SHELF LIFE OF MEAT AND MEAT PRODUCTS AFTER A NON-REFRIGERATED TRANSPORT

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SUMMARY: Shelf life of beef and pork meats, offals and meat products was obtained after a transporting period in non-refrigerated vehicles (at tropical temperature of 32°C). The refrigeration of the products before transport produces an increase of the shelf life of every product with the exception of thinner ones.

Mesophilic aerobes, yeasts and moulds were determined. Average counts of mesophilic aerobes at the end of the shelf life period were up to 10^7 - 10^8 for both conditions. Yeasts and moulds counts on the surface of every refrigerated finished product was higher than their non-refrigerated homologue.

INTRODUCTION: Shelf life of perishable meat products is established considering refrigeration during preservation and distribution.

Changes in storage temperatures are more dangerous to the keeping quality of products than their permanence at a relative high temperature (Brown, 1982). Other factors like an excessive handling can affect appearance, microbiological quality and consequently shelf life of the products (Malton, 1978).

In Cuba non-refrigerated transports are used for the distribution of meat products and there is a coincidence between farest places and hottest climates during transport. Transporting times can reach up to 12 hours. Furthermore, temperatures of chilling rooms are usually between 8° and 12°C (Garcia, M. 1978). In such conditions reductions of the shelf life of the products are expected.

This paper deals with shelf life of meats, offals and meat products transported without refrigeration.

MATERIALS AND METHODS: Meats, offals and meat products treated by two different procedures, refrigerated before transport (i) and non-refrigerated before transport (ii) were: beef and pork meats, tongue, liver and heart from beef and pork, ham, smoked pork loin, "butifarra" type sausage, frankfurter type sausage, and two types of semi-cooked hamburgers pastes.

In the first treatment the meats, offals and products were taken 18 - 20 hours after refrigerated storage at 4° - 6°C (i).

In the second treatment (ii) the meats and offals were taken immediately after slaughter and the products after 8 - 10 hours at ambient temperature.

The products were submitted to a simulated transport in a controlled temperature chamber at 32°C. Meats and offals remained there for 10 h., meat products during 12 h and semi-cooked hamburgers 6 h. Measurements of A_w to the products were made (JAN 27 Novasina equipment was used). After this period the products were placed into a chilling room at 8°- 10°C.

Samples were taken daily for sensory evaluation and before transportation, after transportation and at the rejection for microbiological analyses.

For sensory analyses, the meats and offals were served in plates for odor. The products were served sliced, and semi-cooked hamburgers were formed (ca. 20 g each), and fried in sunflower oil at 150°- 160°C. A group of 7 - 10 experienced judges made the acceptance rejection test for off-flavor detection.

Plate counts were made of mesophilic aerobes (plate count agar 35° ± 1°C, 48 h) inside and outside the products and outside the meats, offals and semi-cooked hamburgers. Analyses of yeasts and moulds (malt extract agar, 25°C, 5 days) were made out side the products.

Shelf lives were obtained using the maximum likelihood techniques for incomplete failure data developed for Weibull distribution law (Nelson 1982). Computations were made by the program "Ploteo de Riesgo" elaborated in our Applied Math. Dept. Statistical disagreement between microbial counts belonging to different treatments were tested through analyses of variance and Duncan's multiple ranges comparison test taking into account a significance level of 0.05 (Bowker et. al 1976).

RESULTS AND DISCUSSION: Table 1 shows the results of shelf life estimations of the products.

The resulting shelf lives were in every cases lower for non-refrigerated samples than the refrigerated homologues. Thus confirming the effect of refrigeration on microbiological and organoleptic quality of the products. Examples of Weibull hazard plots are showed in figures 1 - 4

It can be noted that frankfurter type sausage exhibited the same results in both conditions. This is a very thin product and the refrigerated one become hot in only two hours exposed to 32°C; for butifarra type sausage, a light difference was obtained for the same reason.

However, non-refrigerated semi-cooked hamburgers pastes exhibited a great reduction (half the time) from the refrigerated ones; because they are hot packed in large trays (12 - 15 cm height); thus it contributes to hold the products cool (temp. below 25°C which is almost inhibiting for some m.o. (Genigiorgis, 1986).

For fresh meats and offal a pronounced difference between refrigerated and non-refrigerated products was obtained

Table 1 Shelf lives of the products.

Product	A_w	Shelf life (days) refrigerated (i)	Shelf life (days) non-refrig. (ii)
Virginia type ham	0.971	16	14
Smoked pork loin	0.977	9	7
Habana type sausage	0.970	7	6
Butifarra type sausage	0.972	3	2
Frankfurter type sausage	0.977	4	4
Semi-cooked hamburger paste ("frita" type)	0.973	4	2
Semi-cooked hamburger paste ("croqueta" type)	0.970	4	2

Table 2 Shelf lives of fresh meats and offals.

Product	Shelf life (days) refrigerated (i)	Shelf life (days) non-refrig. (ii)
Pork meat	3	2
Pork liver	3	2
Pork heart	3	2
Pork tongue	3	2
Beef meat	3	2
Beef liver	3	2
Beef heart	3	2
Beef tongue	3	2

As expected, shelf life of fresh meats and offals was reduced to 2 days in every case for non-refrigerated conditions. Storage life is influenced both by the storage temperature and by the time they remain stored at this temperature (Gunning et. al. 1989).

Tables 3 - 6 show microbiological results. Significant differences were obtained for the samples before and after transportation (Table 4) 10 hours at 32°C is a sufficient time to obtain a microbial growth on the surface of the products. Obviously every sample reached counts up to 10^7 - 10^8 c.f.u.g^{-1} at the rejection; slime and off odor productions was typical of those counts (Ingram et. al. 1967). For hamburgers, Puig et. al. 1985 obtained similar results.

Plate counts of moulds on the surface of the products at the rejection (5% probability of failure) were up to 10^6 c.f.u.g^{-1}. In general visible and microscopic counts were obtained, similar to

Jesenka (1983). In every case yeasts and moulds counts were higher for refrigerated products before transportation than for the non-refrigerated ones. It is probably due to the condensation produced on the surface of the products when they are changed to a higher temperature (Brown, 1982).

Table 3 Total mesophilic counts inside and outside the products. Mean of $\log_{10}$ c.f.u.g^{-1}

Interior the product	Before transp. period	After transp. period	At the rejection	S.E.
Virginia type ham	2.49 a	3.13 b	6.90 c	0.1790
Smoked pork loin	2.81 a	3.47 b	7.09 c	0.1891
Habana type sausage	2.95 a	3.52 b	7.15 c	0.1607
Butifarra type sausage	4.05 a	4.39 a	6.99 c	0.2391
Frankfurter type sausage	3.68 a	4.76 b	6.90 c	0.1358
Semi-cooked hamburger paste ("croqueta" type)	4.08 a	5.60 b	8.14 c	0.2033
Semi-cooked hamburger paste ("frita" type)	3.88 a	4.85 b	7.57 c	0.1848
Exterior the product				
Virginia type ham	2.79 a	3.38 a	8.15 b	0.2386
Smoked pork loin	2.95 a	3.55 b	7.95 c	0.1419
Habana type sausage	3.23 a	3.53 a	8.00 b	0.1622
Butifarra type sausage	3.76 a	4.60 b	8.07 c	0.1856
Frankfurter type sausage	3.64 a	4.47 b	7.89 c	0.2598

Mean values without letter in common differ significantly ($P<0.05$)

Table 4 Total mesophilic counts on the surface of fresh meats and offals. Mean of $\log_{10}$ c.f.u.g^{-1}

Product	Before transp. period	After transp. period	At the rejection	S.E.
Pork meat	4.27 a	5.28 b	7.86 c	0.1675
Pork liver	4.28 a	5.39 b	7.76 c	0.2029
Pork heart	3.79 a	4.72 b	7.08 c	0.2348
Pork tongue	4.05 a	4.95 b	8.03 c	0.2135
Beef meat	4.09 a	4.92 b	8.03 c	0.1788
Beef liver	3.99 a	5.03 b	8.06 c	0.1902
Beef heart	3.99 a	5.09 b	7.72 c	0.2276
Beef tongue	3.85 a	5.00 b	7.96 c	0.1865

Mean values without letter in common differ significantly ($P<0.05$)

Table 5 Mould counts on the surface of meat products. Means of $\log_{10}$ c.f.u.g^{-1}

Product	Before transp. period	After transp. period	At the rejection	S.E.
Refrigerated pork ham Non-refrigerated pork ham	0.00 d 0.00 d	1.82 c 1.16 c	5.05 a 3.74 b	0.2433
Refrigerated pork loin Non-refrigerated pork loin	0.00 0.00	1.02 0.43	4.90 4.15	0.3162
Refrigerated Havana sausage Non-refrig. Havana sausage	0.00 0.44	1.02 0.53	3.15 2.77	0.2894
Refrigerated butifarra Non-refrigerated butifarra	0.92 0.43	1.74 0.43	4.09 3.68	0.2536
Refrigerated frankfurter Non-refrig. frankfurter	0.00 0.00	1.02 0.87	4.72 3.86	0.2236
Refrigerated semi-cooked croqueta Non-refrigerated semi-cooked croqueta	0.92 0.43	2.42 1.43	4.48 3.94	0.2015
Refrigerated semi-cooked frita Non-refrigerated semi-cooked frita	0.00 0.87	0.87 0.53	4.05 4.75	0.2828

non common letter significant difference $p < 0.05$

CONCLUSIONS: Initial refrigeration of fresh meats, offals and meat products improves the shelf life if they are transported without refrigeration with similar levels of initial contamination, the keepability of hot finished products is shorter than these of could products before transport. Higher counts of yeasts and moulds on the surface of products refrigerated before transport is probably due to water condensation.

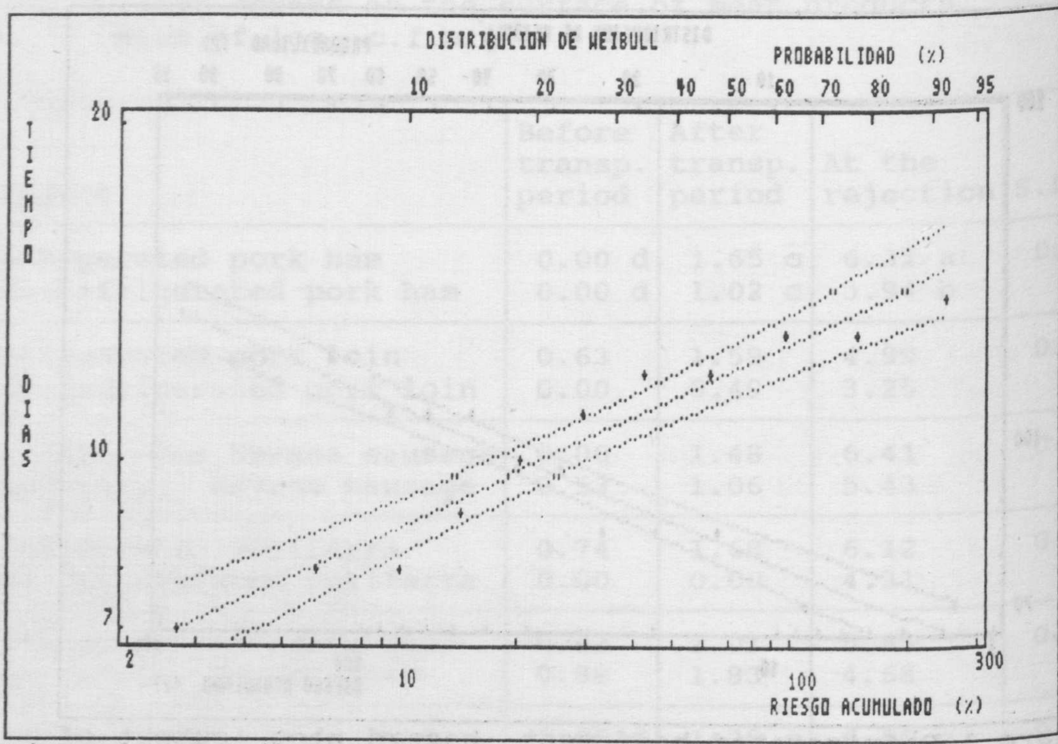

Figure 3 Refrigerated Habana type sausage hazard plot (program output)

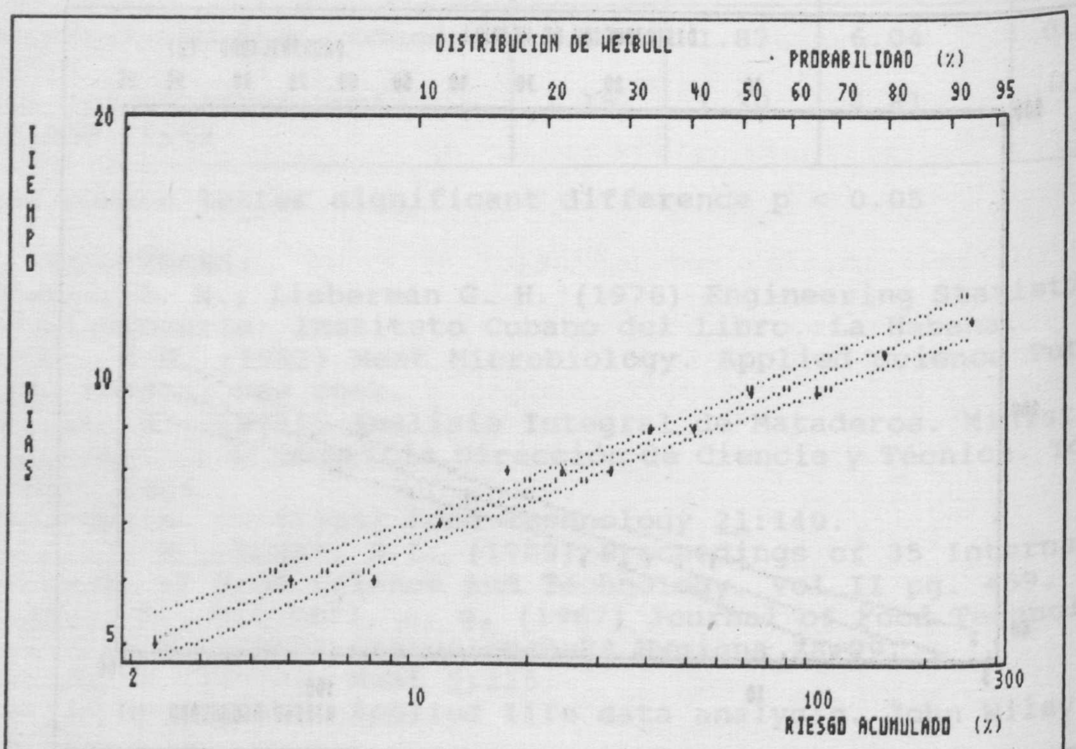

Figure 4 Non-refrigerated Habana type sausages hazard plot (program output)