

o b e i k e s . c o m

# Conclusion

## CONCLUSION

It could be concluded that:

- 1- Fungal species differ greatly in their resistance to gamma radiation.
- 2- *Curvularia lunata*, *Alternaria alternata* and *Fusarium oxysporum* were more radiation resistance than corresponding *C. tuberculata*, *A. tenuissima* and *F. semitectum*.
- 3- The relative high radiation resistant fungal species contained high protein content in addition to higher amino acids content particularly sulfur containing amino acids and double bond amino acids such as histidine.
- 4- The relative high radiation resistant fungi contained higher lipid content and fatty acid content specially unsaturated fatty acids.
- 5- The relative radiation resistant fungal species contained higher amount of nucleic acids (DNA and RNA).
- 6- Although the resistant species could resist the harmful effect of gamma irradiation but the results indicated that 12.5 kGy was quite sufficient to eliminate *C. lunata* completely from lupine seeds and *A. alternata* from chicken feed either after irradiation or during storage.
- 7- Irradiation dose of 10.0 kGy completely eliminated *F. oxysporum* contaminated chicken feeds and these feeds remained free from the spores of that fungi through out the storage period (3 months).

o b e i k e a d . c o m

# Summary

## SUMMARY

There are many different methods used in inhibiting and controlling fungal growth in food and in agricultural commodities. Traditional methods using chemical compounds, heat and biological control have limited effect and many disadvantages as well. A modern, advanced and clean technology is now well established and known as "Food irradiation technology". This technology appeared to be effective and efficient in controlling fungi contaminating agricultural commodities. However, it was found that some fungal genera such as *Curvularia*, *Alternaria* and *Fusarium* are more resistant to ionizing radiation than others.

The aim of the present study was:

- 1- Isolation and identification of radiation-resistant fungi (*Curvularia* spp., *Alternaria* spp. and *Fusarium* spp.) from their natural products particularly foods, feeds, soil, .....etc.
- 2- Determine the "radiation decimal reduction dose" ( $D_{10}$ -value) of fungal spores to know the sensitivity or resistance of these molds to irradiation.
- 3- Examine the role of cellular composition (total proteins, amino acids, total lipids, fatty acids, DNA and RNA content) in the radiation-resistance.
- 4- Prevention of mold growth contaminating the food by using irradiation.

In this study, fifty three isolates of, *Curvularia* (C), *Alternaria* (A) and *Fusarium* (F) were isolated from different sources i.e. wheat (w), potato (p), tomato (t), mandarin (m), fenugreek (f), bread (b), orange (o), lupine (l), chicken feed (c), soil (s) and air (a). Five isolates were selected

from each genus according to the difference in the morphological characters and the source of food. The obtained results were summarized as follows:

- 1- The growth diameter of *Cl*<sub>1</sub> exposed to 10.0 kGy recorded 7.0 cm after 6 days of incubation while it reached 4.0 cm after 7 days of incubation in case of *Co*. Meanwhile, dose level 6.0, 8.0 and 9.0 kGy completely inhibited the growth of *Cl*<sub>2</sub>, *Ca* and *Cs*, respectively.
- 2- The growth diameter of *Am* and *Af*, completely inhibited after exposing to 9.0 kGy, while *Ac* recorded 2.9 cm after 7 days of incubation at the same dose. Meanwhile 5.0 kGy completely inhibited the growth of *Ab* and *At*.
- 3- The growth diameter of *Fp*, *Ft*, *Fs* and *Fc* completely inhibited after exposing to 4.0, 7.0, 8.0 and 9.0 kGy, respectively after 7 days, while *Fw* completely inhibited at 6.0 kGy after 5 days.
- 4- Two isolates from each genus were chosen to represent the highest and lowest radiation resistance of the three genera for further studies. The relative resistant isolates identified as *Curvularia lunata* (*Cl*<sub>1</sub>), *Alternaria alternata* (*Ac*) and *Fusarium oxysporum* (*Fc*), while the sensitive isolates identified as *C. tuberculata* (*Cl*<sub>2</sub>), *A. tenuissima* (*At*) and *Fusarium semitectum* (*Fp*).
- 5- The radiation resistance of the six fungal species was studied as a function of biomass. The biomass of the six resistant and sensitive fungal species were decreased by increasing the dose level of radiation; dose level 8.0 kGy almost inhibited the growth of *C. tuberculata* and *F. semitectum* while it decreased the dry mass of *C. lunata*, *A. alternata*, *A. tenuissima* and *F. oxysporum* by 67.8, 47.8, 92.0 and 61.2%, respectively.

- 6- The radiation resistance of the six fungal species belonging to *Curvularia*, *Alternaria* and *Fusarium* was studied through determination of D<sub>10</sub>-value. D<sub>10</sub>-value (the radiation dose in kGy which kills 90 % of the initial count of the cells) of the six selected fungal species were studied. Treatment of fungal spores with radiation reduced their viable counts and this reduction was proportional with the irradiation dose. The D<sub>10</sub>-values of *C. lunata*, *C. tuberculata*, *A. alternata*, *A. tenuissima*, *F. oxysporum* and *F. semitectum* in saline solution were found to be 1.92, 1.25, 1.47, 0.47, 1.31 and 0.70 kGy, respectively. Meanwhile, in lupine seeds, the D<sub>10</sub>-values of *C. lunata* and *C. tuberculata* were 2.25 and 1.56 kGy respectively, and in chicken feed, the D<sub>10</sub>-values of *A. alternata*, *A. tenuissima*, *F. oxysporum* and *F. semitectum* were 1.70, 1.30, 1.83 and 1.23 kGy respectively. It could be noticed that the D<sub>10</sub>-values of these fungi under investigation were higher in substrates than saline solution.
- 7- The total protein content of the three relative resistant strains *C. lunata*, *A. alternata* and *F. oxysporum* were 76.88, 72.69 and 69.83%, respectively, while three relative sensitive species *C. tuberculata*, *A. tenuissima* and *F. semitectum* were less than the resistant once since they recorded 70.13, 64.06 and 46.88%, respectively.
- 8- The content of the total amino acids in *C. lunata*, *A. alternata* and *F. oxysporum* were 129.2, 114.4 and 49.2 mg/g, respectively, while in the relative sensitive strains: *C. tuberculata*, *A. tenuissima* and *F. semitectum* were 101.0, 74.0 and 63.2 mg/g, respectively. Meanwhile, the resistant strains: (*C. lunata*, *A. alternata* and *F. oxysporum*) contain higher content of sulfur containing amino acids (Cysteine, Methionine) or double bond amino acids

- (histidine) than the relative sensitive strains: *C. tuberculata*, *A. tenuissima* and *F. semitectum*.
- 9- The total lipids content of the highly relatively resistant strains: *C. lunata*, *A. alternata*, *F. oxysporum* were 16.26, 12.57 and 8.16%, respectively. Meanwhile, the total lipids in the relative sensitive strains: *C. tuberculata*, *A. tenuissima* and *F. semitectum* were less than the resistant once, since they recorded 6.99, 3.91 and 5.76 % respectively.
  - 10- The percentages of the total unsaturated fatty acids in the resistant strains: *C. lunata*, *A. alternata* and *F. oxysporum* were 73.48, 71.68 and 70.11 %, respectively, while in the relative sensitive strains: *C. tuberculata*, *A. tenuissima* and *F. semitectum* were less than the resistant once, since they recorded 69.11, 68.67 and 53.38 %, respectively.
  - 11- The total nucleic acids content of the resistant strains *C. lunata*, *A. alternata* and , *F. oxysporum* were 36.63, 35.13 and 33.41 mg/g, respectively, compared with 29.60, 28.17 and 28.46 mg/g for *C. tuberculata*, *A. tenuissima* and *F. semitectum*, respectively.
  - 12- Gamma irradiation with dose level 4.0 kGy decreased the total protein content, in the tested strains, especially in the sensitive ones since they recorded 9.45, 15.55 and 14.23 % for *C. tuberculata*, *A. tenuissima* and *F. semitectum*, respectively compared with 6.50, 8.52 and 9.42 % for *C. lunata*, *A. alternata* and , *F. oxysporum*, respectively in the relative resistant ones.
  - 13- Gamma irradiation with dose level 4.0 kGy decreased the content of the total amino acids to 109.6, 62.0, 62.6, 59.6, 36.6 and 55.6 mg/g in *C. lunata*, *C. tuberculata*, *A. alternata*, *A. tenuissima*, *F. oxysporum* and *F. semitectum*, respectively, especially, sulfur containing amino acids (cysteine, methionine) or double bond amino acids (histidine).

- 14- Gamma irradiation with dose level 4.0 kGy decreased the total nucleic acids content, in the tested strains, especially in the sensitive ones since they recorded 30.7, 46.75 and 34.29 % for *C. tuberculata*, *A. tenuissima* and *F. semitectum*, respectively compared with 20.28, 21.72 and 27.18% for *C. lunata*, *A. alternata* and , *F. oxysporum*, respectively in the relative resistant ones.
- 15- The values of RNA and DNA decreased by exposure the tested species to 4.0 kGy, but the percentage of decreasing were higher in DNA than RNA, also higher in the relative sensitive strains than the resistant strains. The percentage of decreasing recorded 32.8, 33.7 and 29.7 % in the resistant strains: *C. lunata*, *A. alternata* and *F. oxysporum*, respectively, compared with 40.6, 59.4 and 55.0 % in the sensitive strains *C. tuberculata*, *A. tenuissima* and *F. semitectum*.
- 16- The results of the storage experiment showed that the count of *C. lunata*, *A. alternata* and *F. oxysporum* (the relative resistant ones) artificially contaminated lupine seeds or chicken feeds increased after the first month either in the unirradiated or irradiated samples with doses (2.5-7.5 kGy). Thereafter the remain cells decreased gradually during the end of the storage periods (3 months). 10 kGy was sufficient to complete elimination of *F. oxysporum* contaminated chicken feeds, while 12.5 kGy completely freedom chicken feeds or lupine seeds from *A. alternata* and *C. lunata*, respectively.

obeyika.com

# References

## REFERENCES

- Abd El-Rahman, D.G. (2005):** Application of irradiation for limitation of *Fusarium* growth and toxin production in some food and feed. M.Sc. Thesis, Microbiology Dept., Faculty of Sci., Ain Shams Univ., Cairo, Egypt.
- Abd El-Rahman, I.M. (1973):** Effect of radiation on air fungal population. M.Sc. Thesis, Faculty of Sci, Cairo Univ., Cairo, Egypt.
- Abo El-Khair, I.A. (1986):** Effect of gamma-irradiation on growth and activity of some fungi. M.Sc. Thesis, Botany Dept., Faculty of Sci., Zagazig Univ., Egypt.
- Adam, Y.M.; Aziz, N.H. and Attaby, H.S.H. (1995):** Isolation of radiation resistant fungal strains from highly radioactive field. *Isotope Rad. Res.*, 27, 1, 63-69.
- Alexander, P.; Dean, C.J.; Hamilton, I.D.G.; Lett, J.T. and Parkins, G. (1965):** Cellular Radiation Biology. 18<sup>th</sup> Ann. Symp. Fundamental Cancer Res., Publ. Univ., Texas: 241.
- Anellis, A.; Berkowitz, D. and Kemper, D. (1973):** Comparative resistance of nonsporogenic bacteria to low temperature and gamma irradiation. *Applied Microbiology*, 25: 517.
- AOAC (1990):** Official Methods of Analysis of the Association of Official Analytical Chemists. 15<sup>th</sup> Ed Washington, USA.
- Appiah, V.; Odomten, G.T. and Langerak, D.S. (1980):** In vitro studies of the combination of heat and radiation on conidia of *Aspergillus flavus* Link. IFFIT, report No.3, November 1980, Wageningen, Netherland.
- Ashwell, G. (1957):** Methods in Enzymology. Interscience, publishers Inc., New York.

- Atallah, S. (1997):** Food irradiation and safety relationships. Reports of the AGFUND/WHO-CEHA Gulf states workshop on food safety, WHO, held in sharja, UAE, From 27-29 October 1997.
- Awny, N.M. (1982):** Studies on the effect of combination treatments of gamma radiation and other factors on certain microorganisms. Ph.D. Thesis, Botany Dept., Collage for Women, Ain Shams Univ., Cairo, Egypt.
- Aziz, N.H. (1982):** The microflora of poultry diet in relation to human and poultry disease and control by gamma radiation. M.Sc. Thesis, Fac. Of Science, Ain Shams Univ, Cairo, Egypt.
- Aziz, N.H. and Abd El-Aal, S.S. (1990):** Influence of potassium sorbate and sodium benzoate on gamma-irradiated conidia of *A. ochraceus*, *P. chrysogenum* and *F. moniliforme*. Isotope and Rad. Res., 22, 140-150.
- Aziz, N.H. and El-Halfawy, N.A. (1991):** Decontamination of toxigenic moulds in stored grains by gamma irradiation. Isotope and Rad. Res., 23(1), 41-47.
- Aziz, N.H. and Saleh, N.A. (1995):** Toxigenic *Fusarium* isolated from animal feed stuffs. J. Egypt Vet. Med. Ass. 55, 881.
- Aziz, N.H. and Youssef, B.M. (2002):** Inactivation of naturally occurring of mycotoxins in some Egyptian food and agricultural commodities by gamma-irradiation. Egypt. J. Food Sci., 30, I, 167-177.
- Aziz, N.H.; Abd El-Rehim, L.M. and El-Far F.M. (1999):** Effect of gamma irradiation on aflatoxin B<sub>1</sub> produced *Aspergillus flavus* in barely containing antimicrobial food additives, Egypt. J. Rad. Sci. Applic., 12(2), 101-116.

- Aziz, N.H.; Attia, E.S.A. and Farag, S.A. (1997):** Effect of gamma-irradiation on the natural occurrence of *Fusarium* mycotoxins in wheat, flour and bread. *Nahrung* 41, 34.
- Aziz, N.H.; Refai, M.K. and El-Far. F. (1989):** Gamma irradiation and potassium sorbate in the control and ochratoxin production by *Aspergillus ochraceus*. *J. Egypt Vet. Med. Ass.*, 49, 951.
- Bao, J.R.; Fravel, D.R.; O'Neill, N.R.; Lazarovits, G. and Berkum, P.V. (2002):** Genetic analysis of pathogenic and nonpathogenic *Fusarium oxysporum* from tomato plants. *Can. J. Bot.*, 80, 271-279.
- Barclay, L.R. and Ingold, K.V. (1981):** Autoxidation of biological molecules. The autoxidation of a model membrane. A comparison of the autoxidation of egg lecithin phosphatidylcholine in water and in chlorobenzene. *J. Am. Chem. Soc.*, 103: 6478.
- Barkai-Golan, R.; Ben-Arie, R. and Reich, S.G. (2002a):** Sensitivity to gamma irradiation of fungi pathogenic to pears. *Int. J. Appl. Rad. & Isotope* 20, Issue 8, 577-583.
- Barkai-Golan, R.; Kahan, R.S. and Temkin-Gorodeiski, N. (2002b):** Sensitivity of stored melon fruit fungi to gamma irradiation. *Int. J. Appl. Rad. & Isotope* 19, Issue 7, 579-583.
- Beuchat, L.R. (1981):** Influence of potassium sorbate and sodium benzoate on heat inactivation of *Aspergillus flavus*, *Penicillium puberulum* and *Geotrichum caudatum*. *J. Food Prot.*, 44 (6), 150-155.
- Bhattacharya, K. and Raha, S. (2002):** Deteriorative changes of maize, ground nut and soybean seeds by fungi in storage. *Mycopathologia*, 155 (3), 135-141.

- Billen, D. (1984):** The role of hydroxyl radical scavengers in preventing DNA strand breaks induced by X-irradiation of toluene-treated *E coli*. *Rad. Res.*, 97, 626.
- Blank, G. and Corrigan, D. (1995):** Comparison of resistance of fungal spores to gamma and electron beam radiation. *Int. J. Food Microbiol.*, 26, 269-277.
- Bligh, E.G. and Dyer, W.J. (1959):** A rapid method of total lipid extraction and purification. *Can J. Biochem. Physiol.*, 37, 911.
- Blok, J. and Loman, H. (1973):** The effect of gamma-radiation in DNA. *Curr. Topics in Rad. Res. Quarterly*, 9, 165.
- Boubrick, F.; Jostere, R. and Yaniv, V. (1995):** Increased sensitivity to gamma-radiation in bacteria lacking protein HU., *Proc. Nat. Acad. Sci. U.S.A.*, 92, 3958-3962.
- Bresler, S.E.; Noskin, L.A.; Stephanova, N.A. and Noskina, J.G. (1979):** Mechanism of radio-protecting action of chemical compounds on *E. coli* cells. *Mol. Gen. Gen.*, 163: 75-85.
- Bridges, B.A. (1976):** In "The Survival of Vegetative Microbes". In Gray, T.R. and Postgate, J.R. Eds., PP. 3183, 26<sup>th</sup> Symposium of Society for General Microbiology, Cambridge Univ. Press, Cambridge.
- Burton, K. (1968):** *Methods in Enzymology*. 12B. Interscience publishers. Inc., New York.
- Butler, M.J. and Day, A.W. (1998):** Fungal melanins. a review, *Can J. Microbiol.*, 44, 1115-1136.
- Carbonneau, M.A.; Rebeyotte, N. and Rebeytrotte, P. (1984):** Polar lipids from the radiation resistances, bacterium *Deinococcus radiodurans* structure investigations on gluco-seaninyl and N-acetylglucosaminyl lipids. *Biochem.*, 66(4), 319.

- Casarett, A.P. (1968):** In "Radiation Biology" (Cliffs, N.J. ed.). Prentice Hall Englewood.
- Christensen, C.M. and Kaufmann, H.H. (1965):** Deterioration of stored grains by fungi. *Ann. Rev. Phytopath.*, 3, 69-84.
- Chu R.D.H. and Vandyk, G.G. (1993):** The effect of dose distribution on sterility assurance for gamma sterilized medical produces. *Rad. Phys. And Chem.*, 42 (4-6), 585-589.
- Counsell, J. J. and Murray, R.G. (1986):** Polar lipid profiles of the genus *Deinococcus*. *Int. J. Syst. Bact.*, 36(2), 202.
- Dahl, T.A.; Midden, W.R. and Hartman, P.E. (1988):** Some prevalent biomolecules as defenses against single oxygen damage. *Photochem. Photobiol.*, 120, 420-425.
- Daly, M.J. and Minton, K.W. (1997):** Recombination between resident plasmid and the chromosome following irradiation of the radio-resistant bacterium *D. radiodurans*. *Gene*, 187, 225-229.
- De-Risio, R.J. (1986):** Sterilization concepts and method of sterilization employed by the hospital and industry. In: "Proceedings of International Scientific Conference of the Sterilization Medical products. Disinfections and Preservation". (Gaughran, E.R.L.; Morrissey, R.F. and You-Sen, W.eds) PP. 17-31 Beijing, China.
- Desrosier, N.W. (1970):** Preservation of Food with Ionizing Radiation, "The technology of Food Preservation". P.313. Third Edition, AVI publishing Company.
- Desrosier, N.W. and Rosenstock, H.M. (1960):** Radiation technology in foods, Agriculture and Biology. AVI. Pub., Co. Inc., West Part, Connecticut.
- Diehl, J.F. (1995):** Safety of Irradiated Foods. Marcel Dekker, Inc. New York, Basel, Hong Kong.

- Domesch, K.H.; Gams, W. and Anderson, T.H. (1981):** Compendium of soil fungi. Vol.1 and 2, Academic Press London.
- Edward, L.A. (1990):** In: "Radiation Biophysics" (Edward, L.A. Ed) Prantice Hall Int.
- El-Ashmaway, A.M.M. (1982):** Effect of gamma radiation on some fungi causing storage diseases of banana fruits. M.Sc. Thesis, Fac. Of Agric., Cairo Univ., Egypt.
- El-Far, F.A.; Saleh, N.A.; Hegazi, S. and Aziz, N.H. (1993):** Some important health significance studies on imported poultry feedstuffs. First International Conference on the Impact of Food Research on New Product Development. January 24<sup>th</sup>-26<sup>th</sup>, Karachi, Pakistan, PP. 379-385.
- El-Fouly, M.Z.; El-Zawahry, Y.A.; Helal, G.A. and El-Hady, A.F. (1990):** Controlling of bacterial flora contaminating animal diets and its components by gamma irradiation. *Isotope & Rad. Res.*, 22, 1, 29-38.
- El-Fouly, M.Z.; Helal, G.A.; El-Zawahry, Y.A. and El-Hady, A.F. (1989):** Controlling the aflatoxin producing fungi contaminating animal feed by gamma irradiation. *Isotop & Rad. Res.* 21(2), 135-145.
- El-Fouly, M.Z.; Youssef, K.A.; Shahin, A.A.M.; Gebreal, H.M. and El-Bialy, H.A. (2002):** Diazinon biodegradation by soil fungi, Int. Conf. for Develop. And The Env. In the Arab World, March, 26-28, Assiut-Egypt.
- El-Kady, I.A.; Moubasher, A.H. and El-Maraghy, S.S. M. (1988):** Zearalenone production by several genera of fungi other than *Fusarium*. *Egypt. J. Bot.*, 31 (13), 99-108.

- El-Sherbeny, G.A. (1982):** Studies on the effect of gamma radiation on growth and metabolism of some fungi isolated from air. M.Sc. Thesis, Botany Dept., Faculty of Sci, Zagazig Univ., Egypt.
- El-Zawahry, Y.A. (1976):** Studies on the effect of gamma radiation on growth and activity of *Rhizobium Liguminosarum*. Ph.D. Thesis, Faculty of Sci., Cairo Univ., Egypt.
- El-Zawahry, Y.A. and Rowley, D.B. (1979):** Radiation resistance and injury of *Yersinia enterocoliytica*. Appl. and Environ. Microbiol., 37, 50.
- El-Zawahry, Y.A.; Mostafa, S.A. and Abdel-Aal, S. (1982):** Radiation resistance of bacterial microflora isolated from some pharmaceutical components. Isotope and Rad. Res., 14(2), 109.
- El-Zawahry, Y.A.; Salama, A.M.; Awny, N.M.; Abo El-Khair, I.A. (1988):** Sugar uptake, carbohydrate metabolism and DNA and RNA of *Paecilomyces violacea* mats arising from gamma irradiated inocula. Egypt J. Rad. Sci. Appl., 5(1), 89-96.
- El-Zawahry, Y.A.; Shehab, A.; Alian, A. and Roushdy, H. (1983):** Radiation effect on the growth and uptake of phosphorous and iodine by some fungi. Arab. J. Nuc. Sci. & Appl.
- Erhart, H.F. (1990):** Irradiation of cereal products for disinfestations and removal of bacteriological contamination. Int. J. Food Microbiol. 9, 1.
- Farkas, J. (1980):** Principles of food irradiation. 2<sup>nd</sup> IFFIT Training Course, Lecture 77, Wageningen, The Netherlands.
- Farkas, J. (1981):** Principles of food irradiation. Third IFFIT Training course, Lecture 77, Wageningen, The Netherlands.

- Farrag, H.A. and Saleh, A.M. (1996):** Change in DNA content, Ploidy pattern and Radio-sensitivity before and after test dose radiation in some microorganisms isolated from urinary transitional cell carcinoma. *J. Egypt. Nat. Cancer Inst.*, 8(2), 213-223.
- Frankenberg, S.D. (1981):** Interpretation of the shoulder of dose response curves with immediate plating of potentially lethal lesions during a restricted time period. *Int. J. Rad. Biol.*, 39, 617-631.
- Frankenberg, S.D.; Frankeberg, M.S. and Harbich, R. (1984):** Interpretation of the shape of survival curves in terms of induction and repair misrepair of DNA dsb. *Br. J. Cancer*, 49, 233-238.
- Gaughran, E.R. and Goudi, A.J. (1974):** Technical developments and properties of sterilization by ionizing radiation. Multiscience publication limited, Monreal.
- Ghaly, M.F. (1986):** Studies on the actinomycetes producing amylase enzyme. Ph.D. Thesis, Dep. of Botany, Faculty of Science, Zagazig Univ., Egypt.
- Giddings, G.C. (1984):** Radiation processing of fishery products. *Food technology*, 38(4), 61-65.
- Giusti, A.M.; Raimodi, M.; Ravagnan, G.; Sapor, O. and Parasass, T. (1998):** Human cell membrane oxidative damage induced by single and fractionated doses of ionizing radiation: A fluorescence spectroscopy study. *Int. J. Rad. Biol.*, 74(5), 595-605.
- Glazunov, A.V. and Kapul'tsevich, Y.G. (1991):** A molecular version of cell inactivation probability model. *Radiologiya*, 31(4), 571-577.

- Goldblith, S.A. (1971):** The inhibition and destruction of the microbial cell by radiation. "Inhibition and Destruction of Microbial Cell". (Hugo, W.B. Ed.), Academic Press, London and New York.
- Goodhead, D.T. (1987):** In "Biophysical Models of Radiation Action, Introductory activity". (Fielden, F.H. Ed), PP. 928-933, Academic Press, New York.
- Grecz, N; Rowley, D.B. and Matsuyama, A. (1983):** The action on bacteria and viruses, In "Preservation of Food by Ionizing Radiation". E.S. Josephson and M.S. Peterson (Eds), CRC Press, Boca Raton, FL.
- Grezelinska, E.; Bartosz, G.; Gwozdziński, K. and Leyko, W. (1979):** Aspin-Label Study of effect of gamma radiation on erythrocyte membrane. Influence of lipid Peroxidation on membrane structure. *Int. J. Rad.*, 36, 325.
- Habbs, C.H. and Mccellam, R. O. (1975):** In "Toxicology, The Basic Science of Poisons". (Cararett, L.J. and Baull, J. Eds) PP. 390, Macmillan Publishing Co., New York.
- Halasz, A.; Badaway, A.; Sawinsky, J.; Kozma-Kovacs, E. and Beczner, J. (1989):** Effect of gamma-irradiation on F-2 and T-2 toxin production in corn and rice. *Folia Microbiol. (Praha)* 34(3), 228-32.
- Hammad, A.A.I. (1995):** Shelf-Life extension of strawberries by combination of some preservatives and irradiation. *Egypt J. Food Sci.*, 23, No.3, P. 217-227.
- Hammad, A.A.I.; El-Mongy, T.M.; Abu-Shady, M.R. and Taha, S.M. (1995):** Microbiol changes in strawberries treated with gamma irradiation to improve their quality. *Egypt J. Food Sci.*, 23, No.1-2, pp. 117-132.

- Hammed, D.A. (2001):** Microbiological and chemical studies on some irradiated medical plants. M.Sc. Thesis, Botany Dept., College of Women, Ain Shams Univ., Cairo, Egypt.
- Hartman, P.E.; Hartman, Z. and Gitardi, M.J. (1988):** Ergothionine, Histidine, and two naturally occurring histidine di-peptides as radio-protectors against gamma-irradiation inactivation of bacteriophage T4 and P<sub>22</sub>. *Rad. Res.*, 114, 319-300.
- Hassanein, W.A.A. (1994):** Studies on the biological changes induced by certain antibiotics and gamma radiation for certain bacteria. Ph.D. Thesis, Dept. of Botany, Faculty of Sci., Zagazig Univ., Egypt.
- Hegazi, M.F.; Shahin, A.A.M.; Shehata, S.T. and Atwa, M.A.M. (2000):** Using gamma radiation to control decay and reduce post harvest losses of grapes and tomatoes. *Az. J. Microbiol.*, Vol. 47, 74-88.
- Hieda, K.; Kobayashi, K.; Ito, A. and Ito, I. (1984):** Comparisons of the effects of vacuum-UV and Far-UV synchrotron radiation on dry yeast cells of different UV sensitivities. *Rad. Res.*, 74-98.
- Howard, P. (1958):** Physical and chemical mechanisms in injuring of cells by ionizing radiation. *Adv. Biol. Med. Phys.*, 6, 553-558.
- Hussein, H.A. (1984):** Gamma radiation effects on the microflora of some food species. M.Sc. Thesis, Faculty of science, Ain Shams Univ., Egypt.
- Hutchinson, V. (1961):** Sulfhydryl groups and the oxygen effect on irradiated solutions of enzymes and nucleic acids. *Rad. Res.*, 14, 721.
- IAEA (1970):** Manual of Mutation Breeding, 119, 21, Vienna.

- IAEA (1973):** The effects of ionizing radiation on bacteria. In "Manual on Radiation Sterilization of Medicinal and Biological Materials". Technical reports Series No. 149, International Atomic Energy Agency, Vienna.
- Ingram, M. and Roberts, T.A. (1980):** Ionizing radiation. In Microbiol Ecology of Foods. "Vol. I", P.46 (ICMSF, Ed), Academic Press, New York.
- Ito, H.; Watanabe, H.; Takehisa, M. and Lizuka, H. (1983):** Isolation and identification of radiation resistant cocci belonging to the genus *Deinococcus* from sewage sludge and animal feed. Agric. Biol. Chem., 47 (6), 1239.
- Jacqueline, E.F.; Braun, E.F.; Sarquis, F.; Vincen T., M. Lafleur, M. and Retel, J. (1996):** Effect of the sulfhydryl compound cysteamine on gamma-radiation induced mutation in double strand M13. Mut. Res., 364, 171-182.
- Kamat, A.S. and Pardhan, D.S. (1987):** Involvement of Ca and DPA in resistance of *B. Cereus* BIS-59 spore to U.V. and gamma-radiation. Int. J. Rad. Biol. Relatstud. Phys. Chem. Med., 51(1), 7-18.
- Kamp, J. (1986):** Cell kinetics and radiation biology. Int. J. Rad Biol., 49: 357-380.
- Kaplan, H.S. and Zavarine, R. (1962):** Correlation of bacterial radio-sensitivity and DNA base composition. Biochem. Biophys. Res. Commun., 8(6), 432-436.
- Kiefer, J. (1990):** Biological Radiation Effects. PP. 159-163. Springer-Vorlag Berlin-Heidelberg.
- Kirn, J.H.; Sac, Y.G.; Yoon, S.C. and Hee, J. (1968):** Studies on the cellular metabolism in microorganisms as influenced by gamma irradiation. Korean, J. Microbiol., 6, 54.

- Koburger, J.A. and Marth, E. (1984):** Yeast and Molds. In speck, M. (Ed), "Compendium of Methods for the Microbiological Examination of Foods". APHA, Inc., Washington, D.C., P.197.
- Kohler, P. and Marahiel, A.M. (1997):** Association of the histone-Like protein HBSu with the nucleoid *B. subtilis*. J. Bact., 3, 2060-2064.
- Koshikawa, T.; Sone, K. and Kobayashi, T. (1993):** A simple identification method for spore forming bacteria showing high resistance against gamma rays. Radioisotopes, 42 (11), 614-623.
- Kulik M.M. and Justice, O.L. (2004):** Survival of two storage fungi after gamma radiation of host seeds. Radiation Botany V. (6), I. (5), PP. 407-412.
- Lawrence D.E. (1971):** In "Cellular Radiobiology" (Lawrence. D.E. Ed Williams Sons, Ltd. London).
- Ley, F.J. (1973):** The effect of ionizing radiation on bacteria. In: "Radiation Sterilization of Medical and Biological Materials", PP. 37-63, IAEA, Vienna.
- Loahranu, P.C. (1995):** Food irradiation, current status and future prospects, In New Methods of Food Preservation. (G.W. Grould, Ed.), Blakie Academic and Professional, London.
- Lorenz, K. (1975):** Irradiation of cereal grains and cereal grain, products CRC Critical Review in food science. Nutrition, 6, 317-82.
- Lye, M.K.; Susan, M.V.; Preston, H. and Kwong, K.W. (1999):** Targeted mutagenesis by duplication insertion in radio-resistant bacterium *D. radiodurans*. Radiation sensitivities of catalase and superoxidedismutase. J. Bact., 181, 666-669.
- Machi, S. (1990):** New trends in radiation processing application in Japan. Proceeding of the Int. Symposium on Radiation Vuleanization of Natural Rubber Latex, pp. 19-26.

- Madhyastha, M.S. and Bhat, R.V. (1984):** *Aspergillus parasiticus* growth and aflatoxin production on black and white pepper and the inhibitory action of their chemical constituents. *Appl. Environ. Microbiol.*, 48, 376-379.
- Malloch, D. (1981):** *Moulds, Their Isolation Cultivation and Identification.* Univ. of Toronto. Press, Toronto, pp. 64-65.
- Mc-Eldowney, S.; Hardman, D.J. and Waite, S. (1993):** *Pollution: Ecology and Biotreatment.* PP. 234-310, Longman Scientific & Technical.
- Mead, J.F. (1976):** Free radical mechanism of lipid damage on consequences for cellular membranes. In "Free Radicals in Biology". (Pryor, W.A. Ed.) Vol. 1, 51-68, Academic Press, New York.
- Melin, A.M.; Carbonneau, M.A. and Rebeyrotte, N. (1986):** Fatty acids and carbohydrate-containing lipids in four *Micrococcaceae* strains. *Biochem.*, 68 (10-11), 1201.
- Milligan, J.R.; Ng, J.Y.; Wu, C.; Agivlera, J.A.; Fahey, R.C. and Ward, J.F. (1995):** DNA repair by thiol in air shows two radicals make a double-strand break. *Rad. Res.* 143, 273-280.
- Ming-Ho, Y. (2001):** Impact of environmental toxicants on living systems. In "Environmental Toxicology" (Ming-Ho, Y. Ed.), Lewis Publishers.
- Minton, R.W. (1996):** Repair of ionizing radiation damage in the radiation resistance bacterium *D. radiodurans*. *Mut. Res.*, 363, 1-7.
- Mironenko, N.V.; Alekhina, I.A.; Zhdanova, N.N. and Bulat, S.A. (2002):** Intra-specific variation in gamma-radiation resistance and genomic structure in the filamentous fungus *Alternaria alternata*: A case study of strains inhabiting Chernobyl reactor No.4. *Ectoxicology and Environmental safety*, V.45, I.2, PP. 177-187.

- Mohamed, N.A. (2003):** The role of proteins and amino acids in the radiation resistance of bacteria. M.Sc. Thesis, Biochemistry Dept., Faculty of Sci., Ain-Shams Univ., Cairo, Egypt.
- Molins, R.A. (2001):** Food Irradiation; Principles, Introduction and Applications. The national Academic Washington, D.C. (USA). Inst. Of Midic, New York, Johan Wiley and Sons Inc., PP. 1-12.
- Moore, R.W.; Anderson, M.E.; Meister, A.; Murata, K. and Kimura, A. (1989):** Increased capacity for glutathione synthesis enhances resistance to radiation in *E. coli*: A possible model for mammalian cell protection. Proc. Nat. Acad. Sci. U.S.A., 86, 1461-1464.
- Morse, M.L. and Carter, L.E. (1949):** The effect of ultraviolet irradiation on the synthesis of nucleic acid of *E. coli*. Bact. Proc. 49, 14.
- Moseley, B.E. (1968):** The repair of damaged DNA in irradiated bacteria. Adv. Microb. Physiol., 2, 173-195.
- Moseley, B.E. and Evans, D.M. (1983):** Isolation and properties of strains of *Micrococcus (Deinococcus) radiodurans* unable to excise ultraviolet light induced pyrimidine dimmers from DNA: evidence for two excision pathways. Can. J. Microbiol., 129, 2437-2445.
- Moseley, B.E.B. (1990):** Radiation, microorganisms and radiation resistance. In Food Irradiation and the Chemist, D.E. Johnston and M.H. Stevenson (Eds), Royal Society of Chemistry, Cambridge, 97-108.
- Mostafa, S.A.; El-Zawahry, Y.A. and Abd El-Aal, S.S. (1983):** Radiation sensitivity of fungal microflora isolated from some pharmaceutical ingredients. Arab J. Nucl. Sci. and Appl., Vol. 16, No. 1, PP. 1-17.

- Mostafa, S.A.; El-Zawahry, Y.A. and Abd-Aal, S.S. (1982):** Radio-sterilization of solid D-glucose, sodium chloride, potassium chloride and their solutions using gamma irradiation. Arab J. Nuc. Sci and Appl, 15(2), 459.
- Moubasher, A.H.; El-Kady, I.A. and El-Maraghy, S.S. M. (1982):** Toxigenic *Fusarium* isolated from cereal grains in Egypt. Proc. Int. Symp. Mycotoxins, 337-343.
- Musilek, L. (1992):** Radiation Technologies. Edicni stredisko, CVUI. 230, PP. 121-167.
- Nakazawa, I.; Nagastuka, S. and Sakurai, T. (1981):** Radiation-induced changes of liposomes and lecithin in non-aqueous media. Int. J. Rad. Biol., 40, 365.
- Naslund, M.; Fedorcsak, I. and Ehrenberg, L. (1976):** Role of peroxide in radio-Protective action of Thiols in *E. coli*. Int. Rad. Biol., 29 (6), 501.
- Nasrat, H.M. (2005):** Physiological studies on some fungi producing vitamin B6, M.Sc. Thesis, Faculty of Science, Zagazig University, Zagazig, Egypt.
- Norberg, A.N. and Serra-Freire, N.M. (1993):** Characterization of the minimal lethal dose of gamma irradiation for *Pencillium citrinum*. Rev. Inst. Med. Trap. Sao Paulo., 35(6), 527-33.
- Orabi, I.A. and Hammad, A.A.I. (1989):** Mycological and chemical studies on irradiated potatoes. Egypt. J. Appl. Sci., 4(3), 662-633.
- Osman, N.E. (1973):** Effect of radiation on soil fungi population. M.Sc. Thesis, Faculty of Sci., Cairo Univ., Egypt.
- Paidhungat, M.; Setlow, B.; Driks, A. and Setlow, P. (2000):** Characterization of spores of *B. subtilis* which Lackdipicolinic acid. J. Bact., 182, 5505-5512.

- Pauli, G.H. and Tarantino, L.M. (1995):** FDA regulatory aspects of food irradiation. *J. Food Prot.*, 58, 209-212.
- Pitt, J.I., and A.D. Hocking (1997):** *Fungi and Food Spoilage*. Blackie Academic and Professional, New York.
- Pryor, W.A. (1980):** Methods detecting free radicals and free radical mediated pathology in environmental toxicology. In "Molecular Basis of Environmental Toxicity" (Bhatnagar, R.S. Ed.). PP. 3-36, Ann. Arbor. Sci. Pub., Ann Ar Bor.
- Radford, I.R. (1988):** The dose response for low LET radiation induced DNA double strand breakage methods of measurement and implication for radiation models. *Int. J. Rad. Biol.*, 54, 1-12.
- Rafai, M.K.; Aziz N.H.; El-far, F.M. and Hassan, A.A. (1996):** Detection of ochratoxin produced by *Aspergillus ochraceus* in feedstuffs and its control by gamma radiation. *Appl. Rad. Isot.*, 47, 617.
- Ragab, M.M.; Kararah, M.A.; El-Fouly, M.Z. and Shahin, A.A.M. (1986):** Control of bulb decay in garlic by using gamma irradiation. *Egypt. Soc. Appl. Microbiol.*, Cairo, 287.
- Richmond, R.C. and Zimbrick, J.D. (1975):** In-vivo radiation induced thymine residue release from *E. coli* DNA. *Biochem. Biophys. Res. Commun.*, 64, 390.
- Richter S.G. and Barnard J. (2002):** The radiation resistance of ascospores and sclerotia of *Pyronema domesticum*. *J. Ind. Microbial Biotechnol.* 29(2), 51-4.
- Risk, M.I.; El-Fouly, M.Z.; Hassan, A.A. and Abd El-Khalek, E.S. (2000):** Effect of radiation on the growth, water activity and nucleic acids of some animal mummies microbial isolates. *J. Microbiol.* 50, 283-294.

- Roger, W.H.; Murty, G.S.; Bishayee, A. and Dandamudi, V.R. (1998):** Radioprotection against lethal damage caused by chronic irradiation with radio-nucleides in vitro. *Rad. Res.* 150(4), 391-399.
- Root, R.; Chatterjee, A.; Chang, P.; Lommel, L. and Blakely, E.A. (1985):** Characterization of hydroxyl radical-induced damage after sparsely and densely ionizing radiation. *Int J. Rad. Biol.*, 47, 157-166.
- Rowley, B.B. and Brynjolfsson, A. (1980):** Potential uses of irradiation in the processing of food. *Food Technology*, 34, 75-77.
- Roy, M.K. and Mukewar, P. (1973):** Combined gamma irradiation and chemical treatment in the control of *Aspergillus niger* and *Fusarium coeruleum*. "Radiation Preservation of Food" International Atomic Energy Agency, Vienna, 193-200.
- Russell, A.D. (1982):** Effects of ionizing radiation on bacterial spore, In: "Destruction of Bacterial Spores". Russel A.D. Ed. Acad. Pres. Inc., London Ltd.
- Russell, A.D. (1990):** Bacterial spores and chemical sporicidal agents. *Clin. Microbiol. Rev.*, 3, 99-119.
- Rustom, I.Y.S. (1997):** Aflatoxin in food and feed occurrence, legislation and inactivation by physical methods, *food Chem.*, 59, 57.
- Sadi, S. (1978):** Irradiation effects on the alcohol fermentation ability of *S. Cerverisiae*. *Majalaj-BATA in Indonesion*, 20 (3-4), 40.
- Salama, A.H.; Awny, N.M.; El-Zawahry, Y.A. and Abo-El-Kair, I.A. (1989):** Effect of gamma radiation on the nitrogen metabolism of *Paecilomyces violacea*. *Egypt. J. Rad. Sci. Applic.*, Vol. 6, No. 1, pp. 27-36.

- Salama, A.M.' Ali, M.I.; El-Krdassy, Z.M. and Ali, T.M. (1977):** Study on fungal radio-resistant and sensitivity. Zbi. Bak. Abt. II. Bd., 132, 10.
- Saleh, Y.G.; Mayo, M.S. and Ahearn, D.G. (1988):** Resistance of some common fungi to gamma irradiation. Appl. Environ. Microbiol., 54, 2134-2135.
- Sanders, S.W. and Maxcy, R. B. (1979):** Patterns of cell division and base compositions and fine structures of some radiation resistance vegetative bacteria found in food. Appl. Environ. Microbiol., 37(1), 159.
- Sankaranarayanan, K. (1982):** Genetic effects of ionizing radiation, in multicellular eukaryotes and the assessment of genetic radiation hazards in man. Amsterdam, El Sevier Biomedical Press.
- Schaefer, G.; Hass. P.; Coquercelle, T. and Hagen, N. (1980):** Properties of an endo-nuclear activity in *Micrococcus luteus* acting on gamma-irradiated DNA and a purinic DNA. Int. J. Rad Biol. Relat. Stud. Phys. Chem. Med., 37, 11.
- Schubert, J. C. (1981):** Introduction to Radiation Chemistry. Lecture 31 at the third IFFIT Training course, Wageningene, The Netherlands.
- Setlow, P. (2000):** Resistance of bacterial spores. In "Bacterial Stress Responses" (Storz, G. and Hengge-Aronis, R. Eds.), pp. 217-230, Am. Soc. Microbiol., Washington, D.C.
- Shahin, A.A.M. (1993):** Control of fungus diseases during storage of certain economic crops using gamma radiation. Ph.D. Thesis, Faculty of Agric., Cairo Univ., Egypt.
- Shahin, A.A.M. (1998):** Effect of different factors including gamma radiation on the growth and aflatoxin production of *Aspergillus flavus* in some seeds. Egypt J. Microbiol., 33(3), 455-468.

- Shahin, A.A.M. and Aziz, N.H. (1997):** Influence of gamma rays and sodium chloride on aflatoxin production by *Aspergillus Flavus*. *Microbios*, 90, 163-175.
- Shalaby, K.E. (1999):** Studies on chitin-degrading fungi in Egypt. M.Sc. Thesis, Faculty of Science, Zagazig University, Zagazig, Egypt.
- Shamberger, R.J.; Andreone, T.L. and Willis, C.E. (1974):** Antioxidants and cancer. IV. Initiating activity of malonaldehyde as a carcinogen. *J. Nat. Cancer. Int.*, 53, 1771.
- Shibko, S.; Koivistoven, P.; Tranyak, C.A.; Newhall, A.R. and Friedman, L. (1967):** A method for sequential quantitative separation and determination of liver homogenate or from subcellular fraction. *Anal. Biochem.*, 19, 514.
- Silliker, J.H.; Elliott, R.P.; Baird-Parker, A.C.; Chistain, J.H.B.; Clark, D.S.; Olson, J.C. and Roberts, T.A. (1980):** Factors affecting life and death of microorganisms. In "Ionizing Radiation in Microbiol. Ecology of Food". International Commission on Microbial Sanctification for Food. Academic Press, New York.
- Silverman, G.J. (1983):** Sterilization by Ionizing radiation. pp. 89-105 In S. Block (Ed.), *Disinfection, Sterilization and Preservation*, 3<sup>rd</sup> ed. Lea & Febiger, Philadelphia.
- Simic, M.G.; Grossman, L. and Upten, A.C. (1986):** In "Mechanisms of DNA damage and repair". (Simic, M.G.; Grossman, L. and Upten, A.C. Eds.), Plenum Press, London.
- Sjarief, S.H. (1990):** Isolation and properties of *D. radiaturans*. Sark. Nat. A.E.A. Jakarta, Indonesia.
- Smith, G. (1961):** An Introduction to Industrial Mycology. Edward A (pub.) Ltd. London.

- Smith, M.D.; Masters, C.I. and Moseley, B.E.B. (1992):** Molecular biology of radiation resistant bacteria. In: "Molecular Biology and Biotechnology of Extremophils" (Herbert, R.A.H. and Sharp, R.J. Eds.). PP. 258-280, Blackie and Sonlimited, Glasgow.
- Sommer, N.F. (1973):** The effect of ionizing radiation on fungi. In "Manual on Radiation Sterilization of Medical and Biological Materials", pp. 73-79, IAEA, Vienna.
- Sommer, N.F., and Fortlage, R.J. (1966):** Ionizing radiation for control of Post-harvest diseases of fruits and vegetables, Advanced in food research. Vol. 51, Academic Press, New York, 147-193.
- Sommer, N.F.; Fortlage, R.J.; Buckley, P.M. and Maxie, E.C. (2004):** Comparative sensitivity to gamma radiation of conidia, mycelia and sclerotia of *Botrytis cinerea*. Radiation-Botany, 12(2), 99-103.
- Stapleton, G.E. (1965):** Developments of radio-resistance in culture of a purineless mutant of *E. coli* K12. Rad. Res., 25, 244.
- Stegeman, H. (1981):** Basic effect of radiation on microorganisms. 3<sup>rd</sup> IFFIT, Training cours, Lect 61. Wageninagen, The Netherlands.
- Swallow, A.J. (1977):** Chemical effects of irradiation. In Radiation Chemistry of Major Food Components. Its relevance to the assessment of the wholesomeness of irradiated foods, (eds. P.S. Elias and A.J. Cohen), International project in the field of food irradiation, International Atomic Energy Agency, Vienna, PP. 5-20.
- Swelim, M.A. (2004a):** Effect of gamma irradiation on growth and cellular structure of two *Fusarium* species. Isotope and Rad. Res., 36, I, 135-150.

- Swelim, M.A. (2004b):** Effect of gamma radiation on the occurrence of fungi and aflatoxin B<sub>1</sub> in animal feed. Bull. Fac. Sci., Assiut Univ., 33(1), 17-26.
- Swez, J. and Pollard, E. (1966):** DNA agar annealing residual DNA after degradation by ionizing radiation. Rad. Res., 29, 475.
- Sztanyik, L.B. (1974):** Application of ionizing radiation to sterilization. In: "Technical Developments and Prospects of Sterilization by Ionizing Radiation" (Gaughram, E.R.L. and Gavidie, A.J. Eds.) PP.6 Multi-Science, Montreal.
- Tallentire, A. (1985):** An observed oxygen effect during gamma-radiation of dried bacterial spores. Nature London, 182, 1024-1025.
- Tanaka, A.H.; Kitayama, M.K.S. and Watanable, H. (1996):** Changes in cellular proteins of *D. radiodurans* following gamma irradiation. Rad. Environ. Biophys., 35, 95-99.
- Thacker, J. (1987):** In "Radiation Mutagenesis in Bacteria and Mutation Cells" (Hendry, F.F. and Scott, P. Eds.), pp. 544-549. Harper and Row Publisher, Inc., New York.
- Thomas, P. (1986):** Radiation Preservation of food of plant origin, Part V., Temperature fruits, Pome fruits, Stone fruits and berries. CRC Critical Reviews in food science and nutrition, 24(4), 357-400.
- Thornley, M.J. (1963):** Radiation resistance among bacteria. J. Appl. Bacteriol., 26, 334.
- Tohamy, E.Y. (1991):** Studies on the biological activity of certain actinomycetes. Ph.D. Thesis, Botany Dept., Faculty of Sci., Zagazig Univ., Egypt.

- Toru, H. and Setsuko, T. (1992):** Comparison of the cellulose Triacetate (CTA) dosimeter and radio-chromic film for evaluating the bactericidal effects of gamma-rays and electron beams. *Rad. Phys. Chem.*, 40(6), 593.
- Urabin, W.M. (1977):** Radiation chemistry of proteins. In "Radiation Chemistry of Major food Components. Its relevance to the assessment of the wholesomeness of irradiated foods". (eds P.S. Elias and A.J. Cohen), International Project in the field of food irradiation, International Atomic Energy Agency, Vienna, pp. 63-130.
- Urbain, W.M. (ed.) (1986):** Food Irradiation: Food Science and Technology Series, London, Academic Press.
- Vankooij, J.G. (1982):** Food preservation by irradiation. *IAEA Bulletin*, 23(3), 33-36.
- Varso, H.H. (1972):** A procedure for isolation and quantitative determination of volatile fatty acids from meat products. *J. Food Sci.*, 37, 136-139.
- Wade, W.N. and Beuchat, L.R. (2003):** Proteolytic fungi isolated from decayed and damaged raw tomatoes and implications associated with changes in pericarp pH favorable for survival and growth of food borne pathogens. *J. Food Prot.*, 66, No.6, pp. 911-917.
- Wang, P. and Schellhorn, H.E. (1995):** Induction of resistance to hydrogen peroxide and radiation in *D. radiodurans*. *Can. J. Microbiol.*, 41, 170-176.
- Wayne, L.N.; Munakata, N.; Horneck, G.; Melosh, H.J. and Setlow, P. (2000):** Resistance of *Bacillus* endospores to extreme terrestrial and extra terrestrial environment. *Micro. Mol. Biol. Rev.*, 64, 548-572.

- Whitby, J.L. and Gelda, A.K. (1979):** Use of incremental dose of cobalt 60 radiation as means to determine radiation sterilization dose. *J. Parental Drug Associ.*, 33, 144-155.
- WHO (1981):** World Health Organization of the United Nation "Wholesomeness of Irradiated Food" Reports of a joint FAO, IAEA, WHO Expert Committee. Technical Rep. Series No. 659, PP.31.
- WHO (1988):** Food irradiation. A technique for preserving and improving the safety of food. WHO/FAO, WHO, Geneva.
- WHO, (1994):** Review of the Safety and Nutritional Adequacy of Irradiated food, Report of WHO consultation, Geneva, 20-22.
- WHO, (1997):** Food Irradiation. Press Release, WHO/68, 19 Sept.
- WHO (1999):** High dose irradiation, wholesomeness of food irradiated with doses above 10 kGy, WHO technical. Report series 890, WHO, Geneva.
- Williams, R.A.D. (1989):** Biochemical taxonomy of the genus thermus. In: "Microbiology of the Extreme Environment and its Potential for Biotechnology". (Dacosta, M.S.; Duarte, J.C. and Williams, R.A.D. Eds.) Elsevier Applies Science, New York.
- Wills, E.D. (1980):** Studies lipid perioxide formation in irradiated synthetic diets and the effects of storage after irradiation. *Int. J. Rad. Biol.*, 37, 333.
- Winder, K. and Eggum, O.B. (1966):** Protein hydrolysis. A description of the method used a the Department of animal physiology in Copenhagen, *Acta Agriculture Scandinavia*, 16: 115.
- Winters, R.A.; Zukowshi, J.; Ercal, N.; Mattews, R.H. and Spitz, D.R. (1995):** Analysis of glutathion and glutathiondi-sulfind, cysteine, homocysteine and other biologica thiol by HPLC following derivitization by N-(1-pyrenyl) maleimide. *Analy. Biochem.*, 227, 14-21.

- Wright, E.G. (1998):** Radiation-induced genomic instability in hameopoietic cells. *Int. J. Rad. Biol.*, Vol. 74, No. 6, 681-687.
- Yamazaki, K.I. (1971):** Studies on tile raido-resistance of *Bacillus* spores. *Agr. Biol. Chem.*, 35(9), 1449-1458.
- Yarmonenko, S.P. (1988):** Direct and indirect effect of ionizing radiation. In "Radiobiology of Human and Animal", Translated from the Russian by G. Leib, Mir Publishers, Moscow.
- Yonei, S. and Furui, H. (1981):** Lethal and Mutagenic effect of malodidaldehyde, a decomposition product of peroxidized lipid, on *E. coli* with different DNA. *Mutat Res.*, 88.
- Youssef, B.M.; Mahrous, S.R. and Aziz, N.H. (1999):** Effect of gamma irradiation on aflatoxin B<sub>1</sub> production by *Aspergillus flavus* in ground beef stored at 5 °C. *J. Food Safety*, 19, 231.
- Yuring, R.; Michael, G.D. and William, B. (2000):** Direct radiation damage to crystalline DNA, What is the source of unaltered base release?. *Rad. Res.*, 153, 436-441.
- Zaider, M. and Brenner, D.J. (1984):** The application of track calculations to radiobiology. *Rad. Res.*, 100, 213.

obeykhalid.com

# Arabic Summary



جامعة بنها  
كلية العلوم  
قسم النباتات

## مقاومة بعض الفطريات لأشعة جاما ودور المحتوى الخلوى فى مقاومة التشعيع

رسالة مقدمة من

**رشا يحيى عبد الغفار محمد**

بكالوريوس علوم . جامعة الزقازيق . فرع بنها (١٩٩٩)

للحصول على

درجة الماجستير فى الميكروبيولوجى

تحت إشراف

أ.د/ على أحمد إبراهيم حماد  
أستاذ الميكروبيولوجى .  
المركز القومى لبحوث وتكنولوجيا الإشعاع  
هيئة الطاقة الذرية . مدينة نصر

أ.د/ محمود عبد المحسن سويلم  
أستاذ الميكروبيولوجى ورئيس قسم النبات  
كلية العلوم . جامعة بنها

د. / محمود محمد هزاع  
أستاذ الميكروبيولوجى المساعد  
كلية العلوم . جامعة بنها

د. / عزة عبد الفتاح محمد شاهين  
أستاذ الميكروبيولوجى المساعد  
المركز القومى لبحوث وتكنولوجيا الإشعاع  
هيئة الطاقة الذرية . مدينة نصر



جامعة بنها  
كلية العلوم  
قسم النباتات

## المحكمون

اسم الطالبة: رشا يحيى عبد الغفار محمد

عنوان الرسالة:

مقاومة بعض الفطريات لأشعة جاما ودور المحتوى  
الخلوى فى مقاومة التشعيع

## لجنة التحكيم

م	الاسم	الوظيفة	التوقيع
١	أ.د/ يحيى أحمد الظواهرى	أستاذ الميكروبيولوجى كلية العلوم – جامعة الزقازيق	
٢	أ.د/ محيى الدين زهير الفولى	أستاذ الميكروبيولوجى المركز القومى لبحوث وتكنولوجيا الإشعاع – هيئة الطاقة الذرية	
٣	أ.د/ على أحمد إبراهيم حماد	أستاذ الميكروبيولوجى المركز القومى لبحوث وتكنولوجيا الإشعاع – هيئة الطاقة الذرية	
٤	أ.د/ محمود عبد المحسن سويلم	أستاذ الميكروبيولوجى ورئيس قسم النبات – كلية العلوم جامعة بنها	

## المخلص العربي

يوجد العديد من الطرق لتثبيط النمو الفطري في الغذاء والمنتجات الزراعية ومنها استخدام المواد الكيميائية والحرارة والمكافحة البيولوجية حيث وجد أن لها تأثير محدود كما أن لها بعض المساوئ، أما الطريقة الحديثة وهي تكنولوجيا تشعيع الغذاء فهي طريقة متقدمة ونظيفة ومعتمدة من المنظمات الدولية المعنية ولكن وجد أن هناك بعض الفطريات لها قدرة نسبية على مقاومة الإشعاع مثل جنس الكيرفيولاريا، الألترناريا والفيوزاريوم، فهي تحتاج إلى جرعات مرتفعة للقضاء عليها.

ويهدف هذا البحث إلى عزل هذه الفطريات ودراسة مدى مقاومتها للإشعاع ودراسة محتواها الخلوي لمعرفة الدور الذي تلعبه هذه المحتويات في مقاومتها للإشعاع.

في هذه الدراسة تم الحصول على ٥٣ عزلة من جنس الكيرفيولاريا، الألترناريا والفيوزاريوم من مصادر مختلفة مثل القمح والبطاطس والطماطم واليوسفي والحلبة والخبز والبرتقال والترمس وعلف الدواجن وأيضاً الهواء والتربة.

تم اختيار خمس عزلات من كل جنس طبقاً للفروق في شكلها الظاهري كذلك اختلاف المصدر المعزولة منه وكانت النتائج التي تم الحصول عليها كالتالي:

١- بالنسبة للعزلات المعزولة من جنس الكيرفيولاريا (C) كان قطر النمو في العزلة  $Cl_1$  (المعزولة من الترمس) والمعرضة لجرعة إشعاعية ١٠ كيلو جراى (٧سم) بعد ستة أيام من التحضين، بينما وصل إلى ٤ سم بعد سبعة أيام من التحضين في حالة العزلة  $Co$  (المعزولة من البرتقال) في حين أن الجرعة ٦، ٨، ٩ كيلو جراى كانت قادرة على تثبيط نمو العزلات  $Ca, Cs, Cl_2$  (المعزولة من الترمس والهواء والتربة) على التوالي.

٢- بالنسبة للعزلات المعزولة من جنس الألترناريا (A) تم تثبيط قطر النمو في العزلتين  $Am, Af$  (المعزولتين من الحلبة واليوسفي) بعد تعرضهم للجرعة ٩ كيلو جراى بينما كان قطر النمو في العزلة  $Ac$  (المعزولة من علف الدواجن) مازال ٢,٩ سم بعد سبعة أيام من التحضين عند نفس الجرعة. في حين أن الجرعة ٥ كيلو جراى كانت قادرة على تثبيط النمو في العزلتين  $Ab, At$  (المعزولتين من الطماطم والخبز).

٣- بالنسبة للعزلات المعزولة من جنس الفيوزاريوم (F) وجد أن الجرعات ٤، ٧، ٨، ٩ كيلو جرای كانت لها القدرة على تثبيط النمو في كل من العزلات الآتية Fc, Fs, Ft, (المعزولة من البطاطس والطماطم والتربة وعلف الدواجن) على التوالي بعد سبعة أيام من التحضين، بينما FW (المعزولة من القمح) يتوقف نموها تماماً بعد تعرضها إلى الجرعة ٦ كيلو جرای عند اليوم الخامس من التحضين .

٤- تم اختيار عزلتين من كل جنس ليمثلا العزلات المقاومة للإشعاع والحساسة له في الثلاثة أجناس المختبرة وعرفت العزلات المقاومة نسبياً للإشعاع كما يلي: كيرفيولاريا ليوناتا (Cl<sub>1</sub>)، ألترناريا ألترناتا (Ac)، فيوزاريوم أوكسي سبورم (Fc). بينما عرفت العزلات الحساسة نسبياً للإشعاع كما يلي: كيرفيولاريا تيوبركيولاتا (Cl<sub>2</sub>)، ألترناريا تينوسيما (At) وفيوزاريوم سيمي تيكتم (Fp).

٥- وجد أن الوزن الجاف للسلاسل المقاومة والحساسة للإشعاع يقل بزيادة الجرعة الإشعاعية حيث أن الجرعة ٨ كيلو جرای كانت قادرة على تثبيط النمو في فطر الكيرفيولاريا تيوبركيولاتا والفيوزاريوم سيمي تيكتم بينما نفس الجرعة أدت إلى انخفاض الوزن الجاف للكيرفيولاريا ليوناتا وألترناريا ألترناتا وألترناريا تينوسيما وفيوزاريوم أوكسي سبورم إلى: ٦٧,٨، ٤٧,٨، ٩٢,٥، ٦١,٢ % على التوالي.

٦- أوضحت النتائج أن الجرعات الإشعاعية اللازمة لقتل ٩٠ % من الجراثيم (قيمة الانخفاض العشري D<sub>10</sub>) للسلاسل المختبرة: كيرفيولاريا ليوناتا، كيرفيولاريا تيوبركيولاتا، ألترناريا ألترناتا، ألترناريا تينوسيما، فيوزاريوم أوكسي سبورم و فيوزاريوم سيمي تيكتم كانت ١,٩٢، ١,٢٥، ١,٤٧، ١,٤٧، ٠,٤٧، ١,٣١، ٠,٧٠ كيلو جرای في المحلول الملحي على التوالي. في حين أن قيمة الانخفاض العشري في الكيرفيولاريا ليوناتا والكيرفيولاريا تيوبركيولاتا الملوثة لبذور الترمس كان ٢,٢٥، ١,٥٦ كيلو جرای على التوالي، أما في حالة ألترناريا ألترناتا، ألترناريا تينوسيما، فيوزاريوم أوكسي سبورم وفيوزاريوم سيمي تيكتم الملوثة لعلف الحيوان كانت قيمة الانخفاض العشري ١,٧٠، ١,٣٠، ١,٨٣، ١,٢٣ كيلو جرای على التوالي. مما يدل على اختلاف مقاومة هذه الأنواع لأشعة جاما وأن هذه المقاومة تزداد في الأوساط الغذائية عنها في المحلول الملحي.

٧- أوضحت النتائج أن كمية البروتين الكلي في السلاسل المقاومة للإشعاع وهي الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم أوكسي سبورم كانت ٦٧,٨٨،

٧٢,٦٩، ٦٩,٨٣ % على التوالي، أما في حالة السلالات الحساسة نسبياً للإشعاع وهي كيرفيولاريا تيوبركيولاتا وألترناريا تينوسيمما وفيوزاريوم سيمي تيكتم فكانت قيمة البروتين الكلى لها أقل من السلالات المقاومة وقد سجلت النتائج الآتية ١٣,٧٠، ٦٤,٠٦، ٤٦,٨٨ % على التوالي.

٨- وجد أن المحتوى الكلى للأحماض الأمينية في الفطريات المقاومة للإشعاع الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم اوكسى سبورم كان ١٢٩,٢، ١١٤,٤، ٤٩,٢ مليجرام / جرام على التوالي، بينما كان في الفطريات الحساسة نسبياً للإشعاع كيرفيولاريا تيوبركيولاتا وألترناريا تينوسيمما وفيوزاريوم سيمي تيكتم ١٠١,٠، ٧٤,٠، ٦٣,٢ مليجرام/جرام على التوالي، وكانت كمية الأحماض الأمينية الكبريتية (سيسئين وميثيونين) وكذلك التي تحتوي على رابطة ثنائية (هستيدين) في السلالات المقاومة نسبياً للإشعاع أكبر عند مقارنتها بالسلالات الحساسة نسبياً للإشعاع.

٩- سجلت الفطريات المقاومة للإشعاع نسبة دهون كلية أعلى مقارنة بالفطريات الحساسة نسبياً للإشعاع حيث كانت ١٦,٦، ١٢,٥٧، ٨,١٦ % على التوالي بينما كانت في كيرفيولاريا تيوبركيولاتا وألترناريا تينوسيمما وفيوزاريوم سيمي تيكتم ٦,٩٩، ٣,٩١، ٥,٦٧ % على التوالي.

١٠- أظهرت النتائج أن نسبة الأحماض الدهنية غير المشبعة في السلالات المقاومة للإشعاع (الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم اوكسى سبورم) كانت ٧٣,٤٨، ٧١,٦٨، ٧٠,١١ % على التوالي وقد كانت أعلى في قيمتها من السلالات الحساسة نسبياً للإشعاع كيرفيولاريا تيوبركيولاتا وألترناريا تينوسيمما وفيوزاريوم سيمي تيكتم حيث كانت ٦٩,١١، ٦٨,٦٧، ٥٣,٣٨ % على التوالي.

١١- الفطريات المقاومة للإشعاع: الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم اوكسى سبورم وجد أنها تحتوي على نسب أعلى في الأحماض النووية مقارنة بالفطريات الحساسة للإشعاع فكانت ٣٦,٦٣، ٣٥,١٣، ٣٣,٤١ مليجرام / جرام على التوالي، بينما كانت في كيرفيولاريا تيوبركيولاتا وألترناريا تينوسيمما وفيوزاريوم سيمي تيكتم ٦٩,٦٠، ٢٨,١٧، ٢٨,٤٦ مليجرام / جرام على التوالي.

١٢- من النتائج السابقة يتضح أن السلالات المقاومة للإشعاع الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم أوكسى سبورم تحتوى على نسب أعلى من البروتين والدهون الأحماض الدهنية غير المشبعة والأحماض النووية وكانت قيمة الأحماض الأمينية الكبريتية (سيستين ، ميثيونين) وتلك التى تحتوى على رابطة ثنائية (هستيدين) أكبر فى السلالات المقاومة للإشعاع.

١٣- عند دراسة تأثير أشعة جاما عند الجرعة ٤,٠ كيلوجراى تناقصت كمية البروتين الكلى فى السلالات المختبرة وخاصة فى السلالات الحساسة نسبياً للإشعاع: (كيرفيولاريا تيوبركيولاتا وألترناريا تينوسيميا وفيوزاريوم سيمى نيكتم) حيث تناقصت بنسبة ٩,٤٥ ، ١٥,٥٥ ، ١٤,٢٣ % على التوالى، بينما فى السلالات المقاومة نسبياً للإشعاع: (الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم أوكسى سبورم) كان مقدار الإنخفاض ٦,٥٠ ، ٨,٥٢ ، ٩,٤٢ % على التوالى.

١٤- الجرعة ٤,٠ كيلوجراى أدت إلى خفض المحتوى الكلى للأحماض الأمينية فى فطريات كيرفيولاريا ليوناتا، كيرفيولاريا تيوبركيولاتا، ألترناريا ألترناتا، ألترناريا تينوسيميا، فيوزاريوم أوكسى سبورم وفيوزاريوم سيمى نيكتم إلى ١٠٩,٦ ، ٦٢,٠ ، ٦٢,٦ ، ٥٩,٦ ، ٣٦,٦ ، ٥٥,٦ على التوالى، وخاصة الأحماض الأمينية الكبريتية (سيستين وميثيونين) وتلك التى تحتوى على الرابطة الثنائية (هستيدين).

١٥- الجرعة ٤,٠ كيلوجراى خفضت نسبة الأحماض النووية الكلية للسلالات المختبرة خاصة فى السلالات الحساسة نسبياً للإشعاع: (كيرفيولاريا تيوبركيولاتا وألترناريا تينوسيميا وفيوزاريوم سيمى نيكتم) حيث سجلت ٣٠,٧ ، ٤٦,٧٥ ، ٣٤,٢٩ % على التوالى، بينما فى السلالات المقاومة نسبياً للإشعاع: (الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم أوكسى سبورم) كانت ٢٠,٨ ، ٢١,٧٢ ، ٢٧,١٨ % على التوالى.

١٦- انخفضت قيمتى كل من DNA, RNA بعد تعرض السلالات المختبرة إلى ٤,٠ كيلوجراى وكانت نسبة النقص فى DNA أعلى من مثيلتها فى RNA وكذلك كانت أعلى أيضاً فى السلالات الحساسة نسبياً للإشعاع عنها فى السلالات المقاومة للإشعاع حيث سجلت نسبة النقص فى DNA فى حالة الفطريات المقاومة للإشعاع كيرفيولاريا ليوناتا، ألترناريا ألترناتا ، فيوزاريوم أوكسى سبورم ٣٢,٨ ، ٣٣,٧ ، ٢٩,٧ % على التوالى، بينما كانت فى الفطريات الحساسة للإشعاع

كيرفيولاريا تيوبركيولاتا، ألترناريا تينيوسيما، وفيوزاريوم سيمى تيكتم كالآتى:  
٤٠,٦ ، ٥٩,٤ ، ٥٥,٠ على التوالى.

١٧- أجريت تجربة تطبيقية لتحديد الجرعات الإشعاعية اللازمة لوقف نمو جراثيم الفطر كيرفيولاريا ليوناتا الملقحة فى بذور الترمس (وهو الأكثر مقاومة للإشعاع) كذلك فطريات ألتراناريا ألترناتا، فيوزاريوم اوكسى سبورم الملقحة فى علف الدواجن لمدة ثلاثة شهور وقد أوضحت النتائج أن العدد الكلى لجراثيم فطر الكيرفيولاريا ليوناتا وألترناريا ألترناتا وفيوزاريوم اوكسى سبورم (السلالات المقاومة نسبياً للإشعاع) يزداد بعد مرور شهر من التخزين سواء فى العينات غير المشععة أو المشععة بالجرعات (٢,٥-٧,٥ كيلو جراى) ثم يتناقص العدد الكلى أثناء فترة التخزين وكانت الجرعة ١٠,٠ كيلو جراى كافية لوقف نمو فطر فيوزاريوم اوكسى سبورم فى العلف سواء بعد التشعيع أو أثناء فترة التخزين بينما كانت الجرعة ١٢,٥ كيلوجراى كافية لخلو علف الدواجن من جراثيم فطر ألترناريا ألترناتا وبذور الترمس من فطر كيرفيولاريا ليوناتا أثناء فترة التخزين.