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# Gamma radiation effect in vacuum-packed dried meat: an alternative to the environment

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## ABSTRACT

Food-borne diseases are the major health problem in many countries. This concern relates to the fact that in recent years the occurrence of foodborne diseases has become frequent due to failure to comply with the hygienic and sanitary standards. The processing of Jerked beef is very similar to the charque and at all stages of their technological processing, the meat is exposed to contamination, especially in operations where is more manipulated. The objective was to determine which doses of radiation between 2kGy, 4kGy 6kGy would be more effective in decontaminating the product sold in a large supermarket network in Recife. The jerked beef is sold in vacuum packaging weighing 500g each, for this work were purchased six bags of 500g, these were divided into two different batches (each of three samples). Under sterile conditions, the meat was cut placed in Petri dishes and weighed, each specimen were made in eight sub-samples each weighing 25g, generating 48 subsamples. Of these 12 sub-samples were assigned to the control group and the remaining (36 sub-samples) were taken to the irradiator with a source of cobalt-60 MDS-Gammacell 220EXCEL Nordionn. The sub-samples were added to an Erlenmeyer flask with 225 ml of sterile water and were agitated for 15 minutes creating wash water, and another part was added to an Erlenmeyer flask with 225 ml of sterile water and was stored at room temperature by having 14 hours to form a water desalting. 1µL Aliquots of these waters were removed and sown in the midst of exhaustion sheep blood agar and incubated at 35 ° C for 24 hours for analysis of bacterial growth and the microbial count. Using the methodology of wash water was not observed in any growth plate. for the desalting water the results were as 'follows: for first experiment in the control group values were between 5.133 x $10^5$ and 9.56 x $10^8$ CFU/ g after irradiation values ranged from 1.7 x$10^5$ to 2x$10^6$ for 2kGy

;0 to 6x10$^4$ for 4kGy and 0 to 6 kGy performing statistical analysis between the control and the doses were not statistically significant of dose 2 kGy (p = 0, 130919) there is a statistical difference in rates of 4kGy (p = 0.040510) and 6 kGy (p = 0.047905) in experiment two control values ranging from 2.3 x 10$^9$ to 4.1 x 10$^9$ CFU / g for the dose 2kGy, and 4kGy 6kGy variants respective values of 6.5 x10$^7$ to 1.05x10$^9$; 1.7 x10$^5$ to 1.76 x10$^5$ and from 0 to 1.3 x10$^4$, as seen in the first experiment, no statistically significant difference in dose of 2 kGy (p = 0.079057) , significant differences were 4 kGy and 6 kGy ($p$ = 0.028125; $p$ = 0.028151, respectively). We can conclude that the dose of 2kGy is ineffective, and doses of 4kGy and 6kGy are effective in decontaminating the jerked beef because there is a statistically significant difference between control and these doses.

**Keywords:** jerked beef, food contamination, irradiation.

## INTRODUCTION

From the standpoint of public health, the population must be within reach not only food of good origin, but also in good sanitary conditions. Since foods are susceptible to contamination by different etiologic agents, which can lead to diseases manifested by the action of pathogenic micro-organisms or their toxins. According to the Food and Agriculture Organization (FAO), one fifth of the world eats meat, so there has been increasing concern to give people a healthier meat because this food is characterized by the nature of the protein consists not only in terms of quantity and quality [1, 2].

Considered to be salted meat products, meat and shredding products subjected to the action of common salt and other curing ingredients in solid form or in brine, in order to ensure their preservation for future consumption [3].

The jerked beef is a product similar to jerky. The main difference is in the flowchart of processing, which allows the addition of sodium nitrite, at the beginning of the process during the step of wet curing. This technique gives a red color to meat and moisture content of at most 56%. At the end of the process is, necessarily, vacuum-packed [4, 5, 6, 7].

The type of meat consumed per person is usually given in combination with the species of animals and conservation methods available for that population. In the Brazilian Northeast has a high consumption of beef jerky and its successor the jerked beef, because these form the basis of various protein dishes such as “arrumadinho”, “escondidinho de charque”among others [8, 9].

The food processing came from the need to preserve food at harvest to final the product and has been developed with the implementation of new technologies that improve the quality and safety and can help minimize risks and maximize benefits [10]. In order to maximize consumer safety, ways to control or reduce contamination are increasingly employed in particular irradiation. In this case, the radiation can eliminate pathogenic micro-organisms present in the meat and make it safe for consumption and it can increase its shelf life. Studies have demonstrated the effectiveness of the implementation of γ radiation in reducing levels of Staphylococcus in salt beef typical of Africa called biltong beef [11, 12, 13].

The objective of this study was to evaluate the effectiveness of radiation doses of γ 2kGy, and 4kGy 6kGy in reducing microbial load jerked beef.

## MATERIALS AND METHODS

### 1 Selection of samples

We used three batches of jerked beef and each batch containing three copies as determined by the RDC No. 12 January 2001, which instructs that each sample unit must contain at least three copies of each lot. The samples were obtained from a large supermarket network active in the city of Recife – Pernambuco-Brazil, in packages weighing 500g (a pound) each (shown in Figure 1).

### 2 Microbiological analysis

The experimental procedure consisted of two series of microbiological tests. The first was made with the product samples before irradiation and the second with irradiated samples. Microbiological tests were performed at the Laboratory of Antimicrobial Drugs and Testing to Department of Antibiotics, Federal University of Pernambuco. We acquired six samples of 500g and these two different batches (three samples each). Under sterile conditions, the meat was cut and placed in a Petri dish and then weighed in order to obtain a more representative sample. Each specimen was made in eight sub-samples weighing 25g, generating 48 sub-samples. Of these 12 sub-samples were assigned to the control group and the remaining (36 sub-samples) were designed to irradiation. The sub-samples were added to an Erlenmeyer flask with 225 ml of sterile water and stirred for 15 minutes creating wash water, and another part was added to an Erlenmeyer flask with 225 ml of sterile distilled water that was at rest at room temperature for 14 hours there is the formation of a water desalting. 1µL Aliquots of these samples were sown in the midst of exhaustion sheep blood agar in Petri dishes in which were incubated at 35 ° C for 24 hours for analysis of bacterial growth and microbial population counts. After the incubation period were made counts of colony forming units per gram (CFU / g) [14, 15].

### 3 Irradiation of samples

The sub-samples were taken for irradiation equipment (irradiated with cobalt-60 source Gammacell 220EXCEL Nordionn-MDS) placed in Petri dishes properly identified as the doses (2, 4 and 6 kGy) and lots. The procedure was performed in Gamma Lab Department of Nuclear Energy, Federal University of Pernambuco.

### 4 Statistical analysis

To assess whether the doses used were effective through the statistical difference between them, we used the Student t test with the help of statistic software 6.0.

## RESULTS AND DISCUSSION

There was no growth in the washing water in any of the two experiments: for the first experiment in the control group values were between 5.133 x $10^5$ and 9.56 x $10^8$ CFU/ g after irradiation values ranged from 1.7 x$10^5$ to 2x$10^6$ for 2kGy ;0 to 6x$10^4$ for 4kGy and 0 to 6 kGy performing statistical analysis between the control and the doses were not statistically significant of dose 2 kGy (p = 0, 130919) there is a statistical difference in rates of 4kGy (p = 0.040510) and 6 kGy (p = 0.047905) in experiment

two control values ranging from 2.3 x $10^9$ to 4.1 x $10^9$
CFU/ g for the dose 2kGy, and 4kGy 6kGy variants

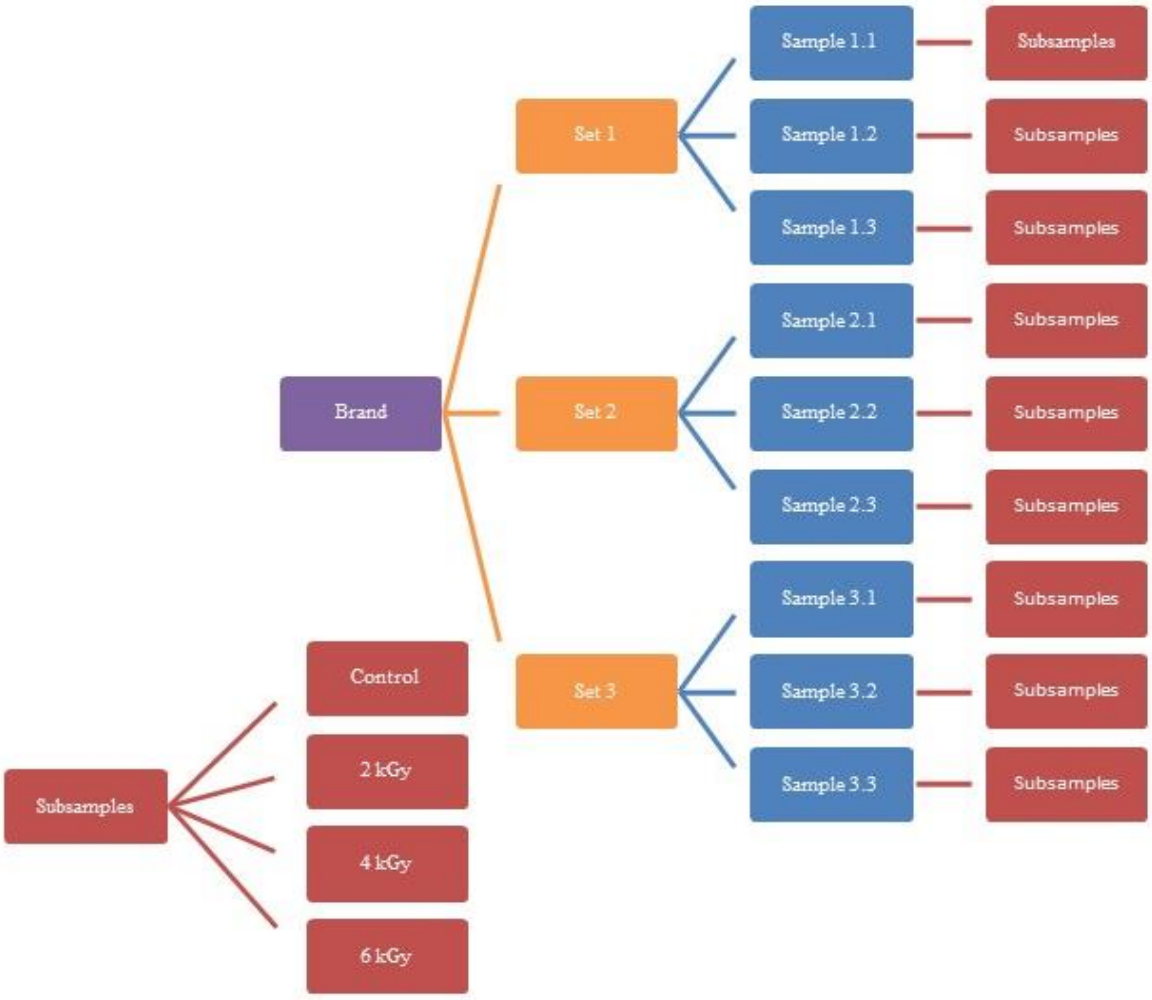


**Figure1.** Sampling Flowchart

respective values of 6.5 x$10^7$ to 1.05x$10^9$; 1.7 x$10^5$ to 1.76 x$10^5$ and from 0 to 1.3 x$10^4$, as seen in the first experiment, no statistically significant difference in dose of 2 kGy (p = 0.079057), significant differences were 4 kGy and 6 kGy ($p$ = 0.028125; $p$ = 0.028151, respectively) as show in Table1.

**Table 1**. Counting of microorganisms before and after irradiation

| Batches | Samples | Control | 2kGy | 4kGy | 6kGy |
|---|---|---|---|---|---|
| 1 | 1.1 | 5,1E+05 | 3,3E+05 | 1,3E+04 | 0,0E+00 |
| | 1.2 | 5,0E+05 | 1,7E+05 | 0,0E+00 | 0,0E+00 |
| | 1.3 | 9,6E+08 | 2,0E+06 | 6,0E+04 | 0,0E+00 |
| 2 | 2.1 | 2,3E+09 | 1,1E+09 | 1,8E+05 | 0,0E+00 |
| | 2.2 | 4,1E+09 | 6,6E+07 | 1,7E+06 | 1,3E+05 |
| | 2.3 | 4,1E+09 | 6,6E+07 | 1,7E+06 | 4,0E+04 |
| 3 | 3.1 | 5,0E+11 | 7,3E+10 | 2,0E+06 | 1,3E+05 |
| | 3.2 | 2,3E+12 | 1,1E+12 | 9,0E+10 | 5,5E+05 |
| | 3.3 | 5,0E+16 | 8,1E+09 | 3,3E+08 | 1,0E+05 |

The products tested are not in accordance with the description in the RDC 12, 2001 of the National Health Surveillance Agency (ANVISA) establishing microbiological standards for food. This regulation relates to the maximum allowable values are 5x$10^3$ CFU (Colony Forming Units) for matured meat products, desiccated sausages, beef jerky, jerked beef and alike.

Costa et al (1999), researching the corned beef sold in the city of João Pessoa-PB found that 60% had higher scores five logarithmic cycles in relation to what the law allows, concluding that the corned beef sold in Singapore was It is produced with raw materials of low microbiological quality or it was contaminated during transport and storage in shops.[22]

In a study with pork, non-irradiated control samples had initial counts of 2.5 x $10^8$ CFU / g, data similar to those found in this work. When the samples were subjected to irradiation process of 2kGy and 4kGy doses, these values ranged from 5.8 x$10^4$ to 8.4 x$10^4$ to 2kGy dose and of 1.8 x$10^3$to 8.8 x$10^3$ to dose 4kGy. Note that with increasing dose, a decrease of one log cycle [16].

Other research using corned beef marketed in the city of São Paulo was found a high rate of contamination by Staphylococcus aureus and other bacteria, the authors also suggested that this problem is related to the microbiological quality are caused by handling and inadequate storage)[23]. Abreu et al (2008) performing a bacteriological analysis of the frogfish (Lophyus gastrophyus) marketed by the Union of Rio de Janeiro State Fishing (SAPERJ) also found that this fish was at odds with the RDC Nº 12, finding surroundings counts 7.5 x106 CFU / g, which suggested a lack of care of the handlers in the establishment. The results suggest that there was a failure in product preparation since it is a vacuum packed cured meat and these packages were in perfect condition. [21]

A study using frozen beef identified a contaminant reduction when we applied a dose of 2.5 kGy, which differs from the results obtained in this study. What can be attributed to the different nature of the products (dried meat / frozen meat).[21]

Research carried out with frozen crabmeat, noted that after the irradiation process with the application of 3kGy and 5kGy there was a decrease on average by 1.3 log cycles and 1.2 log cycles respectively [17]. In another study, the counting of

microorganisms reduced by two logarithmic cycles for 2kGy dose and four logarithmic cycles to 4kGY and the dose of 6kGy there was a reduction of five logarithmic cycles [18]. What this study confirms is that, by increasing the dose, the microbial load reduces.

The Food Department of the University of Pretoria in South Africa published a work with biltong beef, a salted meat similar to jerked beef, that decontamination doses of 4kGy are more appropriate [12]. Confirming the results obtained in this work.

Gamma radiation can also be used for biochemistry. A study of cured beef jerky performed by Domijan et al (2015) was designed to investigate the reduction of a substance present in cured meat products (intentionally contaminated) ochratoxin A (OTA) – ochratoxin A is a mycotoxin produced by molds mainly belonging to Aspergillus and Penicillium species. This ubiquitous mycotoxin is a contaminant of a variety of foodstuffs. Due to its toxic properties, the International Agency for Research on Cancer classified OTA as a possible human carcinogen of the 2B Group [19]

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