European Journal of Medicinal Plants

31(16): 18-23, 2020; Article no.EJMP.62064
ISSN: 2231-0894, NLM ID: 101583475

Gamma Rays Induced Oil and Fatty Acid Alteration in Cumin (*Cuminum cyminum* L.) Seeds

Girjesh Kumar[1] and Mohini Bhardwaj[1*]

[1]Plant Genetics Laboratory, Department of Botany, University of Allahabad, Prayagraj 211002, India.

Authors' contributions

This work was carried out in collaboration between both authors. Author GK designed the study, performed the statistical analysis, wrote the protocol and wrote the draft of the manuscript. Author MB managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJMP/2020/v31i1630326
Editor(s):
(1) Dr. Sabyasachi Chatterjee, Ramananda College, India.
(2) Prof. Marcello Iriti, University of Milan, Italy.
Reviewers:
(1) Hanefi Ozbek, Izmir Bakircay University, Turkey.
(2) Nikola Mitrović, University of Nis, Serbia.
Complete Peer review History: http://www.sdiarticle4.com/review-history/62064

Original Research Article

Received 06 August 2020
Accepted 12 October 2020
Published 04 November 2020

ABSTRACT

Aim: To evaluate the effects of radiation on oil and fatty acid content of cumin by irradiating seeds with varied doses of gamma rays viz.,100 Gy, 125 Gy, 150 Gy, 175 Gy.
Study Design: Oil and fatty acid content was estimated by gas chromatography mass spectroscopy.
Results: The result reveals that oil and fatty acid quantity were significantly changed upon radiation. Oil amount was increased in irradiated seeds whereas fatty acid content was decreased except petroselinic acid and linoleic acid which was increased in comparison to control. In contrast to non irradiated seeds, the lowest dose of gamma found beneficial as oil content and majority of fatty acids were increased.
Conclusion: Therefore, irradiation of cumin seeds for protection and preservation purpose could significantly affect the fatty acid content of cumin as seeds are prone to fungal infections.

Keywords: Fatty acids; gamma radiation; oil content.

**Corresponding author: E-mail: mohinibhardwaj2811@gmail.com;*

1. INTRODUCTION

Cumin is generally known as 'Jeera'or 'Zeera' is an imperative and vital ingredients used in Indian kitchens. Cumin is inhabitant of Egypt, despite of the fact it is majorly produced in India. India is the main producer of cumin in the world. Earlier in Egyptians civilization cumin was used in preservation of mummies. The Romans and Greeks used it medicinally and cosmetically to induce a whitish facial appearance. Because of its characteristic aroma, *C. cyminum* seeds are popularly known as a spice in the food industries of India, Pakistan, North Africa, Middle East, Sri Lanka, Cuba, Northern Mexico, and the Western countries [1].

In conventional medication, the *C. cyminum* seeds used for curing of digestive disorders, dyspepsia, flatulence, diarrhea, toothache, epilepsy, jaundice and colic in Iranian traditional medicine [2,3,4,5,6,7,8] It also has diuretic, cytotoxic, anti-tumor, anti-inflammatory, emmenagogic, anti-fungal and antispasmodic properties [1,9,10,11,12,13].

Cumin seeds are nutritionally prosperous; they supply high amounts of fat, protein, and nutritional fiber. Vitamins B and E and numerous food minerals, particularly iron, are also substantial in cumin seeds [14].

Cumin seed contains 8% moisture, 7% crude fibre, 9.5% total ash, 0.5% acid insoluble ash, 2.3% to 4.8% volatile oil and 25% total ether extract. The flavoring feature of cumin is because of aromatic crucial oil, which can be effortlessly steam distilled. The main constituent of cumin oil is cumin aldehyle, which shows strong antifungal action. The distinctive cumin aroma is due to the presence of cuminaldehyde p-menth-3 en-7-al and p-menth, 1,3 dien 7al. The oil moreover possesses numerous other hydrocarbons and oxygenated compounds [15]. Pandey and Goswami [16] detect the existence of 15 compounds in the cumin oil of which 12 have been identified that constitute 86.4% of the oil. The major compounds were cuminaldehyde (32.6%), p-cymene (14.7%), p-mentha 1,4 dien - 7 al (13.5%) and beta-pinene (12.7%).

Monoterpene hydrocarbons are an additional most important constituent of the oil; sesquiterpenes are inconsequential component [17].

Though cumin possesses enormous pharmaceutical properties but seeds are also prone to various microorganisms' capable spoilage or more often human diseases. Even though used in minimal quantity, spices are a source of food contagion, therefore it is utmost important to prevent and eliminate the pathogenic microflora in the spices. The cumin plant is greatly sensitive to rainfall and rain at some point in harvesting time significantly affects the yield and crop value. Crop eminence is poorly exaggerated by diseases and is reflected in lesser cost once the seeds turned black. Due to evaporableness or heat sensitiveness of the fragile essence and fragrance components of spices and herbs, standard high temperature sterilization cannot be completed without unfavorably disturbing flavor and color [18]. The decontamination method which utilizes rays with high-energy electrons has recently been getting consideration.

Irradiation processing is mostly used to broaden the shelf-life and lock the prominence of foods by reducing the microbe infections which induce the spoiling of food. It is a suitable step towards the disinfection of cereals, spices, dried fruits and nuts [19,20]. Radiation not only identified for its effectiveness to check disinfection but also for its effect on physicochemical properties and natural distinctiveness of food [21,22]. Gamma rays are identified to influence the plant development by stimulating cytological, genetic, biochemical, physiological and morphogenetic alteration in cells and tissue [23]. Gamma radiation has been generally useful in medication and natural science in conditions of genetic effects induced by a counteract instinctive substitute from low dose stimulation to elevated doses inhibition [24,25].

Essential oils and fatty acids have become a subject of significant economic importance, with a constantly escalating market whose fields of importance are straight connected to individual consumption. Therefore, the purpose of this investigation to observe the consequences of gamma radiation on oil and fatty acid composition of cumin.

2. MATERIALS AND METHODS

2.1 Procurement of Seeds

Fresh and healthy seeds of *C. cyminum* L., variety GC- 4 (Gujarat Cumin 4) were supplied by Sardar Krushinagar Dantiwada Agricultural University (S.D.A.U), Jagudan Gujarat.

2.2 Gamma Irradiation

Air tight packets containing cumin seeds were prepared. Gamma radiation was performed using a 60Co source at National botanical Research Institute (N.B.R.I) with effective dose rate of 5.59 KGy/ hr inside gamma chamber -1200 model. Seeds were irradiated with graded doses of gamma rays *viz.*, 100 Gy, 125 Gy, 150 Gy and 175 Gy.

2.3 Estimation of Fatty Acids Content in Gamma Rays

Seed samples were crushed and oil was extracted with solvent extraction method. For GLC analysis, fatty acid methyl ester has been prepared. The test method adopted was IS: 548-(P-III)-(2009) using gas chromatography analysis (GC analysis) from well cleaned and dried seed samples (5 g). For fatty acid analysis seed samples were sent to Mustard Research Promotion Consortium (MRPC), New Delhi.

2.4 Chromatographic Details (Provided by MRPC, New Delhi)

FAME samples were analysed on a Netel Gas chromatograph 9100 equipped with flame ionization detector (FID). Fatty acids were separated with packed SS column, 2 meters x1/8 O.D., chromosorb WHP 100/120 (0.25 mm i.d. 2 m in length, 0.25 µm film thicknesses). The carrier gas was Nitrogen at flow rate of 30 ml min−1, with air 400 ml min^{-1}. The column was temperature programmed at 5°C min^{-1} to 240°C with initial temperature 70°C. The injector was place at 230°C with split ratio of 50:1 and the detector was locate at 240°C.

2.5 Estimation of Oil Content of Seed Samples

Cumin is basically demanded for its oil contents. To ascertain the percentage of oil content, the analysis has been analysed by Mustard Research Promotion Consortium (MRPC), New Delhi. The test method adopted was IS: 7874 – P-I: 1975 for oil estimation.

3. RESULTS AND DISCUSSION

The mean oil content in control sets was 3.38% there is variation in oil content in gamma rays treated seeds. At 100 Gy and 125 Gy an increase in oil content i.e., 6.64 and 5.13 was observed which later found decline up to 3.15 at 150 Gy. Again increase in oil content of 5.02 was noted at 175 Gy and at the maximum dose of gamma rays oil content recorded were 4.77 which were slightly lower than previous dose and higher than control sets. However, most gamma treated seeds show increment in oil content except one.

The fatty acid biosynthesis pathway is a principal metabolic pathway in oil-bearing plants. Acetyl-CoA is the vital constituent of the fatty acid chain, involved in the synthesis of 16- or 18-carbon products, which are the major (up to 90%) fatty acids in plants. Various desaturases located in the plastids and the endoplasmic reticulum are accountable for catalyzing these fatty acids to become monounsaturated (palmitoleic acid, C16:1, and C18:1) or polyunsaturated ones (C18:2 and C18:3). The fatty acid report of cumin seeds after treatment with gamma rays deciphers considerable variations represented in Table 1.

Results revealed that petroselinic acid and linoleic acid were predominated while myristic acid, palmitic acid and stearic acid were found in moderate ratios. In control sets, fatty acid profile represents 4.54% Myristic acid, 5.19% Palmitic acid, 0.69% Stearic acid, 59.23% Petroselinic acid, 29.11% Linoleic acid and 1.24% supplementary minor fatty acids respectively.

Table 1. The fatty acid report of cumin seeds after treatment with gamma rays deciphers considerable variations

Treatment	Oil content (%)	Myristic acid (C14:0)	Palmitic acid (C16:0)	Stearic acid (C18:0)	Petroselinic acid (C18:2)	Linoleic acid (C18:2)	Other minor fatty acid
Control	3.38	4.54	5.19	0.69	59.23	29.11	1.24
100 Gy	6.64	2.16	4.58	0.51	62.93	25.67	4.15
125 Gy	5.13	5.34	4.76	0.66	58.53	29.93	0.78
150 Gy	3.15	3.41	5.17	0.86	59.38	29.87	1.31
175 Gy	5.02	3.55	4.21	0.66	59.35	29.57	2.66

Irradiation caused a noteworthy steady diminish in the unsaturated fatty acid amount and an important saturated fatty acid content augment as irradiation application amplified [26]. Gamma irradiation with different stages of water shortage (modest and harsh water deficit) drop off the fatty acid amount and unsaturation as confirmed by a significant reduction in oleic, linoleic, and linolenic acid proportions and the disappearance of palmitoleic acid [27] as reported in our study Irradiation caused a noteworthy steady diminish in the unsaturated fatty acid amount and an important saturated fatty acid content augment as irradiation application amplified [26]. Gamma irradiation with different stages of water shortage (modest and harsh water deficit) drop off the fatty acid amount and unsaturation as confirmed by a significant reduction in oleic, linoleic, and linolenic acid proportions and the disappearance of palmitoleic acid [27] as reported in our study.

In present investigation, fatty acid profile of gamma irradiated seeds showed variation from control seeds. Highest amount of myristic acid 5.75% was recorded at highest concentration of gamma radiation followed by 5.34% at 125 Gy. Maximum content of palmitic acid was noticed at 150 Gy i.e., 5.17%. Among all the reported fatty acid, amount of petroselinic acid was at peak proportion. At 100Gy dose of Gamma rays, maximum petroselinic acid (62.93%) content was registered followed by 59.38% at 150 Gy of gamma dose. Cumin seeds contain oils with a high concentration of the monounsaturated fatty acid, petroselinic acid. Petroselinic acid could be oxidatively splited to create a combination of lauric acid, which is helpful in the manufacture of detergents, and adipic acid, a six carbon dicarboxylic acid which can be employed in the creation of nylon polymer [28].

Linoleic acid was the second most major fatty acid to be reported. At 125 Gy, highest percentage of linoleic acid (29.93%) was reported which was more than control followed by 29.87% at 150 Gy dose. Additional minor fatty acids were detected in highest proportion at 100 Gy dose (4.15%) which was higher than control.

In this case gamma irradiation caused modifications in both saturated and unsaturated fatty acids of the oil, which revealed enhancement and declining in the comparative quantity of a number of fatty acids present. The findings are in support with preceding studies, in which it was documented that irradiation decreased and amplified some fatty acids [29].

4. CONCLUSION

In conclusion, irradiation of spice seeds is commonly used eliminate microorganisms which on other side brings about some biochemical changes in it. Ionizing radiation might affect the amount of oils by escalating the degree of oxidation. Some fatty acid contents of the cumin samples increased and some decreased with extra radiation dosage.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENTS

The authors are highly thankful to NBRI, Lucknow and MRPC, New Delhi for gamma radiation and GC-MS analysis respectively. The authors also thank head of department and all members of plants genetic laboratory for their valuable support and guidance.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hajlaoui H, Mighri H, Noumi E, Snoussi M, Trabelsi N, Ksouri R, Bakhrouf A. Chemical composition and biological activities of Tunisian *Cuminum cyminum* L. essential oil: A high effectiveness against *Vibrio* spp. Strains. Food Chem. Toxicol. 2010;48:2186–2192.
2. Iacobellis NS, Lo Cantore P, Capasso F, Senatore F. Antibacterial activity of *Cuminum cyminum* L. and *Carum carvi* L. essential oils. J. Agric. Food Chem. 2005;53(1):57–61.
3. De M, De AK, Mukhopadhyay R, Banerjee AB, Miro M. Actividad antimicrobiana de *Cuminum cyminum* L. 2003;44:257-269.
4. Hashemian N, Ghasemi Pirbalouti A, Hashemi M, Golparvar A, Hamedi B. Diversity in chemical composition and antibacterial activity of essential oils of cumin (*Cuminum cyminum* L.) diverse from Northeast of Iran. Aust. J. Crop Sci. 2013;7:1752.

5. Nostro A, Cellini L, Di Bartolomeo S, Di Campli E, Grande R, Cannatelli MA. Antibacterial effect of plant extracts against *Helicobacter pylori*. Phototherapy Research. 2005;19:198–202.
6. Bettaieb Rebey I, Jabri-Karoui I, Hamrouni-Sellami I, Bourgou S, Limam F, Marzouk B. Effect of drought on the biochemical composition and antioxidant activities of cumin (*Cuminum cyminum* L.) seeds. Ind Crops Prod. 2012;36:238–245.
7. Muthamma MKS, Hemang D, Purnima KT, Prakash V. Enhancement of digestive enzymatic activity by cumin (*Cuminum cyminum* L.) and role of spent cumin as a bionutrient. Food Chem. 2008;110:678–683.
8. Eikani HM, Goodarznia I, Mirza M. Supercritical carbon dioxide extraction of cumin seeds (*Cuminum cyminum* L.). Flavour Frag J. 1999;14:29–31.
9. Einafshar S, Poorazrang H, Farhoosh R, Seiedi SM. Antioxidant activity of the essential oil and methanolic extract of cumin seed (*Cuminum cyminum*). Eur. J. Lipid Sci. Technol. 2012;114:168–174.
10. Janahmadi M, Niazi F, Danyali S, Kamalinejad M. Effects of the fruit essential oil of *Cuminum cyminum* Linn. (Apiaceae) on pentylenetetrazolinduced epileptiform activity in F1 neurones of *Helix aspersa*. J. Ethnopharmacol. 2006;104: 278–282.
11. Singh G, Kapoor IP, Pandey SK, Singh UK, Singh RK. Studies on essential oils: Part 10; antibacterial activity of volatile oils of some spices. Phytotherapy Research. 2002;16(7):680–682.
12. Allahghadri T, Rasooli I, Owlia P, Nadooshan MJ, Ghazanfari T, Taghizadeh M, Astaneh SDA. Antimicrobial property, antioxidant capacity and cytotoxicity of essential oil from cumin produced in Iran. J. Food Sci. 2010;75(2):54-61.
13. Oroojalian F, Kasra-Kermanshahi R, Azizi M, Bassami M. Phytochemical composition of the essential oils from three Apiaceae species and their antibacterial effects on food-borne pathogens. Food Chem. 2010;120(3):765-70.
14. Srinivasan K. Cumin (*Cuminum cyminum*) and black cumin (*Nigella sativa*) seeds: Traditional uses, chemical constituents, and nutraceutical effects. Food Quality and Safety. 2018;2(1):1-16.
15. Shankaracharya NB. The spice in India. Symposium on Spice Industry in India. 1974;24-26.
16. Pandey C, Goswami LN. Composition of essential oil from seeds of *Cuminum cyminum* L. Indian Perfumer. 2000;44:265-266.
17. Ahmad Reza Gohari, Soodabeh, Saeidnia. Phytochemistry of *Cuminum cyminum* seeds and its standards from field to market. Phcog. J. 2011;3(25):1-5.
18. Sorenson S. Heat sterilization of spices. First meet. Pepper Exporters Importers Traders Grinders organized by the Int Pepper Community, Bali, Indonesia, 1-2 June; 1989.
19. El-Beltagi HS. Biochemical studies on some Egyptian plants and its relation with environment. M. Sc. Thesis, Biochemistry Department, Faculty of Agriculture, Cairo University; 2001.
20. Cetinkaya N, Ozyardımci B, Denli E, Ic E. Radiation processing as a post harvest quarantine control for raisins, dried figs and apricots. Radiat. Phys. Chem. 2006;75:424-431.
21. Dogbevi MK, Vachon C, Lacroix M. Physicochemical and microbiological changes in irradiated fresh pork loins. Meat Sci. 1999;51:349-354.
22. Golge E, Ova G. The effects of food irradiation on quality of pine nut kernels. *Radiat.* Phys. Chem. 2008;77:365-369.
23. Gunckel JE, Sparrow AH. Ionizing radiations: Biochemical, physiological and morphological aspects of their effects of plants. Encyclopedia of Plant Physiology, Springer-Verlag, Berlin. 1961;16:555-611.
24. Charbaji T, Nabulsi I. Effect of low dosess of gamma irradiation on *in vitro* growth of grapevine. Plant Cell Tiss. Organ Cult. 1999;57:129-132.
25. Afify AMR, El-Beltagi HS, Aly AA, El-Ansary AE. Antioxidant enzyme activities and lipid peroxidation as biomarker compounds for potato tuber stored by gamma radiation. Asian Pac. J. Trop. Biomed. 2012;2:S1548-S1555.
26. Zoumpoulakis P, Sinanoglou VJ, Batrinou A, Strati IF, Miniadis-Meimaroglou S, Sflomos K. A combined methodology to detect γ-irradiated white sesame seeds and evaluate the effects on fat content, physicochemical properties and protein allergenicity. Food Chem. 2012;131(2): 713-721.

27. Yalcin H, Ozturk I, Tulukcu E, Sagdic O. Effect of γ-irradiation on bioactivity, fatty acid compositions and volatile compounds of clary sage seed (*Salvia sclarea* L.). J. Food Sci. 2011;76:1056-1061.
28. Murphy DJ. Designer oilseed crops: Genetic engineering of new oilseed crops for edible and non-edible applications. Agro-Industry Hi-Tech. 1991;2:5-9.
29. Afify AMR, Rashed MM, Ebtesam AM, El-Beltagi HS. Effect of gamma radiation on the lipid profiles of soybean, peanut and sesame seed oils. Grasas Y Aceites. 2013;64(4):356-368.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/62064