Enhancement of bioactive compounds of sprouts during self-life by combined abiotic stresses

Incremento de compuestos bioactivos durante la vida comercial de germinados mediante estreses abióticos

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Abstract

Sprouts (germinated seeds) usually have a high content of nutrients and are a good source of antioxidants, amino acids, and dietary fiber. Germination can eliminate the toxic anti-nutrients present in the seeds and increase the enzymatic activity. The main objective of this work is to study different pre and postharvest treatments to improve biosynthesis of bioactive compounds in germinated seeds. For this purpose, the application of combined abiotic stresses will be addressed, such as LED or UV lights and the application of essential oils. We expect to enhance the nutritional quality of these products to increase their global consumption increasing healthiness of consumers.

Keywords: minimal processing; LED; UV-B; UV-C; essential oils.

Resumen

Los brotes de semillas germinadas suelen tener un alto contenido de nutrientes y son una buena fuente de antioxidantes, aminoácidos y fibra dietética. La germinación puede eliminar los anti-nutrientes tóxicos presentes en las semillas y aumentar la actividad enzimática. El objetivo principal de este trabajo es estudiar diferentes tratamientos pre y postcosecha para mejorar la biosíntesis de compuestos bioactivos en semillas germinadas. Para ello, se abordará la aplicación de tensiones abióticas combinadas, como luces LED o UV y la aplicación de aceites esenciales. Esperamos mejorar la calidad nutricional de estos productos para aumentar su consumo global aumentando la salud de los consumidores.

Palabras clave: procesado mínimo; LED; UV-B; UV-C; aceites esenciales.

1. INTRODUCTION

Germinated seeds were part of the menu of civilizations such as the Sumerians, Celts, Chinese or Essences. In the last decades of the past century, the attention of experts dealing with the healthy nutrition turned more and more towards the determination of the biological value of the nutritional sprouts (1). In fact, they have become a trendy food. For instance, sprouts are 'the product obtained from the germination of seeds and their development in water, harvested before the development of true leaves and which is intended, including the seed' (1). The nutrients of sprouts and microgreens include proteins, vitamins, phenolics, carotenoids, glucosinolates, and minerals. It is worth noting that the content of bioactive compounds in sprouts and microgreens are higher than those of their mature counterparts (2).

All these components have health benefits on our organism against several diseases like increased vitality, prevention of cardiovascular risks, valuable help to eliminate excess fat,

strengthening the immune system, decrease in blood cholesterol levels, significant improvement in digestion, and rejuvenation of the skin cells by reduction of ROS (Reactive Oxygen Substances) (3). In contrast, sprouts are confronted with several agents that contribute to destroy and diminish their quality, such as wounding, radiation exposure, hyperoxia storage and biotic and abiotic stress caused by the enzyme phenylalanine ammonia-lyase (PAL) (4).

Recently, different postharvest treatments techniques have been applied to sprouts in order to enhance the formation of bioactive compounds in germinated seeds. For instance, application of LED lighting (blue, red, and far red) can be enhance the biosynthesis of bioactive compounds, as well as the application of UV (B, C, and B+C) radiation, in combination to essential oils or individually. These techniques are composed of a spectrum from different wavelengths and different color LED lightings: blue, green, far red, red, and cold white. Thus, they allow providing lighting adapted to the plant, according to the level of its growth. In addition, the quality of the ascorbic acid production has demonstrated to be higher, as well as the chlorophyll content under a LED lighting (2).

Similarly, UV-C application has shown to decreased the photosynthetic characteristics, plant length, and the concentrations of chlorophyll and while UV-B radiation positively affects to the stem diameter, fresh weight and dry weight of the plant, which is highly related to the morphology of the plant and the phytochemical content (5).

Besides, every essential oil is composed of different aromatic substances with antibacterial, antiviral and antiparasitic properties. In this way, each molecule will be active to kill an insect, to repel another or to cleanse a plant (6). Regarding essential oil application, thyme is commonly used as species for cooking due to their aroma and other properties such as antimicrobial, antiseptic and antioxidant activities (7). Besides, it is also rich in polyphenols and other compounds with biological activity (8-10). Therefore, it can be used as alternative food additives to delay bacterial food spoilage and inhibit the growth of pathogenic bacteria such as *E. coli* in vegetables (9, 11).

The main aim of this work is to study the different postharvest treatments to enhance the formation of bioactive compounds in germinated seeds. For that, the application of combined abiotic stresses is going to be addressed. Therefore, the following specific goals will be:

- Study of the application of LED lights (blue, red, and far-red) on sprouts during post-harvest to improve their nutritional quality and composition of phytochemical compounds.
- Study of the application of UVB and UVC on sprouts during post-harvest to improve the nutritional quality and composition of phytochemical compounds.
- Study of the application of essential oils (from thyme, Rosemary, olive tree, etc.) on sprouts during post-harvest to improve their nutritional quality and composition of phytochemical compounds.

2. MATERIALS AND METHODS

For the development of this Thesis, it will be divided into three Phases:

Trial I: Study of essential oils and their characterization.

Trial II: Study of the enrichment of seed sprouts, through the addition of essential oils and abiotic stresses (UV-B and UV-C).

- Application of essential oils to seed sprouts and abiotic stresses (UVB and UVC) to increase their shelf life.

Trial III: Study of the enrichment of seed sprouts, through the addition of essential oils and abiotic stresses (LED lights).

- Application of essential oils in seed sprouts and abiotic stresses (Blue, Red and Far Red, LEDs) to increase their shelf life.

3. EXPECTED RESULTS

After applying these techniques, we hope to improve the productivity and quality of these products in order to increase their overall consumption and the health of the consumer. Table 1 represents the different treatments of sprouts during postharvest and their effects on plants, which have reported positive results and improved the physico-chemical properties in a natural way free of harmful and toxic chemicals for the plant and the consumer.

4. CONCLUSIONS

These applied techniques should make it possible to obtain products of high nutritional value, that can improve the human health maintaining the food quality of this kind of product. This fact can contribute to the fight against malnutrition and the development of functional foods, whose consumption can avoid or retard the apparition of chronic diseases.

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Table 1. Expected results of the present study.

Treatment techniques	**Examples of spices**	**Results**
Oil essential (citronella, thyme, coriander, etc.)	Persian clover, sun flower sprouts, and daikon sprouts (12).	The treatment of essential oils has shown several results in common: -Enhancing phytochemicals -Enhanced plants growth -Improve microbial counts (13)
UV-B / UV-C	Mung bean, soybean, white radish sprouts.	The treatment of UVB and C has shown: -Improved of the total phenolic and flavonoid contents, which is related to their antioxidant activities. -UV-B promotes horizontal growth of stems and the synthesis of UV-B absorbing compounds. - Reduces photosynthetic characteristics, plant length, and the concentrations of chlorophyll a and b. - Strengthen the content of micronutrients and also the resistance of plants to pathogens (UV-C) (5)
LED	Alfalfa sprouts (2) and microgreens (14,15)	LED treatment is a less expensive and effective treatment for the nutritional improvement of plants. - LED light stimulates the accumulation of phytochemicals, such as: phenolic compounds, vitamins, glucosinolates, chlorophyll, and carotenoids. - Stabilize accumulation of secondary metabolites (MS) (2)