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# EFFECTS OF GAMMA RADIATION ON CRUDE OIL YIELD AND CHEMICAL COMPOSITION OF *SESAMUM INDICUM* -TAN 99 SEEDS

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**Abstract**

This study was carried out to investigate the physiological effects of gamma radiation generated on *Sesamum indicum* Tan-99 variety seeds. The seeds were irradiated with doses of 0 (control), 100, 200, 300, 400 and 500 Gy gamma radiation in a cesium ($Ce^{137}$) source. The result showed that the highest crude oil yield was also obtained from 500 Gy. The chemical composition of the all extracts were elucidated by GS-MS and were calculated major compound average in linoliec acid (44%) and oleic acid (37%), respectively. Linolenic acid (C18 : 3n6) and cis 11,14-eicosadienoic acid (C20 : 2) were significantly increased at 400 and 500 Gy dose.

Sesame (*Sesamum indicum* L.) is one of the most ancient oilseed crops used by man (Weiss 1971) and it is an economically important oil seed crop which is widely cultivated in many parts of the world, including India, China, Pakistan, Bangladesh, Saudi Arabia and Turkey, and has recently been adapted to semi-arid regions (Uzun *et al.* 2007). Sesame is widely used in food, nutraceutical, pharmaceutical and industry in many countries because of its high oil, protein and antioxidant contents. Hence, in several countries like Germany, China, India and Turkey, ethnobotanical uses against health problems including cancer, cold, colic, etc. are common (Elleuch *et al.* 2007).

Radiation applications are often used on plants in developing varieties that are agriculturally and economically important and have high productivity potential (Jain *et al.* 1998). Seed irridation is one of the most effective methods to improve plant production, yield components and chemical composition (Selania and Stepanenko 1979). Gamma rays generally influence plant growth and development by inducing cytological, genetical, biochemical, physiological and morphogenetic changes in cells and tissues (Gunckel and Sparrow 1961). Gamma rays belong to ionizing radiation and interact on atoms or molecules to produce free radicals in cells. These radicals can damage or modify important components of plant cells. These effects include changes in the plant cellular structure and metabolism e.g., dilation of thylakoid membranes, alteration in photosynthesis, modulation of the antioxidative system and accumulation of phenolic compounds (Wi *et al.* 2005).

The seeds of *S. indicum* Tan-99 used in the present study were provided from Ege Agricultural Research Institute, Izmir-Turkey in 2010. Seeds were irradiated with doses of 0 (control), 100, 200, 300, 400 and 500 Gy gamma radiation. Irradiation was performed in a cesium ($Ce^{137}$) Gammacell 3000 Elan source, dose rate about 9.75 Gy/min (2900 Ci) at the Pamukkale University, Faculty of Medicine in the Department of the Radiology. Non-irradiated samples served as control. Soxhlet extraction was employed to know the yield of crude oil of the *S. indicum* Tan-99 seed. After gamma radiation, the extraction of the seeds was done with Soxhlet apparatus (GFL, SR1050 Inc.) using petroleum ether as a solvent by hot continuous extraction for 6 hrs (Sabzalian *et al.* 2008). The experimental data was subjected to analysis of variance (ANOVA) using the software SAS (Inc. Chicago, IL, USA) for Windows. Significant differences

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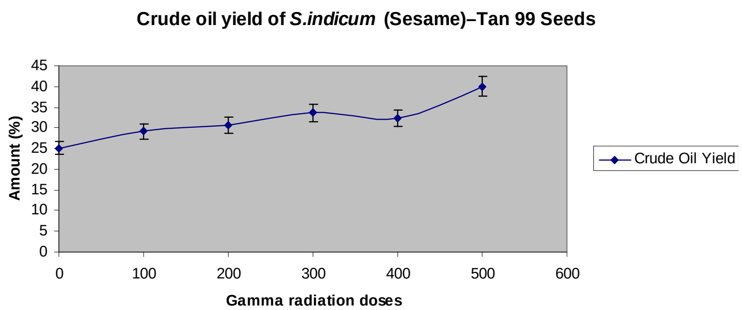
between values were determined using DMRT ($p < 0.05$). GC-MS analyses were carried out on a Agilent 5975 C Agilent 7890A GC-MS equipped with a HP-88 silica column (100 m × 0,250 mm i.d., film thickness 0.20 µm); oven temperature was held at 60°C for 1 min. Then programmed to 175°C at 13°C/min and programmed their temperature to 215°C at 4°C/min; Injector and dedector temperature was 250°C (Bardakçı and Seçilmiş Canbay, 2011). The percentage oil composition of the extracts were determined with MSDChem computer programme.

The effects of gamma radiation on crude oil yield of *S. indicum* Tan-99 seeds are given in Fig. 1. The highest crude oil yield was recorded in the 500 Gy. It is determined that the crude oil yields was measured between 29.15 and 39.98%. Gamma radiation application was increased rate of crude oil yield for all seeds compared to control. Present results are supported by previous published studies that report an increase in oil production by gamma irradiation in several plant species (Sattar *et al.* 1989, Youssef *et al.* 2000).




Significant at 0.05 and 0.01 probability levels, respectively. NS: Non-significant at $p > 0.05$.

Fig. 1. The Effects of gamma radiation on crude oil yield of *S. indicum* (Sesame) Tan-99 seeds (Dry matter, %).

Table 1 shows summary of the fatty acid composition and percentage of saturated and unsaturated fatty acids. Fifteen components of the exract were obtained by soxhlet extraction and were detected by using GC-MS analytical methods. It was determined that, linoliec acid (C18 : 2n6), oleic acid (C18 : 1n9) and palmitic acid (C16 : 0) were the major compounds with average 44, 37 and 12%, respectively. According to Saydut *et al.* (2008) obtained results for the oil content (37 - 63%) of sesame seeds varies widely, the average percentage of oleic and linoleic acid content in the sesame is very similar (41.3 and 43.7%, respectively). The fatty acid composition was not markedly changed by irradiating of the 100 Gy dose. However, irradiating at 400 and 500 Gy significantly increased the percentage of linolenic acid (C18 : 3n6) and cis 11,14 - eicosadienoic acid (C20 : 2). These results indicate that irradiating at higher dose induced decomposition of the polyunsaturated fatty acids. This was probably because, *Sesamum indicum* contains important antioxidant compounds such as carotenoids and tocopherols which can scavenge the radicals generated by gamma radiation.

In conclusion, our results suggested that certain gamma radiation doses positively effect crude oil yield and polyunsaturated fatty acids of sesame (*Sesamum indicum*)-Tan 99 variety seeds. In our results may suggest that gamma radiation can be used in increasing the oil yield and field trials are suggested for further elucidation of effects of gamma radiation on seeds and their biological activities.

**Table 1. Chemical compositions of *S. indicum* (Sesame)-Tan 99 in GC-MS methods.**

| | Compound | Structure | Rt | Control (%) | E1 (%) | E2 (%) | E3 (%) | E4 (%) | E5 (%) |
|---|---|---|---|---|---|---|---|---|---|
| Saturated fatty acids | | | | | | | | | |
| 1 | Lauric acid ME* | (C12 : 0) | 27,3 | - | - | - | - | - | - |
| 2 | Myristic acid ME* | (C14 : 0) | 30,4 | 0,04 | 0,04 | 0,07 | 0,09 | 0,11 | 0,14 |
| 3 | Palmitic acid ME* | (C16 : 0) | 34,5 | 12,88 | 12,87 | 12,81 | 12,79 | 12,74 | 12,78 |
| 4 | Heptadecanoic (Margaric) acid ME* | (C17 : 0) | 36,5 | 0,08 | 0,08 | 0,07 | 0,05 | 0,11 | 0,04 |
| 5 | Stearic acid ME* | (C18 : 0) | 39,1 | 4,22 | 4,22 | 4,18 | 4,15 | 4,39 | 4,14 |
| 6 | Arachidic acid ME* | (C20 : 0) | 43,3 | 0,22 | 0,21 | 0,25 | 0,26 | 0,31 | 0,27 |
| 7 | Pentadecanoic (Pentadecyclic) acid ME* | (C15 : 0) | 32,3 | - | - | - | - | - | - |
| **Unsaturated fatty acids** | | | | | | | | | |
| 8 | Myristoleic acid ME* | (C14 : 1) | 31,8 | - | - | - | - | - | - |
| 9 | Palmitoleic acid ME* | (C16 : 1) | 35,5 | 0,19 | 0,21 | 0,19 | 0,18 | 0,18 | 0,19 |
| 10 | Oleic acid ME* | (C18 : 1n9) | 40,3 | 37,23 | 37,21 | 36,53 | 36,19 | 35,92 | 37,16 |
| 11 | cis-11 eicosenoic acid ME* | (C20 : 1) | 44,9 | - | - | - | - | - | - |
| 12 | Linoliec Acid ME* | (C18 : 2n6) | 42,1 | 44,66 | 44,63 | 44,61 | 44,60 | 44,60 | 44,63 |
| 13 | G-linolenic acid ME* | (C18 : 3n6) | 44,2 | 0,05 | 0,08 | 0,15 | 0,32 | 0,41 | 0,22 |
| 14 | cis 11,14 eicosadienoic acid ME* | (C20 : 2) | 48,3 | 0,06 | 0,08 | 0,10 | 0,23 | 0,35 | 0,11 |
| 15 | EPA (Eicosapentaenoic acid) ME* | (C20 : 5n3) | 53,3 | - | - | - | - | - | - |

ME: Methyl ester, Rt: Retention time, control (%): Control extract (not irradiated), E1 (%): Applied 100 Gy dose extract, E2 (%): Applied 200 Gy dose extract, E3 (%): Applied 300 Gy dose extract, E4 (%): Applied 400 Gy dose extract, E5 (%): Applied 500 Gy dose extract.

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