MICROBIOLOGICAL AND PHYSICAL-CHEMICAL EVALUATION OF PORK SHOULDER AND PORK SCAPS TREATED WITH IONINZING RADIATION (COBALT 60)

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Introduction

The term radiation refers to a physical process of emission and propagation of energy – ionizing radiation. Radiation can also further defined as the amount of radioactive energy absorbed by a food as it passes through the radiation field during treatment. The measure unit used to describe the dose, or the amount of absorbed radiation, is the Gray (Gy) (GERMANO and GERMANO, 2001). The objective of the radiation process is to sterilize or preserve foods by destroying microorganisms, parasites, insects and others pests, thereby extending shelf life. In addition, the irradiation process also preserves freshness and does not impart any detectable differences to the treated foods. Between a quarter and a third of the world's food supply is lost after harvest. (MOSELEY, 1990). It is estimated that 6,5 to 33 million individual illness cases in the United States are of foodborne origin, causing the death of 9.000 every year. Radiation kills bacteria by breaking down the DNA molecule and by generating free radicals that destroy microorganisms and inhibit enzyme processes such as sprouting and ripening. Although irradiation is absolutely safe from a food safety standpoint, the process does impart certain physical-chemical changes to irradiated meats, such as color, pH and water binding capacity (WBC). Meat color is the single most important factor in the purchase decision. Studies reporting on the effect of irradiation on the color of fresh meats suggest that changes in color vary with radiation dosage, species and packaging type (NANKE, SEBRANEK and OLSON, 1998). The pH value is of utmost importance to the quality of meats and interferes with their technological characteristics. The pH has a decisive effect on the conversion of myoglobin to oxymyoglobin, in addition to contributing to flavor development (PARDI *et al.*, 2001). The pH value also significantly impacts on the water binding capacity of meats in that the higher the pH value, the greater their water binding capacity (up to the isoelectric point of the myofibrilar proteins). The WBC is an essential quality parameter to both the meat processing industry and the consumer. FORREST *et al.*, (appud PARDI et al., 2001) defined WBC as the capacity of meat to retain its water during application of external forces. The water holding capacity of fresh meat influences its technological qualities, such as processability and processing yield. As for the consumer, low WBC has a detrimental effect on the appearance of fresh meat during cutting up and may have a negative influence on its quality (SCHÄFER *et al*, 2002).

Materials and Methods

Analyses were performed on samples of pork shoulder and pork scraps. The pork shoulder meat was trimmed to remove excess fat and subsequently cut into uniform pieces prior to packaging. Next, the trimmed meat was divided into 270 g portions arranged into expanded polystyrene trays. Next, part (50%) of the trays were vacuum packed, while the other part (50%) were sealed with polyethylene stretch film. Four samples of each meat and packaging combination were tested and subsequently analyzed. Two trays of each meat/packaging combination were irradiated with 1,6 KGy while the two identical but non-irradiated other trays were used as control samples. The samples were stored in freezing chambers at –18ºC up to the moment they were irradiated.

Two trays of each treatment were analyzed using the rinsing technique. The following microbiological analyses were performed on the rising water of irradiated and non-irradiated meat samples of each meat/packaging type combination: determination of the Most Probable Number of coliforms, total mesophilic and psychrotrophic aerobic counts and presence of *Salmonella ssp* (VANDERZANT & SPLITTSTOESSER, 1992).

Color was determined with a Minolta spectrophotometer (CM 508-d) performing eight color measurements of each of the three samples of each treatment. The puncture electrode of a digital portable Digimed DM2 direct color meter was inserted in slits made in the meat about two hours after irradiation. The water binding capacity was determined using the method described by GRAU and HAMM (1953) and modified by HOFMANN *et al.* (1982).

Results and Discussion

The *E. coli* results showed a reduction of 3 log cycles in the irradiated samples in comparison to the control samples and were below the detection limit, with exception of the vacuum packed pork shoulder samples which exhibited a reduction of 2 log cycles due to the packaging type used. Irradiation resulted in a reduction of at least 2 log cycles for mesophilic bacteria as compared to the mesophilic counts exhibited by the control samples. However, this reduction did not appear to be significant since the initial counts were very high, that is, above the dilution limit of the method used. The irradiated samples presented a decrease of at least 1 log cycle for psychrotrophic count in comparison to the non-irradiated control samples. This reduction in the psychrotrophic bacteria count should not be considered significant for the same reason mentioned above for the mesophilic bacteria count. Not detected *Salmonella ssp.* in any of the samples analyzed (Figure 1 and 2)

P.V.IR (pork shoulder vacuum irradiated) P.A.IR (pork shoulder air irradiated) P.V.C (pork shoulder vacuum control) P.A.C. (pork shoulder air control) R.V.IR (pork scraps vacuum irradiated) R.A.IR (pork scraps air irradiated) R.V.C (pork scraps vacuum control) R.A.C. (pork scraps air control)

The samples of irradiated pork shoulder packaged under vacuum and in air yielded higher brightness values (L*) than the non-irradiated control samples. Although this increase in brightness was more pronounced in the vacuum-packed meat samples, the differences between the samples were not significant as determined by the Tukey test (95% confidence interval; $p< 0,05$). Pork scraps on the other hand showed a decrease in L* values after irradiation both for the vacuum-packed samples and the samples in oxygen permeable packaging. However, only the sample contained in the oxygen permeable packaging exhibited a significant difference compared to the other pork scrap samples. In general, the a* values decreased for all the irradiated pork shoulder samples analyzed. However, this reduction was much greater for the vacuum packed meats, which were found to exhibit a significant difference in comparison to the other samples. The pork scrap samples differed from the pork shoulder samples in that they exhibited increased a* values. Also in this case the samples contained in the oxygen permeable packaging presented a significant difference when compared to the other samples. As for pork shoulder, the b* value of the irradiated samples increased but did not present any significant difference between the samples. The b* value for pork scraps was found to be different in that a reduction was observed in the samples packaged in oxygen permeable material and an increase in the vacuum packed samples. However, no significant differences were found between the samples (Figure 3).

The irradiated vacuum packed pork shoulder and pork scrap samples exhibited slightly higher pH values as compared to the control samples. A reduction of the pH value was observed in the irradiated shoulder and scrap samples packed in air permeable material, but no significant differences were found in any of the samples analyzed. According to literature, the normal water binding capacity (WBC) of pork meat ranges from 0,442 to 0,515 (semi-membraneous muscle). According to the same authors, meats with WBC below 0,40 is considered PSE (pale, soft, exudative), whereas meats with WBC above 0,640 are classified as DFD (dark, firm, dry). The water holding capacity (WBC) of pork shoulder decreased both in the samples contained in the oxygen permeable packaging material as in the vacuum packed samples. Significant differences were found between the vacuum-packed pork shoulder control sample (which exhibited the highest WBC value prior to irradiation) and the other samples. On the other hand, the irradiated pork scraps contained in the oxygen permeable packaging material showed an increase in WBC, which was found to be significantly different from the evolution of the WBC values yielded by the other treatments. Decrease of the WBC was observed in the vacuum-packed pork scrap samples, but without any significant difference (Figure 4).

Conclusion

E. coli was found to be highly sensitive to irradiation and was reduced to non-detectable levels. Irradiation reduced the total mesophilic count by at least 2 log cycles. Psychrotrophic counts were reduced by at least 1 log cycle. Irradiation did not bring about any changes in the pH values of samples of pork scraps (6,036 – 6,112) and pork shoulder (6,210 – 6,403). Irradiation promoted a decrease of the water holding capacity (WBC), except for the irradiated pork scraps packaged in oxygen permeable material. Irradiation changed objective color measurements of the meats analyzed. However, the objective color characteristics are dependent on the species, type of raw material, packaging and radiation dose.

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Figure 1 - Microbiological Analyses of pork shoulder

Microorganism	Pork shoulder Air Control	Pork shoulder Air Irradiated	Pork shoulder Vacuum Control	Pork shoulder Vacuum Irradiated
E.coli (log MPN/g)	≥3,04	<1,0	1,3	<1,0
Mesophilic (log CFU/g)	>6,15	4,04	>6,15	4,39
Psychrotrophic (log CFU/g)	6,04	5,20	>6,15	4,81
Salmonella ssp (25g /sample)	Absent	Absent	Absent	Absent

Figure 2 - Microbiological analyses of pork scraps

Microorganism	Pork scraps Air Control	Pork scraps Air Irradiated	Pork scraps Vacuum Control	Pork scraps Vacuum Control
E.coli (log MPN/g)	≥3,0	<1,0	≥3,0	<1,0
Mesophilic (log CFU/g)	>6,11	4,59	>6,08	4,52
Psychrotrophic (log CFU/g)	>6,11	5,20	>6,08	5,08
Salmonella ssp (25g /sample)	Absent	Absent	Absent	Absent

Figure 3 - Mean values and Estimate for Standard Deviation Estimate (ESD) of the values L*, a* and b* for each treatment type.

Sample	L*		a*		b*	
	Mean	ESD	Mean	ESD	Mean	ESD
P.V.IR	42,585	3,361	5,964	1,882	6,395	2,150
P.A.IR	43,659	4,637	7,688	1,395	5,895	3,517
P.V.C	39,483	2,940	8,907	1,521	4,799	1,561
P.A.C	41,730	4,467	8,723	1,784	4,890	2,777
R.V.IR	44,885	3,383	8,308	1,913	7,158	1,729
R.A.IR	39,390	6,490	11,486	3,364	5,574	4,545
R.V.C	46,173	2,876	7,870	1,865	4,693	2,153
R.A.C	43,835	5,756	9,475	2,294	7,637	3,439

Figure 4 - Mean values and Estimate for Standard Deviation (ESD) of pH and CRA

Sample	pH		CRA	
	Mean	ESD	Mean	ESD
P.V.IR	6,403	0,175	0,375	0,043
P.A.IR	6,210	0,179	0,391	0,026
P.V.C	6,346	0,185	0,455	0,067
P.A.C	6,291	0,235	0,421	0,033
R.V.IR	6,112	0,181	0,445	0,060
R.A.IR	6,036	0,259	0,447	0,040
R.V.C	6,094	0,144	0,470	0,042
R.A.C	6,044	0,270	0,378	0,055