INFLUENCE OF THE ULTRAVIOLET LIGHT ON THE SENSORIAL, PHYSICAL-CHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF SOME VEGETAL PRODUCTS

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Abstract

The research follows the increase of preservation duration for vegetables and fruits through mixed preservation procedures: UV irradiation and chilling, checking in the same time sensorial, physical-chemical modifications, which took place during treatments.
As sample have been used green salad, banana and apple juice, the irradiation being made with UV light with λ=254 nm, at 10 cm distance from UV source and product.
The results show that the salad sample was negatively influenced by UV light action due to large surface and small thickness of product, which is affected by caloric and photochemical effect of UV.
Banana and apple juice have benefit positively by UV action, and it was prolonged the preservation period with 100%, without having negative effects on the sensorial, physical-chemical properties and on vitamin C.

Keywords: salad, banana, apple juice, preservation, UV light, irradiation

1. INTRODUCTION

The ultraviolet lights are invisible radiations with the wavelength between 10-400 nm. They can be short (250-280 nm), medium (280-315 nm) and long wavelength (315-400 nm).

From the specialty literature it can be observed the germicide action of ultraviolet light on microorganisms. The most efficient are the ultraviolet lights with λ=254 nm, which are produced by germicides lamps. The irradiation efficacy is influenced by the irradiation duration, the distance between the light source and the product sample, including the power of the source.

The destroy or inactivation action of the microbial cell is explained by the modification of the cell's structure and permeability, with modifications at the level of mitochondrion and of the genetic material caused by the photochemical effects produced by ultraviolet light.

In the same time there are produced physical-chemical, histological transformations with direct effects of the sensorial characteristics. The level of these transformations depends on the light power, irradiation duration and the distance between the source and sample.

2. THE RESEARCH PURPOSE

The main purpose of the research is the increase of the preservation duration for vegetables and fruits by using mixed preservation procedures by irradiation and chilling. In the same time it have been followed the main physical-chemical and sensorial transformations of vegetables products irradiated with ultraviolet lights.

3. MATERIALS AND WORK PROCEDURE

It have been used to all analysis parallel samples, non –irradiated and irradiated with ultraviolet light in different conditions (irradiation power, duration etc.) with germicide lamps with mercury stems of the type LF – 106 S, having power of 12 W and the frequency of 50 Hz and λ=254 nm and LF-150 S, having power of 50 W and λ=254 nm, powered at 230V.

It have been selected different samples (green salad, banana and apple juice) and have been determined in the same time the sensorial, physical-chemical, biochemical and microbiological characteristics at different time intervals.

There have been made analysis regarding the evolution of the sensorial characteristics, determinations of soluble dry matter, C vitamin, peroxidases' activity and total number of germs.

For each analysis have been used standards methods. The research was carried on in several phases, each phase having its own well defined objectives:
1. Evolution of the sensorial characteristics of fresh green salad non-irradiated and irradiated with ultraviolet lights in different conditions
The results are showed in table 1.

Technical data:
- LF – 106S, 230 V – 50 Hz, 12 W;
- LF – 150S, 254 nm Grid-Tube, 50 W.

P_M – witness sample, non-irradiated salad;
P_I – irradiated salad to lamp LF – 106S, τ=10 min, h=10 cm;
P_{II} – both sides irradiated salad to lamp LF – 106S, τ=10 min, h=10 cm;
P_{III} - irradiated salad to lamp LF – 150S, τ=10 min, h=10 cm;

Tab1e 1.

Duration	P_M	P_I	P_{II}	P_{III}
19 hours	- light faded; - specific color with light tinge of yellowy to exterior; - no odor.	- faded; - light tinge of yellowy; - no odor.	- very faded; - green-yellowy color; - not specific odor.	- light faded; - specific color; - no odor.
38 hours	- light faded; - specific color with light tinge of yellowy to exterior; - no odor.	- faded; - light tinge of yellowy; - no odor.	- physical weather-beaten; - green-light yellowy color; - not specific odor.	- light faded; - specific color; - no odor.
57 hours	- light faded; - specific color with light tinge of yellowy to exterior; - no odor.	- faded; - yellow color; - no odor.	- very faded; - yellowy-greenish color; - no odor.	- faded; - green-yellowy color; - no odor.

Through analysis of the recorded results, it can be observed the negative effect of the salad irradiation with ultraviolet light. It has to be remarked that immediately after irradiation, the most irradiated sample (PII – with both side irradiation) was effectively weather-beaten (not proper aspect – faded and improper color and not a specific odor). The powerful sensorial modifications have eliminated the necessity to carry on other investigation analysis.
The explanation of these modifications is given by the caloric and photochemical effect exercised by ultraviolet light on the salad leaves, having a very small thickness (it is known the fact that ultraviolet lights have a power of penetrability of solid tissues of 1 mm).

Evolution of sensorial characteristics of the existing banana in a maturity stage after preservation, then UV irradiated and introduced in chilling.

Using parallel samples non-irradiated and irradiated have been obtained the results from table 2.

Technical data:
- LF – 106S, 230 V – 50 Hz, 12 W;
- LF – 150S, 254 nm Grid-Tube, 50 W.

P_M – witness sample, non-irradiated banana;
P_I – irradiated sample.

Table 2.

Duration	P_M	P_I
19 hours	- light soft; - light tinge of brown; - specific odor.	- light tinge of brown; - specific odor.
38 hours	- light soft; - brown; - specific odor.	- brown; - specific odor.
57 hours	- light soft; - brown; - specific odor.	- brown; - specific odor.
163 hours	- not proper aspect; - deformed texture; - not-specific odor.	- brown; - specific odor. - specific, good taste.

Through analysis of the results it can be observed that the germicide effect of ultraviolet has positively influenced the evolution of the sensorial characteristics related to aspect, texture, tissues' rigidity etc.

It can be also observed that the sample pulp UV irradiated was not spoilage after 7 days of preservation in chilling in the conditions of the spoilage of the non-irradiated sample. \this result indicates the possibility of prolongation of the preservation duration of banana through mixed methods (UV irradiation and chilling). In order to establish exactly how long will be increased the preservation's duration it is necessary to continue the research using fresh product samples, immediately after harvesting. It can be appreciated that the presence of the coat to the banana's surface, with a thickness of 2-3 mm, offers to the pulp a barrage against the VV action, the lights having its action only on the coat.
The inactivation or destruction of surface micro Flores and enzymes activity, prolongs the preservation duration of banana without influence on the sensorial and nutritional characteristics of their pulp.

Evolution of the sensorial, physical-chemical, biochemical and microbiological characteristics of the UV irradiated apple juice, chilled.

Sensorial characteristics

Results of the sensorial analysis are showed in table 3.
Technical data:

- LF – 106S, 230 V – 50 Hz, 12 W;
- LF – 150S, 254 nm Grid-Tube, 50 W.

P_M – witness sample, non-irradiated apple juice;
P_I – irradiated apple juice to lamp LF – 150S, τ=10 min, h=10 cm;
P_{II} – irradiated apple juice to lamp LF – 150S, τ=5 min, h=10 cm;
P_{III} - irradiated apple juice to lamp LF – 106S, τ=10 min, h=10 cm;
P_{IV} - irradiated apple juice to lamp LF – 106S, τ=5 min, h=10 cm;

Table 3

Duration	P_M	P_I	P_{II}	P_{III}	P_{IV}
Initial	- light yellow color, without sediment, specific odor,	- dirty orange color, without sediment, specific odor,	- orange color, without sediment, specific odor	- dirty orange color, without sediment, specific odor,	- orange color, without sediment, specific odor
18 hours	- light yellow color, without sediment, specific odor	- dirty orange color, without sediment, specific odor	- dirty orange color, with sediment, specific odor	- dirty orange color, with sediment, specific odor	- dark orange color, with sediment, specific odor
42 hours	- orange color, without sediment, specific odor	- dirty orange color, without sediment, specific odor,	- orange-brown color, with sediment, specific odor	- orange-brown color, with sediment, specific odor	- orange-brown color, with sediment, specific odor
55 hours	- dirty orange color, with sediment, specific odor	- dirty orange color, with sediment, specific odor	- orange-brown color, with sediment, specific odor	- orange-brown color, with sediment, specific odor	- orange-brown color, with sediment, specific odor

Through the analysis of the obtained results it can be observed that in a first stage, immediately after irradiation, there are not recorded sensible modifications of the sensorial characteristics of

apple juice excepting slight color modifications (light darkness of the irradiated samples), caused by presence of fine suspensions in the underdone gross juice and to photochemical effect of UV. During time, both samples, non-irradiated and irradiated presents the same sensorial characteristics.

Determination of peroxidases activity

The analysis of peroxidases activity (using the experimental methods presented in literature) shows the following result:

- non-irradiated sample: peroxidases activity = 0,175;
- UV irradiated sample for 5 minutes at 10 cm distance: peroxidases activity = 0,120.

So it can be observed a cutting down of the oxidative enzymes activity to the UV irradiated products (in certain conditions) with a positive effect.

Determination of C vitamin

It have been effectuated analysis using STAS method with 2.6 diclorfenolindofenol and the iodometrical method.

STAS method with 2.6 diclorfenolindofenol:

mg ascorbic acid/100 g = ((V*t)/M)*100*d (1)

In which:
V – volume of the 2,6 diclorfenolindofenol solution used in titration, in ml;
t – solution of 2,6 diclorfenolindofenol by rapport with ascorbic acid, mg/ml;
M – product mass analyzed, in g;
d- effectuated dilution;
M= 5 g apple juice
d=10
$t_{2,6\ diclorfenolindofenol/ascorbic\ acid} = 0,125$

For non-irradiated sample:
V_N = 0.4 ml 2,6 diclorfenolindofenol

For irradiated sample:
V_i= 0.4 ml 2,6 diclorfenolindofenol

For non-irradiated sample:
$P_N = ((0.4*0.125)/5)*100x*10 \rightarrow P_N$ = 10 mg ascorbic acid / 100 g

For irradiated sample:
$P_i = ((0.4*0.125)/5)*100x*10 \rightarrow P_i$ = 10 mg ascorbic acid / 100 g

Iodometric method:
mg ascorbic acid/100 g = ((V*t*100*d)/M (2)

In which:
V – volume of KIO_3 0.004 N solution used in titration, in ml;
t – titrul of solution of KIO_3 0.004 N by rapport with ascorbic acid, mg/ml;
M – product mass analyzed, in g;
d- effectuated dilution;
M= 5 g apple juice
d=10
$t_{KIO3/ascorbic\ acid}$ = 0,352 mg ascorbic acid / ml KIO_3
For non-irradiated sample (P_N): V_N = 0.1 ml KIO_3 0.004 N
For irradiated sample (P_i): V_i= 0.1 ml KIO_3 0.004 N

For non-irradiated sample:
$P_N = (100*0.352*0.1*10)/5 \rightarrow P_N$ = 7.04 mg ascorbic acid / 100 g

For irradiated sample:
$P_i = (100*0.352*0.1*10)/5 \rightarrow P_i$ = 7.04 mg ascorbic acid / 100 g

After analyzing the results it can be observed that through UV irradiation it have not produced decrease of vitamin C level during the UV irradiation.

Determination of soluble dry matter

The analysis made on the two parallel samples, non-irradiated and irradiated with UV for 5 minutes to 10 cm between the irradiation source and analyzed sample, shows that this value remain unchanged for both samples, 13,5 % soluble dry matter.

Determination of the evolution of total number of germs NTG

This is the main analysis which is indicated the bactericide effect of UV light and the preservation effect of irradiation operation.

Technical data:

- LF – 106S, 230 V – 50 Hz, 12 W;
- LF – 150S, 254 nm Grid-Tube, 50 W.

P_M – witness sample, non-irradiated apple juice;

P_I – irradiated apple juice to lamp LF – 150S, τ=10 min, h=10 cm;

P_{II} – irradiated apple juice to lamp LF – 150S, τ=5 min, h=10 cm;

P_{III} - irradiated apple juice to lamp LF – 106S, τ=10 min, h=10 cm;

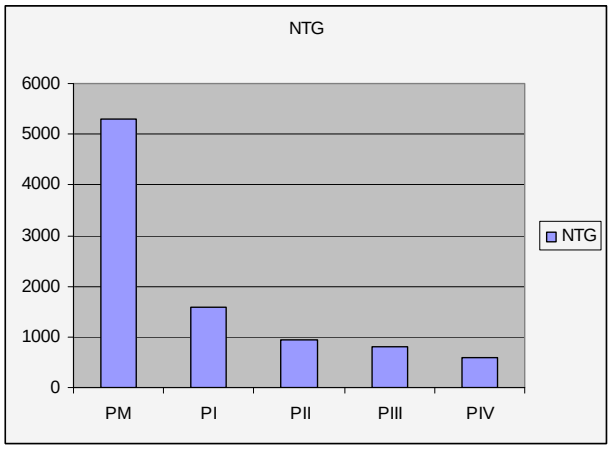
P_{IV} - irradiated apple juice to lamp LF – 106S, τ=5 min, h=10 cm;

In order to make determinations there were used nutrient medium of meat bouillon and agar (BCA) for cropping bacteria at 37^0C for 24 hours and malt and agar must (MMA) for cropping yields and moulds at 25^0C for 5 days.

Table 4

P_M		P_I		P_{II}	
BCA	MMA	BCA	MMA	BCA	MMA
3300 µorg.	2000 µorg.	550 µorg.	1050 µorg.	-	930 µorg.
NTG P_M= 5300 Germs/ 1 ml		NTG P_I= 1600 Germs/ 1 ml		NTG P_{II}= 930 Germs/ 1 ml	

P_{III}		P_{IV}	
BCA	MMA	BCA	MMA
-	800 µorg.	-	600 µorg.
NTG P_{III}= 800 Germs/ 1 ml		NTG P_{IV}= 600 Germs/ 1 ml	



From table 4 it can be observed that the UV irradiation decrease the total number of microorganisms with 70% at irradiation with a germicide lamp with a power of 12 W, for 5 minutes, to a distance of 10 cm between the irradiation source and sample, with UV light having λ=254 nm (P_I).

By increasing the irradiation duration to 10 minutes in the same conditions it will be obtained a decrease of the number of microorganisms with 83% (P_{II}).

Using a powerful germicide lamp, of 50 W, with an irradiation time of 5 minutes with radiations having λ=254 nm, it will be obtained a decrease of total number of germs with 86% (P_{III}) and increasing the irradiation time to 10 minutes to the same lamp, it will be obtained a decrease in the number of microorganisms with 89% (P_{IV}).
In the same time it can be observed a more powerful sensibility of bacteria to irradiation by rapport with yields and moulds. In this case, for sample II, III and IV bacteria have been entirely destroyed.

4. CONCLUSIONS

- It is not recommended the irradiation of leaves with UV light due to the negative effects caused by lost of the main sensorial characteristics: faded aspect, dehydration, modified color, strange odor;
- For the fruits from banana category, the mixed procedure for preservation by UV irradiation for 10 minutes, at distance of 10 cm to irradiation source, using UV light with λ=254 nm, followed by chilling, prolongs the preservation duration, due to the inactivation and destruction of the most part of surface micro flora.
- The prolongation of the preservation duration is also favored by the significant reduction of the enzymes activity;
- The most sensible microorganisms to the UV light action are bacteria (by rapport with yields and moulds);
- Apple juice can be preserved by the combined action of UV irradiation (λ=254 nm) at 10 cm to source and other preservation methods (chilling or pasteurization) with the condition that the thickness of the juice to be no greater than 1 cm;
- Apple juice is recommended to be boiled before treatment;
- The determinations made during the research shows that the C vitamin content of the soluble dry matter has not been affected by UV lights.

5. REFERENCES

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