STABILITY OF VITAMIN A IN IRRADIATED BEEF LIVER

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ABSTRACT

In this study, vitamin A and β-carotene were analized in 3kGy Co-60 γ-irradiated and unirradiated samples of bovine liver. Six different lots of samples were obtained at the meat market, two samples per lot weighing about 100g each, kept at -15°C as long as possible. Pre-treatments and analysis methods were those described in Institute Adolfo Lutz Norms for Food Analysis, using two-gram samples in duplicates. The total vitamin A content of the samples varied a lot. The means and standard deviations of vitamin A retention percentage after irradiation were 106±8.2 (12 replications). Similarly, β-carotene retention percentage was 98±21.4 (24 replications). These results show that there were no losses of neither vitamin A nor protovitamin A as a consequence of irradiation with a dose suitable for the reduction of spoilage and pathogenic organisms.

I. INTRODUCTION

Vitamin A and carotene are complex and essential micro-nutrients that exist in more than one chemical form, but only pure vitamin A is usually called retinol [1]. Retinol is found in rather few foods; these include liver, milk, butter, egg yolk and fish liver oils such as cod liver oil. Carotene is one of the pigments in all green leaves and it occurs also in tomatoes, apricots, carrots and red palm oil. The body converts the carotene into vitamin A in the wall of the intestine as it is absorbed into the blood. The total vitamin A activity of a food, called retinol equivalent, is determined not only by its retinol content, but also by materials chemically very close to retinol, but not so active, and a range of carotenes of varying activity. The most active form of carotene is β-carotene (molecular weight 536.89). Deficiency of vitamin A reduces the resistance to infection (measles, diarrhea, respiratory infections etc) an extremely serious Brazilian problem mainly in the Northeast region.

Retinol may occur as a free alcohol (molecular weight 286.46), esterified to fatty acids or as a aldehyde or acid. In animals, the vitamin is most abundant in the liver, where it is stored generally as free alcohol or in an esterified form [2]. One international unit (I.U.) of vitamin A containts 0.3μg vitamin A alcohol, or 0.344 μg vitamin A acetate or 0.55 μg vitamin A palmitate or even 0.6.μg of β-carotene. Vitamin A can be assayed by direct measurement of its ultraviolet absorption or by photometric evaluation of color reactions if the sample solution contains substances other than vitamin A that absorb in the same region. The chemical or physicochemical determination of β-carotene depends upon measurement of the yellow color of its solutions in organic solvents. The light absorption of carotene is characterized by two maxima lying close together, their exact location depending upon the solvent [3].

The development of food preservation processes has been driven by the need to extend the shelf-life of foods whilst maintaining their safety; one of the main concerns being the nutrient loss The destruction of provitamins A in processed and stored foods can follow a variety of pathways depending on reaction conditions. In the absence of oxygen there are a number of possible thermal transformations, particularly the cis-trans isomerization to the neo-β-carotenes. This has been shown to occur in both cooked and canned vegetables. Overall losses of vitamin A activity during anaerobic sterilization may vary from 5 to 50 %, depending on temperature, time, and the nature of the carotenoids. At higher temperatures, β-carotene can fragment to yield a series of aromatic hydrocarbons, the most prominent is ionene [2].

The objective of the present work is to evaluate the vitamin A and beta-carotene stability in irradiated bovine liver.

II. MATERIAL AND METHODS

In this study, six different lots of bovine liver samples were obtained at a butcher shop, two samples per lot weighing about 100 g each, one of them was irradiated and the other not. As carotene is very sensitive to light and oxygen, care was taken at all stages to preserve it.

The samples were kept at -15°C as long as possible. Irradiations were performed in a Co-60 Gammacell 220 (AECL) with a dose of 3kGy.The irradiation time was between 3,63 and 3,75 hours in the period April - July 1996. In order to analise vitamin A and beta-carotene in the same samples methods of the Instituto Adolfo Lutz (IAL) [4] were used.

For quantitative analyses of vitamin A a photometric assay using antimony trichloride was employed. This method, described by Carr-Price [3], is routinely used at the IAL. It consist on a saponification (absolute ethanol, potassium hydroxide) followed by an extraction with light petroleum. The extracts were washed until free from alcali with water and filtered over anhydrous sodium sulfate. The light petroleum extracts were evaporated in a current of nitrogen in the colorimeter cuvettes, dissolved once again in chloroform containing acetic anhydride and then the antimony trichloride solution was added. The extinction was immediately measured at 620nm in a Coleman Junior II, model 6/35. Vitamin A content was determined using a calibration curve prepared previously with vitamin A acetate the concentration range was of 10 to 50 I.U. (1g = 2.8-2.9x10^6 I.U.) [3].

For β-carotene determination, the samples extracted and diluted in petroleum ether, were measured at the maximum, between 447nm and 451nm, in a spectrophotometer Hewlet Packard Power. Results were expressed as I.U. of vitamin A, being 1g β-carotene = 1.6x10^6 vitamin A [4].

III. RESULT AND DISCUSSION

The experimental data of vitamin A and β-carotene determinations of bovine liver samples are shown on Tables I and II. As shown, the total vitamin A and β-carotene contents of the samples varied a lot.

The means and standard deviations of vitamin A aactivity retention after irradiation were 106±8.2 (12 replications). Similarly, β-carotene retention percentage was 98±21.4 (24 replications). These results show that there were no losses of neither vitamin A nor protovitamin A as a consequence of irradiation with a dose of 3 kGy, suitable for the reduction of spoilage and pathogenic microoorganisms.

TABLE I. Vitamin A content of bovine liver samples.

-Vitamin A (IU/100g) content		
Irradiated	*Non Irradiated*	*Retention (%)*
23000	22666,5	101,47
120000	115000	104,35
45450	44458,33	102,23
84833,33	82500	102,83
188020,8	184375	101,98
87500	87500	100,00
27000	27000	100,00
107500	106250	101,18
49735	40000	124,34
76500	72250	105,88
202083,32	190104,15	106,30
112666,7	92500	121,80
	X:	**106,03**
	s	**8,23**

TABLE II. β-carotene content of bovine liver samples.

β carotene (IU/100g)content		
Irradiated	*Non Irradiated*	*Retention (%)*
990,88	816,42	121,37
988,89	1326,55	74,55
12745,6	11669,72	109,22
12496,82	14559,06	85,84
30023,42	39559,12	75,90
57127,06	55181,29	103,53
10008,01	12305,93	81,33
10398,7	11707,4	88,82
1219,43	2147,62	56,78
2202,44	2012,68	109,43
4381,17	4037,55	108,51
4549,03	4241,83	107,24
1024,64	1046,1	97,95
880,01	1320,88	66,62
9926,53	9297,53	106,77
9115,07	11446,88	79,63
24439,28	30023,42	81,40
66847,25	52505,35	127,32
10330,1	10694,7	96,59
12784,8	12775,7	100,07
1666,16	1855,37	89,80
2260,68	2036,81	110,99
6013,38	3930,17	153,01
4948,14	4136,85	119,61
	X:	**98,01**
	s:	**21,41**

Other authors found that by braising liver to an internal temperature of 77°C it resulted in a 90 to 100 %

vitamin A activity retention whereas mincing and cooking resulted in a 87% retention [5] measured by a similar experimental system.

Usually a dose between 0.3-0.5kGy is sufficient for the prevention of parasitic diseases transmitted by means of foods. Also, a dose of 3kGy is in general sufficient to destroy pathogenic microorganisms [6] The current Brazilian legislation on food irradiation includes poultry and fish and fish products but does not mention beef and pork meat or any of the entrails. On the coming legislation, items deleted and new products will be surely included.

For medical sterilisation purposes doses of 25 kGy and above are used, whereas in most food applications , doses considerably lower than this one are used [7].

It is well kown that considerable losses can occur in cooking and storage of food [7].

When pork liver was irradiated to 5 kGy at 0 ° C a 4% vitamin A loss was verified after one week and a 13% loss after 4 weeks [7].

PARVIAINEN [8] explained the differences in vitamin A content of bovine liver sampling among different authors as a consequence of diverse analytical methods employed. In the present work, the great variety of data can be attributed to the age of the animal or even to the animal feed nutritional wellfare.

In this study, there was no loss of vitamin A in bovine liver when irradiated with a 3 kGy dose. This paper is a contribution to the development of food irradiation processing . It has filled up a gap that was in the dark until recently. Radiation processing was wrongly believed to preserve foodš but at the same time a means of distroying food micronutrients. This kind of experiment shows that irradiated foods can be used now safely for treat children with hypovitaminosis and patients requiring sterile diets.The present data present an optimistic folow up for the commercial application of this processing.

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