المحمولة بها، واستطاع Yanxia وآخرون (2016) إبادة الفطريات *Cladosporium cucumerinum*، *Colletotrichum orbiculare* و *Didymella bryoniae* داخل بذور الخيار وعلى سطحها بعد تعريضها لدرجة 70م° لمدة 40- 120 دقيقة. عن التحميص بفرن الميكروويف، درس كل من Basaran و Akhan (2010) تأثير المُعَاملة بالميكروويف على بذور البندق hazelnuts الملوثة صناعياً بالفطر *A. parasiticus* في كثافة الفطر، وسجلا حدوث انخفاض معنوي بعد التعرض لمدة 60ثانية، و يزداد الانخفاض بزيادة درجة الحرارة واقترابها من 50- 55م لمدة 120ثانية.

وفي دراسة أخرى اختبر Knox وآخرون (2013) التأثير الإبادي لاستخدام الميكروويف لمدة 0، 15، 30 و45ثانية في خفض كمية الحمل الجرثومي في بذور القمح، ووجد أن المُعَاملة خفضت معنوياً أعداد الفطريات المُترممة والمُمْرضة مثل spp *Fusarium* و *Microdochium nivale* في البذور، وأظهرت نتائج تعريض بذور البازلاء السليمة والمصابة لطاقة الميكروويف انخفاض تكرار الفطريات في البذور المصابة، والسليمة ظاهرياً (عبد العالي، 2016)، وفي بحث آخر أُجري من قبل Motallebi (2016) قام فيها بتعريض البذور الزيتية لمحاصيل فول الصويا، دوار الشمس، و الكانولا لطاقة الميكروويف لدراسة تأثيرها على حيوية البذرة وبقاء الفطر *A. niger* ، أثبتت النتائج أن الطاقة الحرارية المُنْتجة قتلت جراثيم الفطر.

و نظراً للأهمية الغذائية لمحصول الفول السوداني، أجريت الدراسة بهدف استخدام بعض تقنيات المُعَالجة مثل النقع في الماء المالح، والنقع في الماء الساخن، والتحميص (الحرارة الجافة) بالفرن العادي وفرن الميكروويف في خفض نسبة تكرار الفطريات المحمولة في بذور الفول السوداني.

مواد وطرائق البحث

مصدر العينة: استخدم في هذه الدراسة عينة من بذور الفول السوداني صنف Landraces، تم شراؤه من السوق المحلية، وثبت تلوثه بفطريات التخزين المُنْتجة للسموم *A. flavus*، *A. niger* و *P. italicum* (القاضي والجالي، 2020) كما في الشكل (1).

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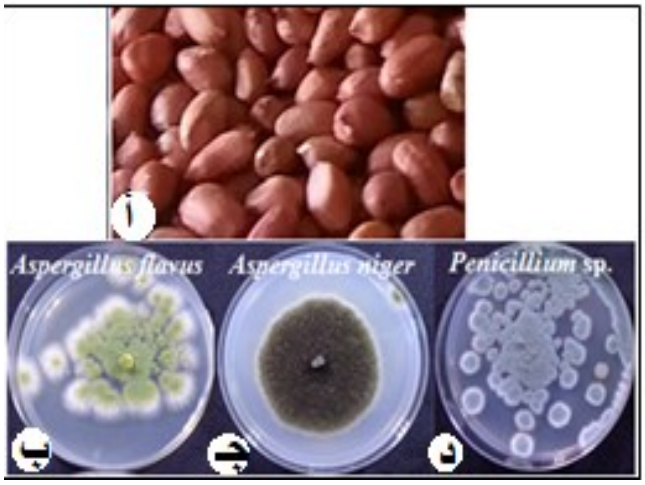

شكل(1): أ: بذور الفول السوداني صنف Landraces، B: فطريات التخزين المعزولة من البذور (ب: *A. flavus* ، جـ: *A. niger* ، د: *P. italicum*)

طرائق المُعَالجة

الماء الساخن Hot Water: نُقِعت عينة عشوائية (150 بذرة) في ماء الصنبور لمدة 5 ساعات لحث أو تحفيز الفطر الساكن داخل البذرة على النمو، ثم غُمِرت في حمام مائي ساخن درجة حرارته 50م°، و60م°، و70م° لمدة 10 دقائق لقتل الميسليوم. وُضِعت البذور على ورق ترشيح، وتركت لتجف تماما (Masum وآخرون، 2009).

الماء المالح Salt Water : عُوملت 150 بذرة بنقعها في محلول ملح الطعام بالتراكيز 10 و15 و20% (وزن/حجم) لمدة ساعة، ثم تُركت على ورق ترشيح لتجف تماماً (Kazemi وآخرون، 2014).

التحميص العادي Ordinary Roasting: وُضِعت البذور في حاويات معدنية وجرى تحميصها في فرن كهربائي عادي في درجة حرارة 150°م لمدة 10، و20، و30دقيقة (شكل2). تم إخراج البذور من الفرن، وتركها لتبرد في درجة حرارة الغرفة (Ogunsanwo وآخرون، 2004).

شكل (2): تحميص بذور الفول السوداني بالفرن العادي في أزمنة مختلفة (أ: 10دقائق، ب: 20دقيقة، جـ: 30دقيقة)

التحميص بالميكروويف Microwave Roasting

استخدم فرن الميكروويف نوع Nikai (NMO-583) بقدرة 1400W– تردد 2450MHz. اختير عدد 150 بذرة بشكل عشوائي ووضعت في أطباق بتري زجاجية بقطر 9سم (شكل3) ونُقِلت إلى مركز الميكروويف على الطبق الدوار Tumtable. عُوِملت البذور بالحرارة الجافة القصوى 100م°، ثم أُخرجت من الفرن بعد 1، 3، 5 و7دقائق (Knox وآخرون، 2013)، وتُرِكت لتبرد.

شكل (3): تحميص بذور الفول السوداني بفرن الميكروويف في أزمنة مختلفة (أ: دقيقة، ب: 3دقائق، جـ: 5دقائق)

تقييم درجة التلوث: تَبِعَ عمليات المُعالجة السابقة تعقيم البذور سطحياً بمحلول هيبوكلوريت الصوديوم NaOCl تركيز 10%، لمدة 2دقيقة، ثم غُسِلت بالماء المُعَقم، وجُفِفت بورق الترشيح. وُزعت بمعدل 5بذور/ طبق على وسط أجار البطاطس والسكروز PSA (Potato Sucrose Agar) في 3 مكررات، وحُضِنت في درجة حرارة 25±2م° لمدة 5أيام

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لتشجيع ظهور الفطريات المحمولة بها. تم حساب نسبة تكرار الفطر بالمعادلة:

التكرار (%)= [عدد البذور المصابة بنوع الفطر/ العدد الكلي للبذور المختبرة] × 100 (Neha و Razia، 2013).

التحليل الإحصائي: نُفِذت الدراسة باستخدام التصميم العشوائي التام في تجربة عاملية من عاملين: العامل الأول ضم 4 معاملات لكل طريقة مُعَالجة، والعامل الثاني شمل 3 فطريات. النسب المئوية حُولت زاوياً قبل تحليلها إحصائيا باستخدام برنامج Co Stat واختبار LSD تحت مستوى المعنوية ($P \leq 0.05$) للمُقَارنة بين متوسطات المُعَاملات.

النتائج والمناقشة

أظهرت التجربة وجود اختلافات في نسب ظهور الفطريات باختلاف طرق المُعَالجة، حيث بينت نتائج نقع البذور في الماء الساخن (جدول1) انخفاض نسبة تكرار الفطريات في المستويات الثلاثة لدرجة الحرارة، فكانت 13.3% و 46.7% في بذور الشاهد للفطرين *A. flavus* و *A. niger* على الترتيب وانخفضت إلى 6.7% لكلا الفطرين تحت تأثير ارتفاع الحرارة من 50م° وحتى 70م°، مع عدم تسجيل وجود الفطر *P. italicum* عند درجة الحرارة نفسها. نتائج التحليل الإحصائي أشارت إلى تسجيل اختلافات معنوية في تأثير درجة الحرارة على وجود الفطر داخل البذرة. نجاح نقع بذور المحاصيل المختلفة في الماء الساخن لخفض المسببات المرضية الفطرية، البكتيرية وحتى الفيروسية لوحظ من قبل الباحثين في دراسات عديدة(Rahman وآخرون، 2008 ، عبد العالي، 2016). يُعزى انخفاض تكرار الفطريات في البذور إلى تأثير درجات الحرارة المُرتفعة التي تخترق طبقات البذرة وتقتل الفطريات الكامنة أعمق فيها، وتتسبب في فقدان الغشاء الخلوي لوظيفته الحيوية أو تحطيم المكونات السيتوبلازمية وتحلل الخلايا (De Maranon وآخرون، 1999)، كما لخص Baker (1962) تأثيرات الحرارة المُرتفعة في تغيير طبيعة الإنزيمات والبروتينات وإطلاق أو تحرير الدهون، وتختلف هذه الخصائص باختلاف المضيف والطفيل، والتي تضر بمكونات خلية الطفيل كالنواة، والريبوسومات والميتوكوندريا.

جدول(1): المعالجة بالنقع في الماء الساخن بدرجات حرارة مختلفة لمدة 10 دقائق

درجة الحرارة (م°)	*A. flavus*		*A. niger*		*P. italicum*	
	*	التكرار (%)	*	التكرار (%)	*	التكرار (%)
0	2	13.3 (21.39)	7	46.7 (43.11)	7	46.7 (43.11)
50	1	6.7 (15.00)	3	20.0 (26.56)	1	6.7 (15.00)
60	1	6.7 (15.00)	1	6.7 (15.00)	0	0.0
70	1	6.7 (15.00)	1	6.7 (15.00)	0	0.0
LSD at 5%	الحرارة: 6.8 الفطريات: NS الحرارة × الفطريات: NS					

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*: عدد البذور المصابة بالفطر

الأرقام بين القوسين النسبة المؤية للتكرار محولة زاويا

NS: Non Significant (لا توجد فروق معنوية).

نجح تطبيق أسلوب مُعَالجة البذور بالنقع في تركيزات مختلفة من كلوريد الصوديوم 0% ، 10% ، 15% و20% في خفض وجود الفطريات معنوياً(جدول2)، فكانت نسبة الإصابة 13.3% في بذور الشاهد، وانخفضت إلى 6.7% للفطر *A. flavus* ، وكانت 46.7% لكلا الفطرين *A. niger* و *P. italicum* في بذور الشاهد، واختفى تماما (0%) ظهورهما في البذور المعاملة بالتركيز 20%، وهذا يتفق مع نتائج دراسات أخرى أشارت إلى كفاءة التركيزات العالية من محلول NaCl في خفض نسبة الإصابة بالفطر *A. flavus* في بذور الذرة (Thamaboripat وآخرون، 1992)، وفطريات *Cercospora cruenta* و *S. vignicola* في بذور الأرز (Kawube وآخرون، 2005)، والفستق الملوث بالفطرين *A. flavus* و *A. niger* (Nawar، 2008)، بسبب أن المحلول الملحي يحدث تغيرات مورفولوجية على الفطر تقود إلى تغيرات فسيولوجية تؤثر على النمو (Aboul-Nasr،

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2014)، كما أن التركيز 20% ثبط نمو الفطر *A. niger* بنسبة 100% ويتطابق هذا مع ما ذكره Nawar (2008) عن فعالية كلوريد الصوديوم في تثبيط نمو الفطرين *A. flavus* و*A. niger* بنسبة 100%.

جدول (2): المعالجة بالنقع في تركيزات مختلفة من الماء المالح لمدة ساعة

التركيز %	*A. flavus*		*A. niger*		*P. italicum*	
	التكرار (%)	*	التكرار (%)	*	التكرار (%)	*
0	13.3 (21.39)	2	46.7 (43.11)	7	46.7 (43.11)	7
10	20.0 (26.56)	3	13.3 (21.39)	2	13.3 (21.39)	2
15	6.7 (15.00)	1	0.0	0	13.3 (21.39)	2
20	6.7 (15.00)	1	0.0	0	0.0	0
LSD at 5%	التركيز: 6.3 الفطريات: NS التركيز × الفطريات: 10.9					

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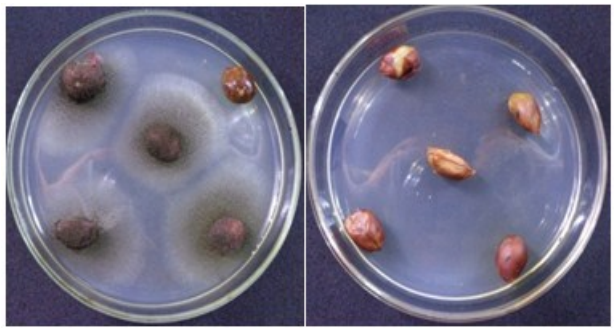
الأرقام بين القوسين النسبة المؤية للتكرار محولة زاويا

NS: Non Significant (لا توجد فروق معنوية).

حققت مُعَاملة تحميص بذور الفول السوداني الملوثة طبيعياً بفطريات التخزين باستخدام الفرن العادي وفرن الميكروويف اختلافات ظاهرية في فعالية كلا الطريقتين (شكل4)، حيث كانت البذور خالية تماماً من الفطريات بعد تحميصها بالميكروويف (100م° لمدة 5د)، وتحضينها على الوسط الملائم للنمو، في حين تمكن الفطر *A. niger* من الظهور على البذور التي جرى تحميصها في الفرن العادي (150م° لمدة 30 د).



شكل (4): تحضين البذور بعد المعالجة. على اليمين (فرن الميكروويف 100م° لمدة 5د) وعلى اليسار (الفرن العادي (150م° لمدة 30د)

أشارت النتائج المُدونة في الجدول (3) إلى أن تعريض البذور لدرجة الحرارة 150م° تحت أزمنة مختلفة قللت معنوياً من وجود الفطريات وكان التحميص لمدة 3دقائق الأفضل في خفض نسبة تكرار الفطرين *A. flavus* و *P. italicum*، في حين لم تتأثر نسبة تكرار الفطر *A. niger* تحت المعاملة نفسها، حيث سجل وجوده بنسبة 26.7%. نتائج مطابقة أوردها Bennett و Colyer (2010) عند معاملة بذور القطن بالحرارة الجافة 70°م ، 80°م و90°م لم تقضي تماماً على الفطر *Fusarium ox.* f. sp. *vasinfectum* في البذور بالرغم من انخفاض نسبة الإصابة، وفي دراسة أخرى سجل Alam وآخرون، (2014) إبادة كاملة للفطرين *Colletotricum capsici* و *F. Moniliforme* إضافة إلى خفض وجود *Curvularia lunata* و *Rhizopus stolonifer* في حين لم يتأثر وجود الفطر *A. flavus* تحت درجة الحرارة نفسها.

جدول (3): المعالجة بالتحميص بالفرن العادي (150م°)

الزمن (دقيقة)	*A. flavus*		*A. niger*		*P. italicum*	
	التكرار (%)	*	التكرار (%)	*	التكرار (%)	*
0	13.3 (21.39)	2	46.7 (43.11)	7	46.7 (43.11)	7
10	6.7 (15.00)	1	46.7 (43.11)	7	13.3 (21.39)	2
20	6.7 (15.00)	1	0.0	0	6.7 (15.00)	1
30	0.0	0	26.7 (31.11)	4	0.0	0
LSD at 5%	الزمن : 8.1 الفطريات: NS الزمن × الفطر: NS					

القيم في الجدول متوسط 3 مكررات

*: عدد البذور المصابة بالفطر

الأرقام بين القوسين النسبة المؤية للتكرار محولة زاويا

NS: Non Significant (لا توجد فروق معنوية).

بينت نتائج استخدام التحميص بالميكروويف في درجة حرارة 100م° لفترة زمنية 1 ، 3 ، 5دقائق خفض التلوث الطبيعي بالفطريات (جدول4) واختفاء الفطر *A. flavus* تحت جميع

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الأزمنة، في حين سجل اختفاء ظهور الفطر *A. niger* عند 3د و5د، وأقتصر الظهور على الفطر *P. italicum* بتكرار بلغ 6.7% بعد مرور 3د من التحميص. كان زمن التحميص لمدة 5دقائق كافياً للقضاء على الأنواع الثلاثة للفطريات، في حين تحولت البذور إلى زيت بعد مرور 7دقائق من التحميص عند درجة الحرارة نفسها. أشارت نتائج التحليل الإحصائي إلى وجود اختلافات معنوية بين أزمنة التحميص وتأثيرها على وجود الفطر، كما ظهرت الاختلافات المعنوية كذلك بين الفطريات تحت المعاملة نفسها. نتائج مطابقة تحصل عليها More وآخرون (1992) ذكر فيها أن درجة الحرارة 90°م أو أكثر بقليل كانت كافية للقضاء على الفطريات *A. candidus*، *A. niger*، *Eurotium* spp. و*Penicillium* spp. في بذور السورجم.

جدول (4): المعالجة بالتحميص بفرن الميكروويف (100م°)

الزمن (دقيقة)	*A. flavus*		*A. niger*		*P. italicum*	
	*	التكرار (%)	*	التكرار (%)	*	التكرار (%)
0	2	13.3 (21.39)	7	46.7 (43.11)	7	46.7 (43.11)
1	0	0.0	1	6.7 (15.00)	3	20.0 (26.56)
3	0	0.0	0	0.0	1	6.7 (15.00)
5	0	0.0	0	0.0	0	0.0
7	–	–	–	–	–	–
LSD at 5%	الزمن : 4.7 الفطريات: 4.1 الزمن × الفطر: NS					

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*: عدد البذور المصابة بالفطر

الارقام بين القوسين النسبة المؤية للتكرار محولة زاويا

NS: Non Significant (لا توجد فروق معنوية).

–: عدم اتمام الكشف عن الفطريات بسبب تحول البذور الى زيت

في دراسة أخرى أجراها Motallebi (2016) أثبت فعالية طاقة الميكروويف في قتل جراثيم الفطر *A. niger* في بذور بعض المحاصيل الزيتية. دراسات عديدة وثقت فعالية استخدام الميكروويف في السيطرة على فطريات البذرة (Borgen، 2004 ؛ Basaran و Akhan، 2010؛ Knox وآخرون، 2013). ذكر Copson (1975) أن فعالية الميكروويف في إبادة الفطريات المحمولة في البذور تكمن في أن حرارة الميكروويف تمزق خلايا الميكروبات مباشرة، في حين عزى Mohapatra وآخرون (2016) السبب إلى زيادة التحلل الإلكتروليتي لجزيئات الكالسيوم والبروتين وتسرب الحمض النووي DNA من خلية الفطر مما يؤدي إلى هلاكه.

الاستنتاج

نستنتج من هذه الدراسة أن كلاً من الماء الساخن والماء المالح، الفرن العادي، وفرن الميكروويف أدى إلى الحد من نمو الفطريات *A. flavus*، *A. niger* و*P. Italicum* في بذور الفول السوداني، وأن المُعَالجة بالتحميص في فرن الميكروويف كانت الأفضل في القضاء على فطريات التخزين بنسبة 100% بعد مرور 5دقائق، والتي قد تكون مُبَشِرة بالخير في السيطرة على ملوثات البذور المُنْتجة للسموم.

الأخلاقيات البحثية

هذا البحث جزء من رسالة ماجستير للباحث الثاني وتحت إشراف الباحث الأول، كما أن جميع البيانات والصور أصيلة وليست مُقْتبسة.

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Application of the Best Techniques to Reduce the Percentage of Storage Fungi in Peanut Seeds *Arachis hypogaea*

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Abstract: This study was conducted during the season 2019-2020 with the aim of testing the efficiency of some techniques to eliminate or reduce the frequency of storage fungi, namely *Aspergillus flavus*, *A. niger*, and *Penicillium italicum* naturally contaminating peanuts seeds. The seed sample was treated by soaking in hot water (50˚c, 60˚c, 70˚c), soaking in salt water at concentrations 10%, 15%, 20%, roasting in an ordinary oven at 150˚c for 10, 20 and 30 min, and roasting in a microwave oven at 100˚c for 1, 3, 5 and 7 min. The frequency of fungi occurrence percentage was estimated in seeds after treatments and incubation on the nutrient medium Potato Sucrose Agar (PSA). The results indicated the efficiency of all the techniques used in reducing the frequency of fungi in the treated seeds, as the fungus *P. italicum* was the most sensitive fungus under all techniques, and the study proved the superiority of the treatment by microwave roasting over the rest of the techniques, as it eliminated all the fungi carried in the seed by 100% when the duration of time used is 5 minutes.

Keywords: Hot Water, Salt Water, Dry Heat, Microwave, Seed Borne Fungi, Peanut.

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