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Effect of Laser Pre-Treatment on Peanut Seeds on Resveratrol Content and Fatty Acid Profile in Field-Harvested Seeds

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ABSTRACT

Objective: To evaluate the effects of laser radiation on peanut seeds as a pretreatment on the resveratrol content and fatty acid profile in the harvested seeds.

Design/methodology/approach: The experiment was established under field conditions located in the municipality of Nicolás Bravo, Chiapa de Corzo, Chiapas. The seeds were irradiated with a red laser with a wavelength of 636 nm and an intensity of 120 mW. The exposure time of the seeds to the laser was 15 min and non-irradiated seeds were used as a control.

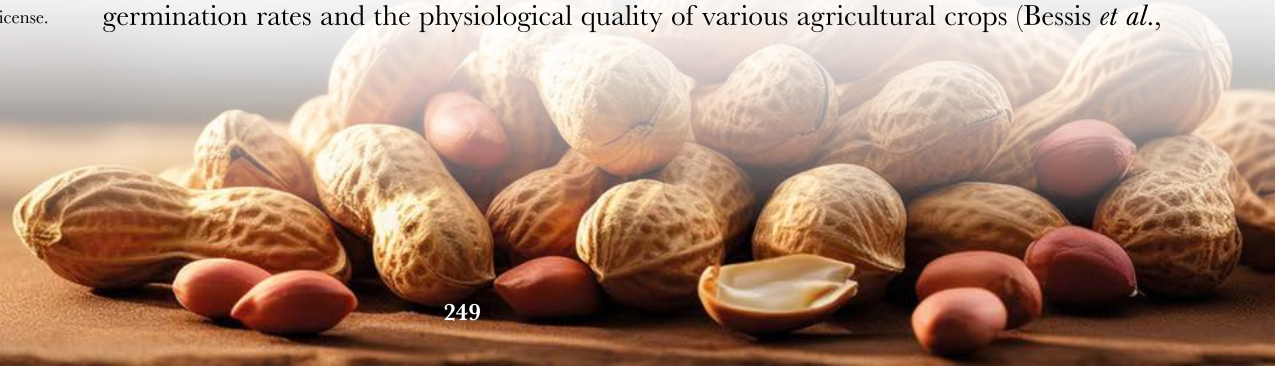
Results: Laser radiation on seeds increased the resveratrol content in the harvested peanut seeds compared to control seeds, and changes were also observed in some fatty acids in peanut oil such as butyric acid, stearic acid and cis 11,14,17 eicosatrienoic acid.

Findings/conclusions: laser irradiation applied to seeds is a low-cost biotechnological alternative that allows generating positive changes in the quality of grains from seeds harvested under field conditions.

Keywords: physical biostimulation of seeds, resveratrol, fatty acids.

INTRODUCTION

The visible light spectrum consists of all light radiations of different colors: violet and blue, ranging from 290 to 500 nm; green, yellow, and orange from 530 to 610 nm; and red from 600 to 750 nm (Singh *et al.*, 2015). Plants in the vegetative and reproductive phases utilize chlorophyll and carotenoids as sensors to capture light; while in the germination phase, phytochromes present in the endosperm and embryo of the seed are the molecules responsible for capturing light radiation (Demotes-Mainarda *et al.*, 2016). Laser is a type of light amplified by stimulated emission of radiation, and due to its potential to concentrate large doses of energy, its application in various biological systems began as a pre-sowing treatment or during some phenological stages of crops, aiming to improve germination rates and the physiological quality of various agricultural crops (Bessis *et al.*,



1962). Bio-stimulation using He-Ne laser (632.8 nm) and laser diodes (650, 660 nm) has been applied in some cereals, such as *Zea mays* L. and *Triticum aestivum* (Toth *et al.*, 1993; Joshi *et al.*, 2012); in some vegetable seeds like *Raphanus sativus* L. and *Solanum lycopersicum* L. (Muszyñski & Gladyszewska, 2008; Álvarez *et al.*, 2011); in oilseeds such as *Carthamus tinctorius* L. and *Helianthus annuus* (Kumar & Srivastava, 2010; Perveen *et al.*, 2010); and in some leguminous seeds like *Medicago sativa* (Wilczek *et al.*, 2005). Currently, the emphasis of various studies is to increase the content of antioxidant compounds and improve the productivity and quality of crops to generate better ingredients and functional foods. Therefore, the objective of this research was to evaluate the effects of laser radiation on seeds as a pre-treatment before planting under field conditions, focusing on the resveratrol content and fatty acid profile of peanut seeds.

MATERIALS Y METHODS

The criollo variety peanut seeds used for this study were collected from the municipality of Jericó, Chiapas, Mexico. The selected seeds for this study had an average size of 1.5-2.0 cm in length and were kept in bags at a temperature and relative humidity of 20±2 °C and 45±2%, respectively, to minimize their metabolic activities and, consequently, loss of viability and energy until the start of the experiments.

The seeds were irradiated with a motorized red laser bar from the brand Steelpro® with a wavelength of 636 nm and an intensity of 120 mW. After conducting tests to select the appropriate exposure time, the conditions for the red laser treatment of the seeds were: an exposure time of 15 minutes at a distance of 15 cm from the seed. Non-irradiated seeds were used as a control. The control and treatment seeds were planted in the field under normal conditions, following the conventional planting method, with a spacing of 30 cm between plants and 60 cm between rows in the locality of Nicolás Bravo, Chiapa de Corzo, Chiapas. Each experimental unit consisted of 200 seeds and was conducted with 3 replications. The pods were harvested manually 115 days after planting; the pods were dried, and the hull was separated from the seeds. The extraction and quantification of resveratrol content (μg/g dry weight) in the hull and seed tissue was performed using the HPLC method described by Limmongkon *et al.* (2017) with some modifications. The separation was carried out on a C18 reversed-phase column. The mobile phase consisted of acetonitrile: water (40:60, v/v) and was run at a constant flow rate of 1 mL/min. The chromatograms were detected using a UV detector at 306 nm. Sigma Aldrich trans-resveratrol was used as a standard to create a calibration curve between the standard concentration and the average peak area. Oil extraction from seeds was conducted using the Soxhlet method, and the preparation of methyl esters of fatty acids followed the methodology described by Santos-Espinoza *et al.* (2020). Fatty acid compositions were analyzed using gas chromatography coupled with mass spectrometry (GC-MS). A completely randomized design was employed, using a simple ANOVA, with the Statgraphics statistical software.

RESULTS AND DISCUSSION

In Table 1, we can observe the resveratrol content in the hull and seeds. The results indicate that there were no statistically significant differences in resveratrol content in the

Table 1. Content of trans-resveratrol in the hull and peanut grains harvested from laser pre-treated seeds before field planting.

Treatments	Resveratrol (μg /g dry weight)	
	shell	Seeds
Control	14.87±0.570 a	7.50±4.27 b
Laser treatment	13.46±0.817 a	54.90±5.40 a
HDS	1.597	11.047

Average values with the same letter in the column are not statistically different (P≤0.05). HDS: Honest significant difference.

hull between the laser treatment and the control. On the other hand, in the seeds, it was observed that the resveratrol content increased sevenfold in the laser treatment compared to the control.

Few studies, such as that of Zhu *et al.* (2020), have investigated the increase in resveratrol content in peanuts in response to physical stimuli, finding that ultraviolet (UV-C) radiation promoted the accumulation of stilbenes by positively regulating the activity of the enzyme stilbene synthase, which is responsible for the synthesis of resveratrol via the phenylpropanoid pathway. They found this to be related to the increased transcription of genes in the stilbene biosynthesis pathway. The fatty acid profile of the oil from the peanut seeds subjected to laser treatment and the control is shown in Table 2. The results show that the most abundant fatty acids present in peanut oil were oleic acid (43-45%), linoleic acid (26%), palmitic acid (11%), stearic acid (4-5%), and cis 11,14,17 eicosatrienoic acid (1-2%), which is similar to what has been reported by various authors, such as Bravo *et al.*

Table 2. Fatty acid profile of the peanut grains harvested from laser pre-treated seeds before field planting.

Methyl esters of fatty acids	Treatments (relative abundance %)		
	Control	Laser treatment	HSD (95%)
Methyl butyrate	0.11±0.006 b	0.19±0.047 a	0.076
Methyl hexanoate	0.18±0.045 a	0.25±0.071 a	0.135
Methyl decanoate	0.04±0.015 a	0.06±0.002 a	0.024
Methyl myristate	0.17±0.081 a	0.09±0.039 a	0.144
Methyl palmitate	11.45±0.264 a	11.70±0.546 a	0.972
Methyl palmitoleate	0.09±0.006 a	0.20±0.117 a	0.189
Methyl heptadecanoate	0.18±0.018 a	0.14±0.035 a	0.063
Methyl stearate	4.96±0.047 a	4.06±0.540 b	0.870
Methyl cis 9-oleate	45.63±0.725 a	43.68±2.199 a	3.711
Methyl linoleate	26.32±0.336 a	26.33±0.533 a	1.010
Methyl arachidate	2.29±0.048 a	1.92±0.365 a	0.591
Methyl cis 11-eicosenoate	1.93±0.004 a	1.64±0.313 a	0.502
Methyl cis 11,14,17 eicosatrienoate	4.27±0.071 b	5.04±0.355 a	0.581
Methyl lignocerate	2.48±0.229 a	1.98±0.631 a	1.076

Average values with the same letter in the row are not statistically different (P≤0.05). HDS: Honest significant difference.

(2018) and Santos-Espinoza *et al.* (2020). The results demonstrate that the laser treatment significantly modified the fatty acid profile of peanut oil, resulting in increases in the relative abundance percentage of butyric acid and cis 11,14,17 eicosatrienoic acid, along with a significant decrease in stearic acid.

In the same way, it was demonstrated that the laser treatment did not affect the most abundant fatty acids in peanut oil, which correspond to unsaturated fatty acids such as oleic and linoleic acids, nor the ratio of oleic to linoleic acid, which mediate the quality of the oil. This is the first report analyzing the effect of laser radiation on seeds as a pre-treatment before planting on the fatty acid profile of peanuts cultivated in the field.

CONCLUSIONS

The laser radiation technique on peanut seeds before planting is a low-cost biotechnological alternative that helps increase the resveratrol content in the seeds. Additionally, it generated changes in the fatty acid profile, which did not affect the most abundant fatty acids in the oil, such as oleic and linoleic acids, thus ruling out the possibility that this technique may have negative effects on the quality of the seed oil.

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