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The Comparison of effects of gamma radiation of crude oil yield on some sunflower (*Helianthus annuus)* seeds

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Abstract: This study compares the effects of different doses gamma radiation on crude oil yield and moisture of different six variety sunflower (*Helianthus annuus* L.) seeds. As materials, sunflower variety Ege-2001, Turay, AS-508, Tunca, TR-3080 and Tarsan-1018 seeds were used and irradiated with doses of 100, 200, 300, 400 and 500 Gy gamma radiation. Control groups were not subjected to gamma radiation. Irradiation was performed in a cesium (Ce^{137}) Gammacell 3000 Elan source, dose rate about 9.75 Gy/min (2900 Ci) in the Pamukkale University Faculty of Medicine in the department of the radiological. Moisture amount of seeds were also measured by AOCS standarts. Extraction of the seeds was done with soxhlet apparatus using petroleum ether by hot continuous extraction for 6 hours. It was found that the highest moisture rate in 100 Gy for all seeds variety. The moisture rate ranged between 3.00 and 9.68% in TR-3080 and Ege-2001, respectively. According to our results, the moisture content of the seed negatively affected by gamma radiation. The significant reduction in seed moisture content (9.68%) began at 100 Gy of gamma rays and continued to decline to up to 4.04% at 500 Gy. The crude oil yield showed not a important increase in 100 and 200 Gy doses. The result showed that the highest crude oil yield was also obtained from 400 Gy and 33.49% in Ege-2001 seeds.

Key words: Gamma Radiation, *H.annuus*, Oil yield

1. Introduction

The sunflower plant [*Helianthus annuus* (L.)] is tall and it produces edible seeds. The sunflower head with its yellow petals radiating from a dark hub of seeds. The seed itself is edible and its oil is used throughout the world for frying and cooking. Sunflower oil composition consists of 90% oleic and 10% linoleic acids. Protein contents of the seed ranged from 20-30% (Flagella et al., 2002; Arshad and Amjad, 2012).

Sunflower is the fourth biggest source of vegetable oil after palm, rapeseed and soybean. Sunflower breeding countries in the world are Russia, Ukraine, United States, France, Canada and Turkey (FAO, 2005). Sunflower seeds are rich in protein and fat. These foods are also necessary for general health (Arshad and Amjad, 2012).

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Radiation are used on plant biotechnology in developing varieties that are economically and agriculturally important species (Jain et al., 1998). Seed irridation is one of the most effective process to develop plant production (Selania and Stepanenko, 1979).

Gamma rays are ionizing radiation and has interaction on molecules or atoms to produce free radicals in plants. These radicals can disrupt or modify significant ingredients of plants and have been reported to effect differentially the physiology, anatomy and morphology of plants depending on the irradiation level. These effects include changes in the plant cellular structure and metabolism e.g. (Rahimi and Bahrani, 2011).

These effects contain changes in the plant cellular metabolism and structure e.g., variance in antioxidative system, photosynthesis and accumulation of phenolic compounds (Wi et al., 2005). In the present study, the comparison of effects of gamma radiation of crude oil yield and moisture content on some *H. annuus* L. (sunflower) seeds were investigated.

2. Material and Methods

2.1. Plant Materials

The seeds of *H. annuus* used in the present study were provided from Ege Agricultural Research Institute, Izmir-Turkey in 2010. As materials, sunflower variety Ege-2001, Turay, AS-508, Tunca, TR-3080 and Tarsan-1018 seeds were used. In order to preserve its original quality, the irradiated and un-irradiated seeds in sealed bags were stored at room temperature without exposure to direct sunlight.

2.2. Gamma radiation

The different radiation doses (0, 100, 200, 300, 400 and 500 Gy) were applied to the sunflower seeds. Irradiation was performed in a cesium (Ce^{137}) Gammacell 3000 Elan source, dose rate ~9.75 Gy/min (2900 Ci) at the Pamukkale University Faculty of Medicine in the Department of the Radiology. Irradiated and non-irradiated samples were stored at room temperature. Non-irradiated samples served as control.

2.3. Crude Oil Yield

After gamma radiation application, about 4 g of *H. annuus* crushed seeds were extracted to Soxhlet apparatus using petroleum ether as a solvent. The extraction was executed for 6 hours with 250 mL of solvent. The extracts were concentrated and the solvent was then evaporated. The extracted oil yield was expressed as percentage, which is defined as weight of oil extracted over weight of the sample taken (Sabzalian et al., 2008).

2.4. Moisture Analysis

Moisture content was determined by AOAC (1984). The moisture content was carried out by oven drying about 2 g of ground seeds at 105 °C for 24h.

2.5. Statistical Analysis

The experimental data was subjected to analysis of variance (ANOVA) using the software SAS (Inc.Chicago,IL,USA) for Windows. Significant differences between a values were determined using Duncan's Multiple Range test ($P<0.05$).

3. Results and Discussion

The effects of gamma radiation on humidity of sunflower seeds are given in Figure 1. The moisture rate ranged between 3.00 and 9.68% in TR-3080 and Ege-2001, respectively. According to the analysis of test, seed moisture content was affected by gamma radiation in a significantly negative one-way. It was found that the highest moisture rate in 100 Gy for all seeds variety. The significant reduction in seed moisture content (9,68%) began at 100 Gy of gamma rays and continued to decline to up to 4,04% at 500 Gy.

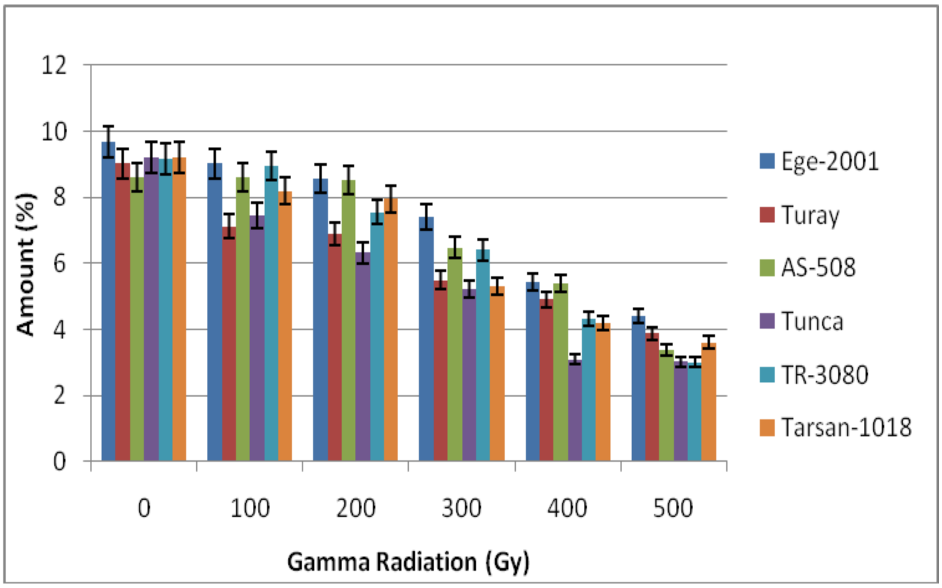

Fig. 1. The effect of gamma radiation on humidity of sunflower seeds

Seed moisture at the time of radiation plays an significant role in the expression of radiation effects (Ohba, 1961; Bhattacharya and Joshi, 1977). Seeds are dry and want to absorption of water and hydrolytic enzymes are activated (Bewley, 1997).

The effects of gamma radiation on crude oil yield of *H. annuus* variety seeds are given in Figure 2. It is determined that the crude oil yields was measured between 10.66 and 33.49%. The lowest crude oil yield was recorded in the Tunca for all doses. The highest crude oil yield was recorded in the Ege-2001 seeds.

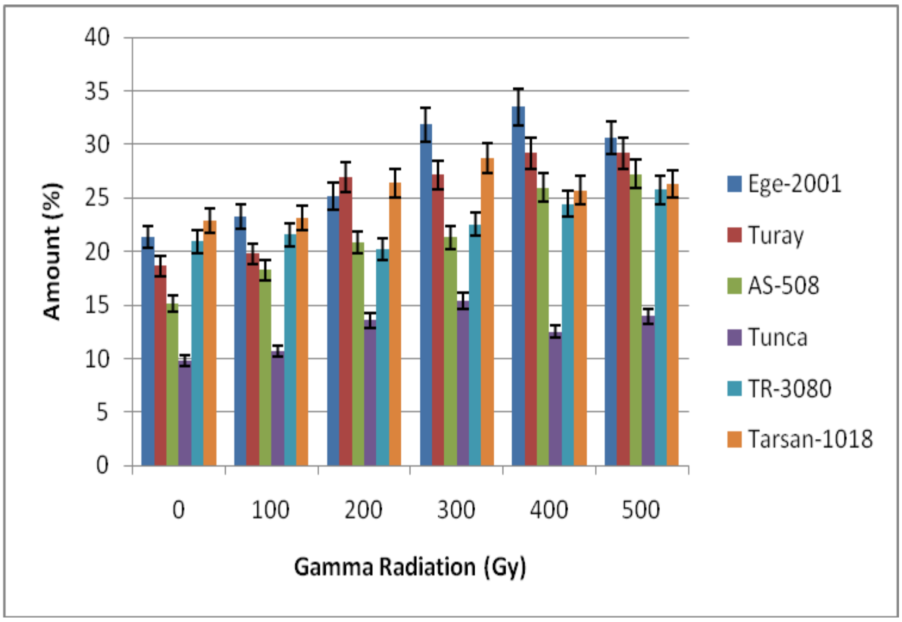

Fig. 2. The effect of gamma radiation on crude oil yield of sunflower seeds

Gamma radiation application was increased rate of crude oil yield for all seeds compared to control. Our 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).

The highest crude oil yield was recorded in the Ege-2001 seeds except for control and 200 Gy dose. The highest crude oil yield is Ege-2001 in 33,49% at 400 Gy dose (Figure 3). Radiation practise are very important in mutation breeding in order to develop necessary features of plants and increasing the genetic variability (Jain et al., 1998). The lowest crude oil yield is Tunca in 10,66% at 100 Gy dose compare to control (Figure 4).

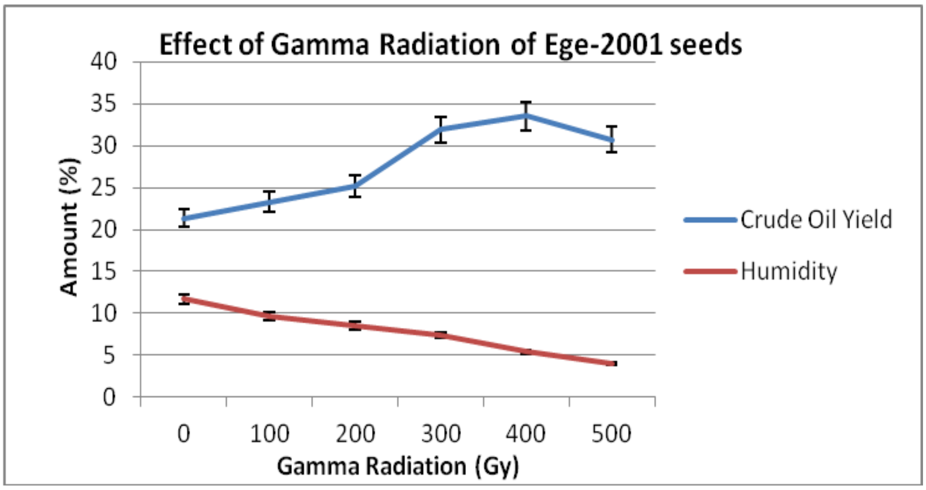

Fig. 3. The effect of gamma radiation of Ege-2001 seeds

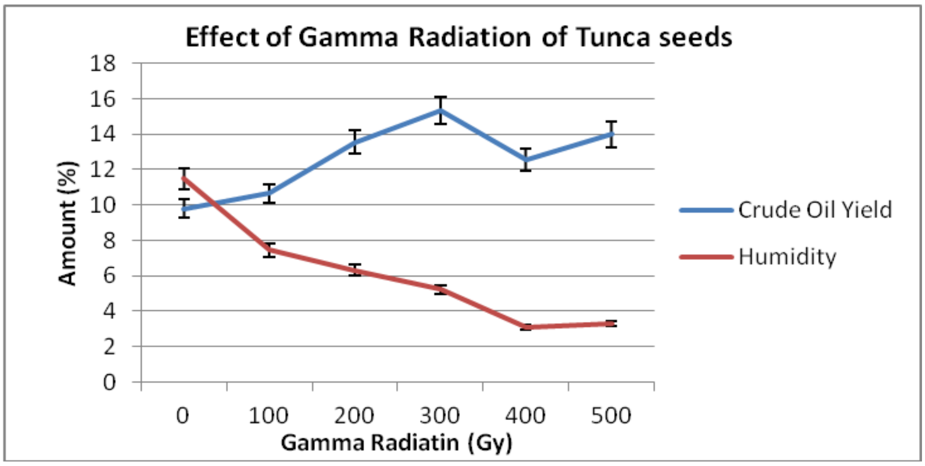

Fig. 4. The effect of gamma radiation of Tunca seeds

Chaudhuri (2002) reported that low moisture rate in lentil (*Lens culinaris*) seeds is more sensitive to radiation and more moisture in seeds has higher resistance to gamma radiation. Similarly, when dose of gamma radiation is increased, moisture level is decreased in Turay (Figure 5), AS-508 (Figure 6), TR-3080 (Figure 7) and Tarsan-1018 (Figure 8) sunflower seeds in our study.

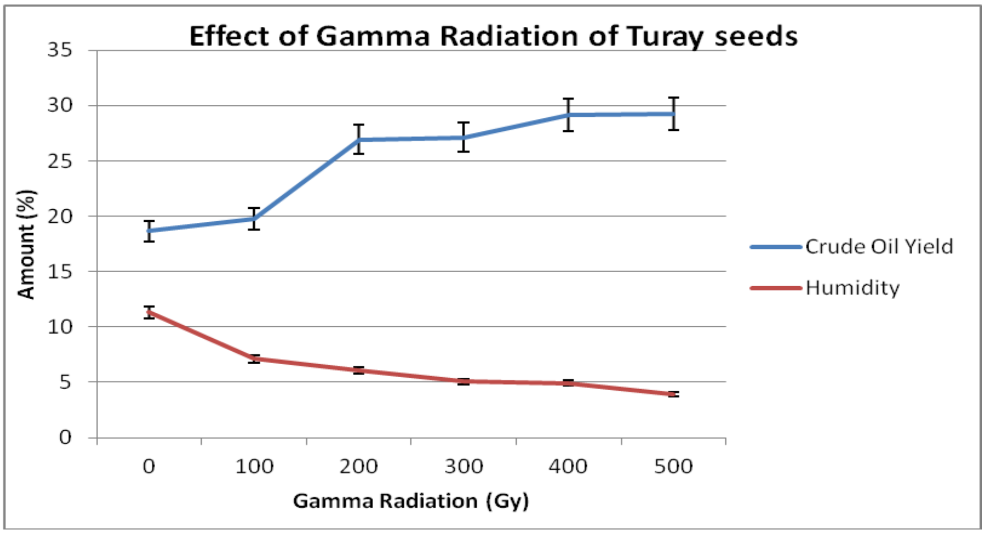

Fig. 5. The effect of gamma radiation of Turay seeds

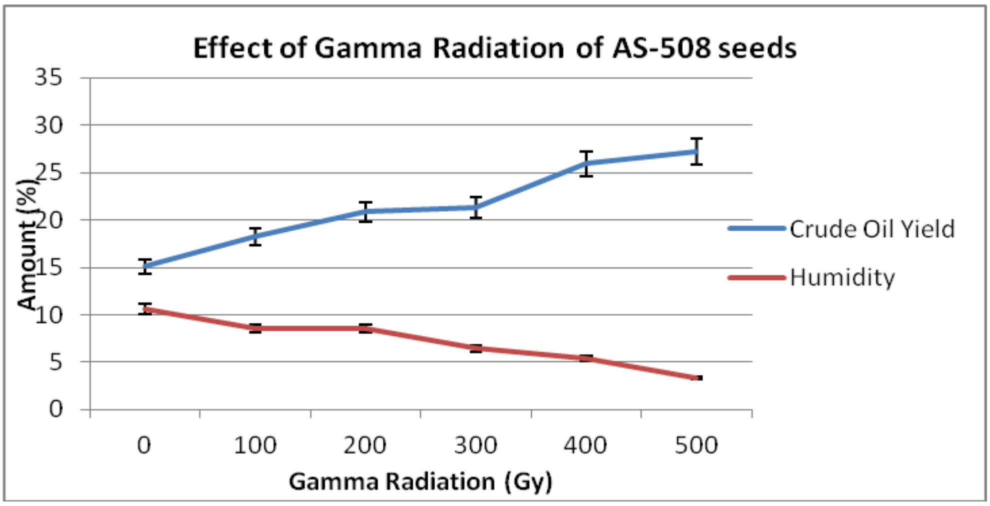

Fig.6. The effect of gamma radiation of AS-508 seeds

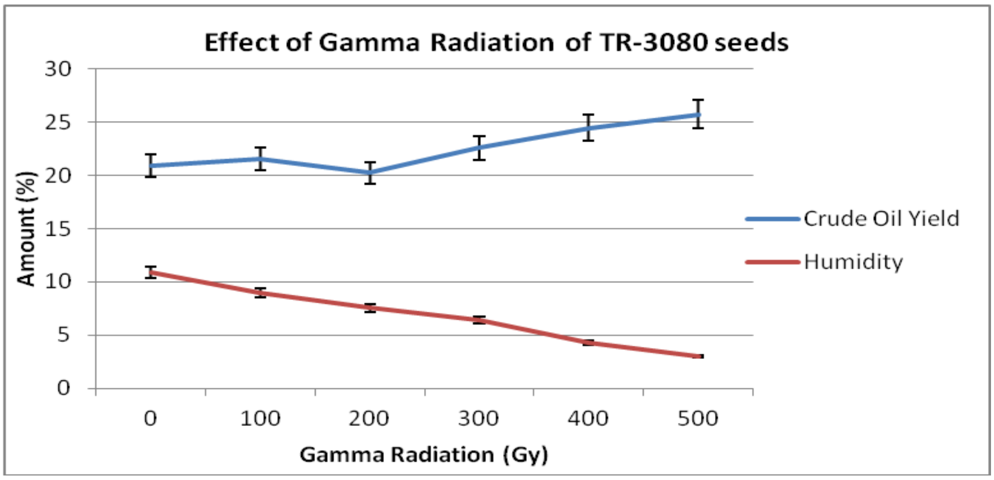

Fig. 7. The effect of gamma radiation of TR-3080 seeds

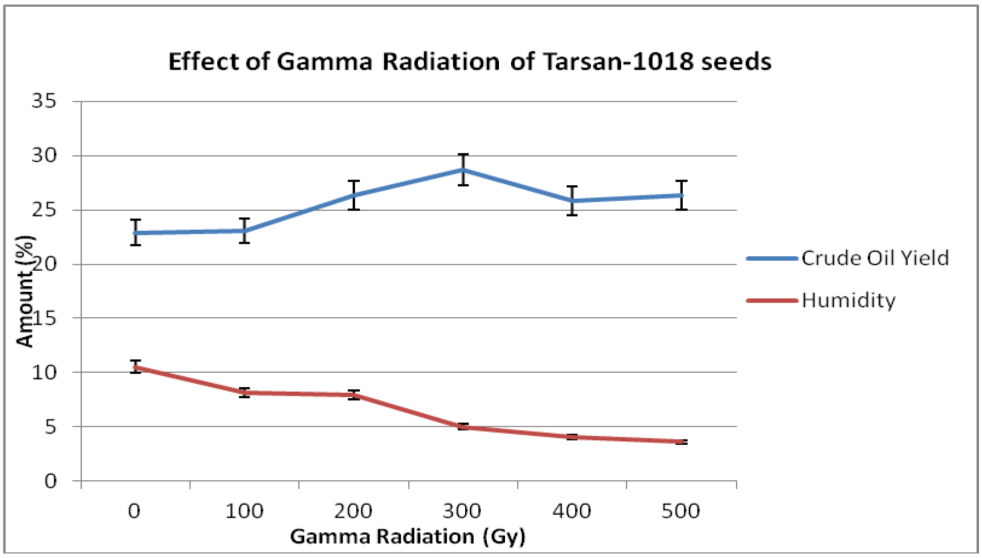

Fig. 8. The effect of gamma radiation of Tarsan-1018 seeds

Okay and Günöz (2009) reported that temperature and moisture affect significantly on embryo formation and development in seeds. In this study, the effect of gamma radiation in six variety of sunflower seed moisture content and crude oil yield were investigated.

As seen from the results given in figures; in accordance with the correct irradiation dose was increased in sunflower seed oil yield. At the same time, It was also provided to reduce the humidity. In conclusion, our results suggested that gamma radiation can be used in both in increasing the oil yield and shelf life of sunflower (*H. annuus*) variety seeds.

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