INFLUENCE OF ULTRAVIOLET RADIATION ON MICROBIOLOGICAL AND SENSORY CHARACTERISTICS OF CERTAIN CATEGORIES OF VEGETABLES PRODUCTS AND THEIR PRESERVATION LIFE

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Abstract:
Research paper aims to highlight the scientific correlation between the influence of ultraviolet radiation (UV) on sensory and microbiological characteristics of plant products in the category of leaves (lettuce) and other types of vegetables or fruit (bananas) and their preservation's duration, through their UV irradiation under certain conditions.
The literature indicates a germicidal action of UV (medium UV) on micro-organisms, optimal for λ = 254 nm. The effectiveness of radiation is influenced by duration of irradiation, the distance between the radiation source and the sample product and radiant power source.
The action of microbial cell inactivation or destruction can be explained by changes in cellular structure and permeability with changes at the level of mitochondria and the genetic material as a result of photochemical effects of UV products. Research highlights the preservative effect of UV radiation (with λ = 254 nm) and also their influence on sensory properties and positive to negative for leafy vegetables and fruits (bananas in our case).

Keywords**:** preservation, UV irradiation, lettuce, bananas

1. INTRODUCTION

Sterilizing effect of ultraviolet radiation (UV) is known and applied in various fields, especially in air sterilization of surgery rooms, running water with a certain thickness of the layer of liquid etc. UV radiation is emitted by mercury vapor lamps and they are classified as short UV with λ = 200-280 nm, medium UV radiation with λ = 280-315 nm and long UV with λ = 315-400 nm. Photons of non-ionizing radiations have a low energy of 3-5 eV, and do not have ionization capacity, but only produce an excitation of molecules, which then leads to their chemical modification. Bactericidal action of UV radiation [1] is achieved through photochemical effects, Their Effectiveness depends on the Dose of UV radiation, and the unit of radiation Dose is the product of radiation intensity (μW/cm2) and duration of irradiation in seconds.
Research specialists worldwide shows that the most effective UV radiation that can be used to preserve certain types of foods without negatively impacting their characteristics are the average wavelength (λ = 280-315 nm). Our work aims to extend research on UV irradiation of vegetable products from leaves category (lettuce) with reduced thickness and of plants with higher thickness (taking research to bananas, which is one of the most perishable vegetable products).
The research aims to increase the shelf life of vegetable products, without significantly alter their sensory characteristics. In our case the main directions of research aimed at studying the combined action of UV radiation and the cold:

- Sensory properties of lettuces and bananas;
- Surface microbiota bananas;
- Shelf-life without significantly changing the sensory properties of the products mentioned above.

It insisted on physicochemical or histological changes in banana pulp, because UV radiation does not penetrate into the depths of the product.

Goals and objectives

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2. MATERIAL AND METHODS

In all determinations, there were used parallel samples non-irradiated and irradiated with radiation in different conditions (irradiation power, duration, distance between the source and the irradiated product, etc.), using germicidal lamps, mercury vapor type LF - 106 S with power of 12 W, 50 Hz and $\lambda = 254$ nm, and LF - 150 S, with output of 50 W, $\lambda = 254$ nm Voltage-220 V.
These categories of lamps have been designed with characteristics (power and wavelength of UV radiation), specific for use in food irradiation [4], taking into account the security measures and the use of annexes provided in the instructions.
There have been chose different samples (lettuce and bananas) while determining the sensory and microbiological characteristics at different time intervals. For each analysis, standardized methods were used. The research has been made in several phases, each with clearly defined objectives as follows:

3. RESULTS AND DISSCUTION

3.1. Evolution of the sensory characteristics of fresh lettuce and irradiated with UV-irradiated at different time intervals.

The results are shown in Table 1 [3].
Technical data:
- Sources of UV irradiation: LF – 106 S lamps, 220 V, 50 Hz, 12 W and LF – 150 S lamps, 254 nmGrid – Tube, 50 W;
- P_M – test witness, unirradiated salad;
- P_I – salad irradiated with LF 106 S lamp, ι = 10 min. h = 10 cm (distance between the source of irradiation and the test witness;
- P_n – salad irradiated on both sides with LF – 106 S lamp, ι = 10 min., h = 10 cm;
- P_m – salad irradiated LF – 150 S lamp, ι = 10 min., h = 10 cm;

From the analysis of results obtained on sensorial characteristics by applying UV irradiation, the negative effect of salad irradiation with UV is ascertained. The most irradiated (on both sides) test witness (P_n) was really degraded (abnormal sere aspect, improper color, non-specific odor). Other investigation analysis was not needed due to the fact that the products were compromised.

Table 1. Evolution of the sensory characteristics of fresh lettuce and irradiated with UV-irradiated at different time intervals

Duration ι	P_M	P_I	P_n	P_m
19 hours	- slightly sere; - specific color, with slight shades of yellowish on the exterior; - no odor	- sere; - slight shades of yellowish; - no odor	- very sere; - green-yellowish color; - non-specific odor.	- slightly sere; - specific color; - no odor
38 hours	- slightly sere; - specific color, with slight shades of yellowish on the exterior; - no odor	- sere; - slight shades of yellowish; - no odor.	- physically degraded; - green color; - light yellowish; - non-specific odor;	- slightly sere; - specific color; - no odor;
57 hours	- sere; - green-yellowish color; - no odor;	- sere; - yellowish color; - no odor;	- dehydrated; - greenish – yellowish color; - no odor;	- sere; - green-yellowish color; - no odor;

The explanation for these modifications is given by caloric and photochemical effect exerted by UV radiations over thin salad leaves, that were fully penetrated by UV radiations (it is known that the penetration power of UV radiations is of approximately 1 mm).

3.2. The evolution of sensorial characteristics of bananas in a certain state of maturity, after irradiation with UV and refrigerated

The results presented in table 2 were obtained by using irradiated and unirradiated parallel test witnesses [3].

Technical data:

- Sources of UV irradiation: LF – 106 S lamps, 220 V, 50 Hz, 12 W and LF – 150 S, 254 nm Grid – Tube, 50 W;
- P_M – test witness, unirradiated banana;
- P_I – banana irradiated with LF 106 S lamp, ι = 10 min. h = 10 cm (distance between the source of irradiation and the test witness;

From the analysis of results obtained on sensorial characteristics of bananas by applying UV irradiation, it is ascertained that the germicide effect of UV radiations has positively influenced the evolution of sensorial characteristics related to aspect, texture, tissues rigidity etc.

Thus, we can see that the pulp of UV irradiated test witness did not degrade not even after 7 days of refrigeration, in comparison with the unirradiated test witness which degraded during this time interval. This result indicates the possibility of increasing the period of conservation for bananas, through mixed methods (irradiation with UV and refrigeration). In order to set precisely norms for bananas preservation, it is necessary to use fresh bananas test witnesses, immediately after they were harvested. We can asses that for bananas (or for other vegetal products with a peel thicker than 1 mm), the presence of covering peel on the surface of the products, provides pulps with a barrier against UV action, the UV radiations acting only on the peel.

Enzymatic activity and surface microbiotics inactivation or destruction extends bananas' conservation period, without seriously influencing sensorial and nutritional characteristics of their pulp.

3.3. The evolution of the total number of germs (NTG) on the surface of the examined bananas

This analysis gives us the opportunity to highlight the bactericide effect of UV radiations and indirectly the preservative effect of UV irradiation procedure.

Technical data:

- Sources of UV irradiation: LF – 106 S lamps, 220 V, 50 Hz, 12 W and LF – 150 S, 254 nmGrid – Tube, 50 W;
- P_M – test witness, unirradiated bananas;
- P_I – bananas irradiated with LF 150 S lamp, ι = 10 min. h = 10 cm (distance between the source of irradiation and the test witness;
- P_{II} – bananas irradiated on all sides with LF – 150 S lamp, ι = 5 min., h = 10 cm;
- P_{III} – bananas irradiated with LF – 106 S lamp, ι = 10 min., h = 10 cm;
- P_{IV}– bananas irradiated with LF – 106 S lamp, ι = 5 min., h = 10 cm;

Nutritive environments of meat broth and agar (BCA) were used for determination, (MMA) for bacteria cultivation at temperatures of 37^0C, for 24 h and malt must and agar (MMA) for yeasts and molds, at 25^0C, for 5 days.

From table 3 we can see that the irradiation with UV reduces the total number of microorganisms with 70 % when the irradiation is performed with a germicide lamp of 12 W, for 5 minutes and with a distance of 10 cm between the source of irradiation and the test witness. The wave length of UV radiations was of 254 nm (P_I).

By increasing the period of irradiation from 5 to 10 minutes, the other criteria remain unchanged, but the total number of microorganisms is reduced by 83% (P_{II}).

Table 2. The evolution of sensorial characteristics of bananas in a certain state of maturity, after irradiation with UV and refrigerated

Duration ι	P_M	P_I
19 hours	- slightly smooth; - slight brown shades on the exterior; - specific odor;	- slight brown shades; - specific odor;
38 hours	- slightly smooth; - brown on the exterior; - specific odor;	- brown; - slight shades of yellowish; - no odor;
57 hours	- slightly smooth; - brown; - specific odor;	- sere; - specific odor;
163 hours	- Abnormal aspect; - Out-of-shape texture; - Non-specific odor;	- brown; - specific odor; - specific taste, pleasant;

Table 3. Reducing the number of microorganisms during UV irradiation

P_M		P_I		P_{II}		P_{III}		P_{IV}	
BCA	MMA	BCA	MMA	BCA	MMA	BCA	MMA	BCA	MMA
3300 germs	2000 germs	550 germs	1050 germs	-	930 germs	-	800 germs	-	600 germs
NTG: 5300 germs/cm^2		NTG: 1600 germs/cm^2		NTG: 930 germs/cm^2		NTG: 800 germs/cm^2		NTG: 600 germs/cm^2	

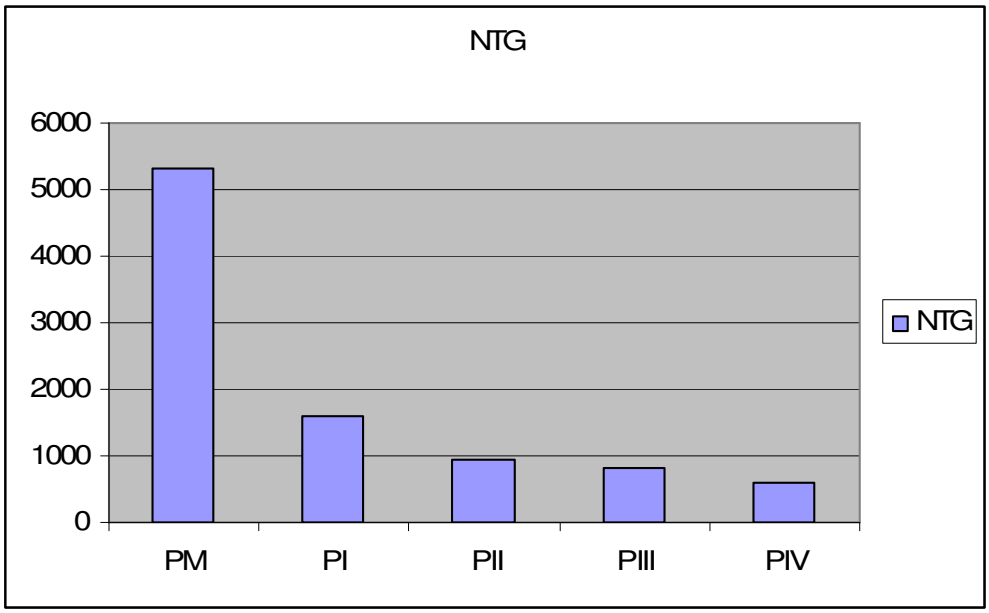

Fig. 1. The evolution of the total number of germs (NTG) on the surface of the examined bananas

A more powerful germicide lamp (50W) was used in the third experiment. By using a period of irradiation of 5 minutes, with irradiations on the wave length of 254 nm, the total number of microorganisms is reduced by 86% (P_{III}).
By using the same conditions, but by increasing the period of irradiation to 10 minutes, the total number of microorganisms is reduced by 89% (P_{IV}).
The sensibility of bacteria to UV radiations is visibly higher than that of yeasts and molds. Practically in tests P_{II}, P_{III}, P_{IV}, bacteria were fully destroyed.

4. CONCLUSIONS

For the fruits that are part of the same category as bananas, mix conservation by UV irradiation (λ = 254 nm), for a period of 10 minutes, with a distance between the source of irradiation and test witness of 10 cm, followed by refrigeration extends their period of preservation with at least 50%;
The extension of the preservation period, as well as the reduction of enzymatic activity (the reduction of the number of microorganisms leads to the decrease of the quantity of enzymes secreted by them) is explained by the germicide effect of UV radiations UV with λ = 254 nm;
The preservation through UV irradiation of green salad (including its leaves) is not recommended, due to the reduced thickness of its leaves, which are negatively affected by irradiation. This effect is explained by the modifications generated by the caloric and photochemical effect exerted by UV radiations on the leaves;
In comparison with yeasts and molds, the most sensible microorganisms to the action of UV radiations are bacteria.

5. REFERENCES

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