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Combined effect of ultraviolet radiation and application of acetic acid on the quality of guinea pig meat and increased of its shelf life

Abstract

The aim of this research was to determine the effect of the combination of Ultra Violet radiation (RUV) and acetic acid (AA) on the quality of guinea pig meat and the increasing of its shelf life. 90 weaned guinea pigs of 14 days old on average were used. A3x3 Factorial Design was used, 9 treatments with 5 repetitions and 2 animals per repetition, considering: Factor 1: UV radiation time (0, 5 and 10 minutes) and Factor 2: Acetic acid concentration (0, 2 and 4%). A total of 45 experimental units were analyzed. The parameters evaluated were meat quality: nutritional, microbiological, physical, chemical and organoleptic characteristics and meat productivity: weight gain, feed consumption, feed conversion, carcass yield, health and mortality of guinea pigs. For the analysis of the data was used Variance Analysis and Duncan's mean comparative test was applied to determine the differences between treatments, using the statistical program SAS (Statistical Analysis System), and for the sensory analysis was used Scalar difference test and Friedman test. The ultraviolet radiation combined with acetic acid enhances the antimicrobial activity and improves the quality of guinea pig meat, increasing its shelf life. The protein, ethereal extract, ashes and nitrogen-free extract of guinea pig meat were not altered by the application of RUV and AA. The moisture and dry matter of guinea pig meat are maintained with the application of RUV and AA. The organoleptic characteristics (smell, color, taste, juiciness and texture) of the meat were not altered by the application of RUV and AA, being greater the preference degree for guinea pig meat that received this application. There was no statistical difference between treatments.

Keywords: guinea pig, UV radiation (RUV), acetic acid (AA), meat quality, shelf life

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Introduction

Food can contain different kind of spoilage agents coming from natural sources, environmental contamination or those who have been incorporated during their production or transformation, in some cases, causing diseases, which are called foodborne illness. Meat is a matrix rich in nutrients that provide an adequate environment for the proliferation of various microorganisms, spoilage, and pathogens microorganisms, within this group are *E. coli* O157 and non-*E. coli*-O157, *Salmonella spp*. and *Listeria monocytogenes*.

Food preservation methods aim to increase the shelf life of products during storage, ideally by applying techniques that prevent microbiological alterations while maintaining quality. That is why today technologies have been created that achieve this goal; among them the UV Radiation stands out, defined as; "Absorption by atoms and molecules produces joint breaks and ion formation (photochemical reactions)".

Nowadays UV radiation is used in different sectors of the food industry, due to the harmful effect it causes on the DNA of many microorganisms. Also, it is chosen because it is a process which does not alter the organoleptic properties of the products and reduces the use of chemical substances. It is used for the preservation of liquid and solid foods, but in solid food, this application is effective at the surface.[1]

For this reason, the aim of this research was to determine the effect of the combination of UV radiation and acetic acid on the quality of guinea pig meat and the increasing of its shelf life.

Materials and methods

The present research was carried out in the guinea pig farm specially prepared for the development of this study and at the laboratories of the Professional School of Agroindustrial Engineering at UNMSM in San Juan de Lurigancho District – Lima city, Perú.

24 guinea pig cages were constructed of brick and had the following dimensions of 0.5m long by 0.5m wide and 0.37m high and wood chips as the bed, where 3 guinea pigs will be housed in each cage. A clay feeder per cage was used, with the capacity of 250 grams, a total of 24 feeders and a drinking trough covered with earthenware, one per cage with a capacity of 250ml, a total of 24 drinking troughs were used.

The balanced feed that was used in the control of the present experimental work was formulated using Mixit-2 plus software for monogastric animals, the raw materials to be used were those found in a local market. The forage was fresh alfalfa in 10% of the live weight, each week the animals were weighed; this was the reference and was increasing as weekly the animals' weight increased. The forage was distributed in two parts one half in the morning and the other half in the afternoon per day.

The drinking water was offered daily and it was clean and fresh, for which the drinking troughs were washed.

90 guinea pigs were used, which were distributed in 9 treatments and 5 repetitions per treatment, where each repetition consisted of 2 animals.

The animals were placed in a prefabricated guinea pig farm with calamine roof. Twenty-four cages of 0.5m long by 0.5m wide and 0.37m high were used, with one clay feeder and one clay drinking trough per cage. A scale of 3Kg of capacity with a sensitivity of 2g was used to control the weight of animals and food.

The use of UV technology for disinfection purposes involves the ultraviolet region of the electromagnetic spectrum, with a wavelength range between 100 and 400 nm. This can be subdivided into: UV short-wave (UV-C) between 200 and 280nm, germicidal range. UV wave medium (UV-B) between 280 and 315nm and UV long wave (UV-A) between 315 and 400nm.

Acetic acid is a natural chemical that is found in apples, cheese, cocoa, grapes, milk, oranges, parsley, peaches, pineapples, raspberries, strawberries and berries. The vinegar is approximately 5% acetic acid. As a GRAS substance, it is often used as a flavoring agent, in the pickling process and to control acidity in processed foods.[2]

The shelf life or expiration of a food can be defined as "the period of time, after processing and/or packaging and under certain storage conditions, in which the food remains safe and suitable for consumption", in other words during this time, it must conserve its physical-chemical, microbiological and sensory characteristics, as well as its nutritional and functional characteristics.

Treatments

9 treatments were evaluated, which are described below:

T1: UV rays for 0 min y 0% acetic acid

T2: UV rays for 0 min y 2% acetic acid

T3: UV rays for 0 min y 4% acetic acid

T4: UV rays for 5 min y 0% acetic acid

T5: UV rays for 5 min y 2% acetic acid

T6: UV rays for 5 min y 4% acetic acid

T7: UV rays for 10 min y 0% acetic acid

T8: UV rays for 10 min y 2% acetic acid

T9: UV rays for 10 min y 4% acetic acid

Parameters evaluated

Physical analysis

Chemical analysis

Microbiological analysis

Sensory evaluation

Experimental design

A 3x3 Factorial Design 9 treatments with 5 repetitions each one, 2 animals per repetition was used, considering: Factor 1: UV radiation time (0, 5 and 10 minutes), Factor 2: Acetic acid concentration (0, 2 and 4) %). A total of 45 experimental units.

Analysis of data

The data were analyzed using the SAS program. Duncan's test was used to compare the averages and for the tasting test was used the Scalar difference test, Friedman test, ANVA and Tukey test.

Results and discussion

Physical analysis

In Table 1 is presented the result of the proximal physical analysis of guinea pig meat, according to the parameters evaluated, the following results are observed:

Table 1 Proximate physical analysis of guinea pig meat (*)

Treatment	Moisture	Dry matter
0'UV+0%AA	59.49	40.51
0'UV+2%AA	66.81	33.19
0'UV+4%AA	69.29	30.71
5'UV+0%AA	62.95	37.05
5'UV+2%AA	70.99	29.01
5'UV+4%AA	70.05	29.95
10'UV+0%AA	71.21	28.79
10'UV+2%AA	66.58	33.42
10'UV+4%AA	66.20	33.80

*The values correspond to the average of three samples per treatment

Moisture: The meat of the guinea pig that received 10 minutes of ultraviolet radiation without acetic acid (10'UV+0% AA) presented the highest percentage of moisture with 71.21%, followed by the meat of the guinea pig of the treatment 5'UV+2% AA with 70.99% and the lowest percentage of moisture was presented by the meat of the guinea pig with 0'UV+0% AA.

Dry matter: The meat of the guinea pig that received 0'UV+0% AA presented the highest percentages of dry matter with 40.51%, followed by the meat of the guinea pig that received 5'UV+0% AA with 37.05% and the lowest percentages of dry matter was presented by the meat of the guinea pig that received 10'UV+0% AA with 28.79%.

Chemical analysis

The results of the proximal chemical analysis of guinea pig meat from different treatments are shown in Table 2. The amount of protein, ether extract and nitrogen-free extract on average is maintained with the application of RUV but decreases with increasing the percentage of AA application. Also, a number of ashes are maintained with the application of both RUV and AA.

It can be seen that the best percentages of protein (17.65%), ethereal extract (13.63%) and ashes (1.38%) were for the meat of the guinea pigs that received 0'UV+0% AA, being the lowest percentage of protein (14.02%) and ashes (0.71%) for the meat of the guinea pigs that received 5'UV+2% AA and the lowest percentage in ethereal

extract (7.82%) was for the meat of the guinea pigs that received 10'UV + 0% AA.

In nitrogen-free extract, the highest percentage (7.88%) was presented by the meat of the guinea pigs that received 5'UV+2% AA, followed by the meat that received 10'UV+0% AA with 7.85% and the lowest percentage of nitrogen-free extract was presented by the meat of the guinea pigs that received 5'UV + 4% AA with 5.58%.

Sensory evaluation

Organoleptic characteristics: The information on organoleptic characteristics of guinea pig meat is shown in Table 3. The tasting panelists familiar with guinea pig meat gave as consensus, guinea pig meat samples which ones received 5 'and 10' of RUV+AA, had an excellent color, smell, taste and juiciness obtaining the best qualifications. Likewise, texture remains the same in all treatments.

When performing the statistical analysis of the results, it was observed that there is no significant difference between the samples on the organoleptic characteristics of guinea pig meat that received different experimental diets (treatments).

When we analyzed the surveys templates done by trained tasters and familiar with the consumption of guinea pig meat, it was found the color, smell, taste, juiciness and texture of the guinea pig meat where the RUV and AA were applied, were not altered and had the best preference, this shows that the application of RUV and AA to guinea pig meat does not affect its organoleptic characteristics.

Preference degree for guinea pig meat: Regarding the preference degree of guinea pig meat of the different treatments are shown in Table 4. The panellists showed much preference with 62.5% for guinea pig meat that received 10'UV+4%AA, then preference with 62.5% for guinea pig meat that received 10'UV+2% AA, they showed little preference for meat that received 0'UV+2% AA and no preference for meat that received neither RUV nor AA (0'UV+0% AA).

When performing the statistical analysis of the results, referring to the preference for the meat of guinea pigs from different treatments, it was observed, there were no significant differences between the samples on the preferences of guinea pig meat that received the different experimental diets (treatments).

The tasters showed a lot of preference for guinea pig meat where RUV and AA were applied, which indicates a high degree of satisfaction of the panellists for the guinea pig meat that received the longest UV application time combined with the highest AA percentage.

Microbiological analysis of guinea pig meat

The result of the microbiological analysis is shown in Table 5 and Figure 1. It is appreciated that there was no growth of colonies in MacConkey agar, that is to say, there was no presence of microbial load, in the same way in Nutritive agar in the treatments with 5'UV+2%AA, 5'UV+4%AA and 10'UV+2%AA. The highest microbial load was presented by the meat of the treatments with 0'UV+0%AA.

Table 2 Proximate chemical analysis of guinea pig meat (*)

Treatment	Protein (%)		Ethereal extract (%)		Ash (%)		Nitrogen-free extract (%)	
	Wet	Dry	Wet	Wet	Dry	Wet	Dry	Wet
0'UV+0%AA	17.65	43.34	13.63	34.07	1.38	3.39	7.85	19.20
0'UV+2%AA	13.16	39.61	13.35	40.58	0.91	2.73	6.10	17.09
0'UV+4%AA	15.13	49.27	8.95	29.10	1.01	3.3	5.62	18.34
5'UV+0%AA	16.04	43.09	12.04	32.20	1.20	3.27	7.77	21.45
5'UV+2%AA	14.02	48.34	9.40	22.19	0.71	2.45	7.88	27.02
5'UV+4%AA	14.75	49.26	8.72	29.10	0.9	2.99	5.58	18.65
10'UV+0%AA	16.65	40.38	11.82	26.56	0.96	2.67	8.56	30.39
10'UV+2%AA	15.07	45.1	10.31	30.97	1.01	3.01	7.03	20.92
10'UV+4%AA	14.88	43.88	10.63	34.66	0.83	2.42	6.47	19.04

*The values correspond to the average of three samples per treatment

There was no presence of a microbial load, this indicates that the application of RUV and AA on guinea pig meat inhibits bacterial growth, decreasing the microbial load on the surface. The UV-C radiation (254nm) has an important bactericidal action and on the other hand, its use is proposed to produce a beneficial effect in the tissues in response to low or sub-lethal doses according to the concept of "hormesis".[3]

UV-C radiation is emerging as one of the technologies with greater application in the future, Cisneros-Zevallos[4] suggests the postharvest application of a type of controlled abiotic stress (for example exposure to UV-C light) to induce production and increase of the synthesis of photochemical compounds with nutraceutical activity or the reduction of undesirable compounds. Thus, stress control induced by UV-C light can be used as a tool to reinforce the beneficial properties of fresh products, whole or cut products.[5]

Ultraviolet radiation combined with acetic acid enhances its antimicrobial activity, as observed in the results presented in this research

Table 3 Organoleptic characteristics of guinea pig meat of different treatments

Treatment	Color	Smell	Taste	Juiciness	Texture
0'UV+0% AA	2.63	3.38	2.63	2.63	2.63
0'UV+2%AA	2.88	2.75	2.63	2.63	3.00
0'UV+4%AA	3.13	3.13	3.13	3.00	3.00
5'UV+0%AA	2.88	3.38	3.00	3.25	3.25
5'UV+2%AA	3.50	3.50	3.13	2.75	2.88
5'UV+4%AA	3.13	3.38	3.13	3.13	3.00
10'UV+0%AA	3.38	3.38	3.13	3.00	3.13
10'UV+2%AA	2.88	3.38	3.38	3.25	3.38
10'UV+4%AA	3.38	3.75	3.88	3.38	3.38

Table 4 Degree of preference for guinea pig meat of different treatments

Treatment	Much preference		Preference		Little preference		No preference		Total
	N°	%	N°	%	N°	%	N°	%	N°
0'UV+0%AA	0	0	3	37.5	3	37.5	2	25	8
0'UV+2%AA	1	12.5	2	25	5	62.5	0	0	8
0'UV+4%AA	2	25	5	62.5	1	12.5	0	0	8
5'UV+0%AA	4	50	0	0	4	50	0	0	8
5'UV+2%AA	2	25	5	62.5	1	12.5	0	0	8
5'UV+4%AA	3	37.5	4	50	1	12.5	0	0	8
10'UV+0%AA	3	37.5	5	62.5	0	0	0	0	8
10'UV+2%AA	3	37.5	5	62.5	0	0	0	0	8
10'UV+4%AA	5	62.5	3	37.5	0	0	0	0	8

Table 5 Microbial load on guinea pig meat

Treatment	Plate count (CFU/mL)	
	Nutritive agar	MacConkey agar
0'UV+0%AA	9.00E+04	0
0'UV+2%AA	2.00E+04	
0'UV+4%AA	0.00E+00	
5'UV+0%AA	1.00E+04	
5'UV+2%AA	0.00E+00	
5'UV+4%AA	0.00E+00	
10'UV+0%AA	0.00E+00	
10'UV+2%AA	0.00E+00	
10'UV+4%AA	1.00E+04	

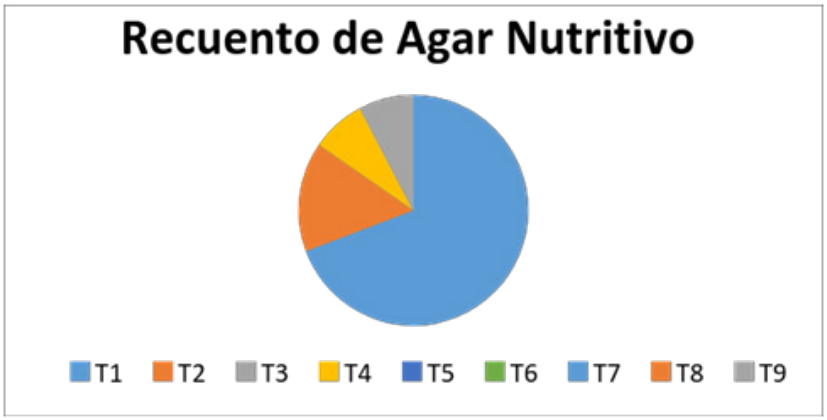

Figure 1 Microbial load on nutritive agar.

Conclusion

At the end of this research work, the following conclusions were reached:

Ultraviolet radiation combined with acetic acid enhances its antimicrobial activity and improves the quality of guinea pig meat, increasing its shelf life.[6–10]

The chemical and physical characteristics of guinea pig meat were not altered by the application of UV radiation and acetic acid.

The organoleptic characteristics (smell, color, taste, juiciness and texture) of the meat were not altered by the application of RUV and AA. The degree of preference was greater for the guinea pig meat that received the application.[11–14]

Recommendations

We recommend carrying out this research in meats for human consumption derived from other minor animals.

Implement this method of increasing the quality of the meat in companies producing and industrializing guinea pig meat.

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None.

Conflict of interest

The author declares there is no conflict of interest.

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