STORAGE STABILITY OF DRIED SALTED MUTTON

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INTRODUCTION

Traditional preservation techniques for both meat and fish include solar drying and/or salting and several such products are known in many parts of the world. In Brazil salted and dried beef ("carne de sol") has been accepted for many years but, in spite of the large potential for goat and sheep in such areas products made from these meats are not well established. In many traditional dry salted products the salt is removed prior to consumption by desorbing the meat or fish in water before preparation of a variety of meals. Such meats are very suited to institutional catering (Zapata **et al.**, 1986). Little though is known regarding the chemical and microbiological stability of such products, especially after storage, although is well established that many intermediate moisture meats can undergo changes during storage at tropical temperatures that affect the colour, texture, flavour and nutritional quality of the product (Ledward, 1981).

The present study was carried out to evaluate the storage stability of dried salted mutton prepared as a product suitable for distribution in developing countries.

MATERIAL AND METHODS

Two Suffolk cross bred ewes, approximately 2.5 years old and weighing about 60 Kg were conventionally slaughtered and the carcasses held overnight at ambient temperature (6ºC). After boning the lean meat was cut into cubes (5 to 8 cm3) and visually separated into lean and fatty portions. After holding at 2 ºC for 16 hours these portions were ground through a 8 mm plate. Half of the lean portion was then mixed with the fatty portion (2:1 by weight) in order to obtain one lean meat and one fatty meat shares. After chemical analysis of these shares mixes were formulated to yield products containing 74.6% meat (all lean or lean to fatty shares in the ratio 2:1), 25% salt and 0.4% potassium sorbate. After thorough mixing with a large stainless steel spoon the blends were equilibrated at 2ºC for 1 hour and pressed into cakes using a manual burger press. The amount of meat pressed (about 300g) and the pressure applied was kept as constant as possible to yield cakes approximately 11 cm in diameter, 3 cm high and weighing about 284 g.

The cakes were dried in a circulating air oven (Gallenkamp Economy Incubator Size 2) at 40 ºC for 48 hours. During this time the cakes were occasionally turned to obtain more uniform drying.

The dried salted meat cakes were packed under 29 in of vacuum in nylon/polyethylene film (two cakes per pack) and stored at 2 or 30ºC. Some cakes were packed in cellulose cling film and stored at 30 ºC. At regular intervals samples were removed for analysis.

All analysis were carried out on samples groun twice through a 4 mm plate (Kenwood, Model A920). The moisture content was determined by oven drying, protein by Kjeldahl nitrogen estimation, fat by Soxhlet extraction with petroleum ether and ash by incineration at 525 ºC as described in AOAC methods (1984). Sodium chloride was determined by dissolving the ash in boling water and titrating against sodium nitrate (AOAC, 1984).

Protein solubility in 3% SDS and 1% B-mercaptoethanol was determined as described by Obanu **et al.** (1975); the percent soluble hydroxyproline by the method of Herring, **et al.**

(1967) and the malonaldehyde concentration, as the TBA number by the method of Hoyland & Taylor (1989).

Reflectance spectra from 700 to 370 nm were determined against magnesium oxide using a Perkin-Elmer Model 124 reflectance spectrophotometer. Water activity was measured using Water Activity System CX-1 (Decagon Devices, Inc. U.S.A.). The sorbate content of the samples was determined on filtered methanolic extracts (11-12 g of meat in 150ml of methanol containing 25 ml of 0.25 % ethyl para-hydroxybenzoic acid as internal standard) by absorbance at 254 nm following purification by anion exchange high pressure liquid chromatography (Webster **et al.**, 1986).

Total aerobic and anaerobic bacteria, yeast, moulds and coliforms were estimated by standard procedures (Harrigan & McCance, 1966).

RESULTS AND DISCUSSION

Proximate composition

Proximate analysis of the meats indicated that the "fatty" samples of meat before salting (2 parts lean trimmings, 1 part fat trimmings, Table 1) contained about 30% fat compared to about 15% in the "lean" samples. After manufacture all samples lost about 25% moisture which was compensated for by the salt concentration also being about 25% (Table 1). That the salt and sorbate concentrations are similars to the levels originally incorporated into the meats suggests that even during the drying phase (40 ºC for 48 hrs) most liquid is lost as drip and not through evaporation as evaporation would lead to an increase in the measured salt and sorbate contents.

Storage Stability

The initial water activities of the dried, salted meats were between 0.74 and 0.76 and changed little during storage even in the product packed in cling film and stored at 30ºC.

As oxidative changes were expected to be of paramount omportance in limiting the shelf life of these products TBA determinations were made at intervals of 15 days. At 2 ºC in vacuo there was some fluctuation during storage with an apparent increase during 15 days storage followed by a decrease over the next 15 - 30 days and a subsequent increase after a total of 60 days storage (Table 2). At 30 ºC in vacuo there was a steady decrease over 30 days and then an increase. Although these meats were packed under vacuum some oxidative changes during preparation are to be expected which could account for the relatively high initial values. Some oxygen would of course be dissolved and trapped in the meat even on vacuum packaging and further oxidation could ensue during storage. However in intermediate moisture meats TBA numbers ar often seen to decrease on storage due to reaction of malonaldehyde with proteins (Ledward, 1981). Such competing reactions could account for the variations seen in Table 2. Not unexpectedly the samples stored in air exhibited higher TBA numbers but again there was an apparent decrease then increase in value. Interestingly the values for the lean samples were higher than for the fatty ones in the stored samples yet in the vacuum packed samples the lean sample, as might be expected, exhibited the lower values. Obviously TBA numbers are not good indices of quality for these meats since malonaldehyde is not an abundant end product of the oxidative changes. Though not assessed by a trained panel no noticeable odour changes were detected in any samples.

When treated with a solution of 3% SDS and 1% B-mercaptoethanol about 84% of the nitrogen was soluble and in none of the samples was there any significant change on storage (Table 3) although the air stored samples were always slightly less soluble than those stored in vacuum. At Aw 0.85 it is known that glycerol/ sorbate desorpted meats exhibit marked loss of solubility in SDS/B-mercaptoethanol when stored in air

at 37 ºC (Ledward, 1981). Thus the lack of reactivity of these systems is as expected, even in the air stored samples at 30 ºC. It is believed that sorbate is a potential reactant in reactions leading to loss of solubility in SDS/B-mercaptoethanol (Obanu & Ledward, 1986) and in glycerol desorpted meats of Aw 0.85 there is a marked loss of sorbate when such samples are stored in air at 37 ºC (Webster **et al.**, 1986). In the vacuum packed samples, at both 2 and 30 ºC, there was no loss of sorbate during storage, the concentration being in the range 0.40 to 0.45% when measured at 15, 30 and 60 days. An apparent loss in the air stored samples at 30 ºC was seen, the concentration after 60 days being 0.33%. This lends some support to the contention that oxidation of sorbate may be responsible for the slight loss of protein solubility in SDS/B-mercaptoethanol (Webster **et al.**, 1986).

It has been claimed that the reactions leading to the breakdown of the haemoproteins in meat also require oxygen and are affected by temperature and Aw similarly to those reactions leading to loss of protein solubility in SDS/B-mercaptoethanol (Ledward, 1981, 1985). In support of this contention it was seen that the vacuum packed samples were relatively stable with regard to colour, no change being observed at 2 ºC during 60 days storage (Fig. 1) whilst at 30 ºC the inner portions of the cake were unchanged although the outer surface faded to a light brown colour and losts its characteristic haemoprotein type (Fig. 1), presumably due to the presence of residual oxigen. Cakes stored in air at 30 ºC faded quite rapidly.

Myoglobin is one of the most thermally stable proteins in meat yet it is seen that during processing it is converted from the mixture of the native oxy (reflectance minima at 540 and 580 nm) and met-pigments (reflectance minima at 410, 505 and 630 nm) to cooked meat haemoproteins with reflectance minima at about 410, 540 and 630 nm (Ledward, 1971, Fig. 1). This suggests that during processing most proteins will denature and coagulate; this is advantageous since it means protein should not be lost during the desorption process. An exception to this general rule is collagen which may be degraded and solubilised during extended storage of intermediate moisture meats at elevated temperatures, even in the absence of oxygen (Ledward, 1981). This often being followed by a decrease in prolonged storage as crosslinking reactions dominate. This degradative reaction, although little affected by Aw (Ledward, 1985) is very sensitive to temperature, being markedly slower at 28 compared to 38 ºC (Ledward, 1981). Thus little effect of storage on this parameter, and its consequent effect on texture was expected in these products. This was found to be the case (Table 4).

CONCLUSION

It is seen that these dried salted meats can be kept for up to 60 days at 30 ºC with little loss of textural or nutritional quality although loss of colour due to haemoprotein breakdown may occur. Packaging in vacuum though will minimise this loss in colour and for centralised manufacture would be recommended. Obviously at Aw 0.75 in the presence of high concentrations of salt, low oxygen tension and 0.4% residual sorbate microbiological problems should be non-existent and when analysed after 60 days for aerobes, anaerobes, coliforms, yeasts and moulds none were detected. Although the salts needs to be removed from the meat prior to consumption this is easily achieved by washing in water. For example, the salt content was reduced to about 2% by soaking the disaggregated product in 8 times its weight of water for 10 min and then repeating the process. Fragments of meat desalted in this way reabsorb water to regain an almost fresh meat appearance.

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Table 1.- Proximate composition of original meats and the final dried salted meat products. Values are Means ± Standard deviations of duplicates.

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Major Components	Fresh meats		Dried salted meats	
	Lean trimmings	Fatty trimmings	Lean products	Fatty products
Moisture (%)	65.92 ± 0.30	52.69 ± 0.21	37.48 ± 0.08	27.94 ± 0.16
Protein (%)	19.14 ± 0.73	15.38 ± 0.47	19.22 ± 0.17	15.37 ± 0.27
Fat (%)	18.41 ± 0.23	31.83 ± 0.47	16.97 ± 0.18	32.28 ± 1.94
Ash (%)	0.84 ± 0.01	0.68 ± 0.04	27.17 ± 0.14	26.23 ± 0.21
Salt (%)	-	-	25.01 ± 0.09	24.19 ± 1.01

The residual sorbate content of the lean dried salted meat was 0.40% with an error of less than 5%.

Table 2.- TBA Numbers of dried salted meat products during storage at 30 and 2ºC. Values are Means ± Standard deviations of 4 determinations.

Product	Temp. ºC	Vacuum	Time (days) 0	15	30	45	60
Lean	2	Yes	3.37±0.22	3.79±0.32	2.32±0.28	2.57±0.36	4.19±0.22
Fatty	2	Yes	3.95±0.46	5.51±0.52	2.84±0.43	3.37±0.60	4.94±0.50
Lean	30	Yes	3.37±0.22	2.61±0.32	1.22±0.11	1.46±0.10	1.86±0.15
Fatty	30	Yes	3.95±0.46	2.84±0.55	1.78±0.27	2.09±0.20	2.86±0.41
Lean	30	No	3.37±0.22	8.61±0.33	ND	ND	5.30±0.59
Fatty	30	No	3.95±0.46	6.14±0.53	ND	ND	4.47±0.30

ND Not determined

Table 3.- Protein solubility (percent) of dried salted meat products in SDS/B-mercaptoethanol solution during storage. Values are Means ± Standard Deviation of 2 determinations.

Storage conditions	Storage time (days)			
	0	15	30	60
2ºC/vacuum packaging	84.24 ± 0.99	87.96 ± 0.00	83.61 ± 0.25	88.54 ± 1.17
30ºC/vacuum packaging	84.24 ± 0.99	88.68 ± 0.44	85.48 ± 0.35	88.25 ± 1.17
30ºC/open packaging	84.24 ± 0.99	80.53 ± 1.62	79.44 ± 0.49	84.60 ± 1.06

Table 4.- Soluble hydroxyproline content (percent), in dried salted meat products during storage. Values are Means ± Standard Deviation of 2 determinations.

Storage Time (days)	Storage conditions		
	2ºC/vacuum packaging	30ºC/vacuum packaging	30ºC/open packaging
0	2.62 ± 1.08	2.62 ± 1.08	2.62 ± 1.08
15	3.69 ± 0.27	3.18 ± 0.25	4.70 ± 0.19
30	4.28 ± 0.56	4.29 ± 0.62	2.98 ± 0.43
45	2.93 ± 0.19	2.52 ± 1.18	2.61 ± 0.12
60	0.32 ± 0.06	2.01 ± 1.35	1.63 ± 0.23

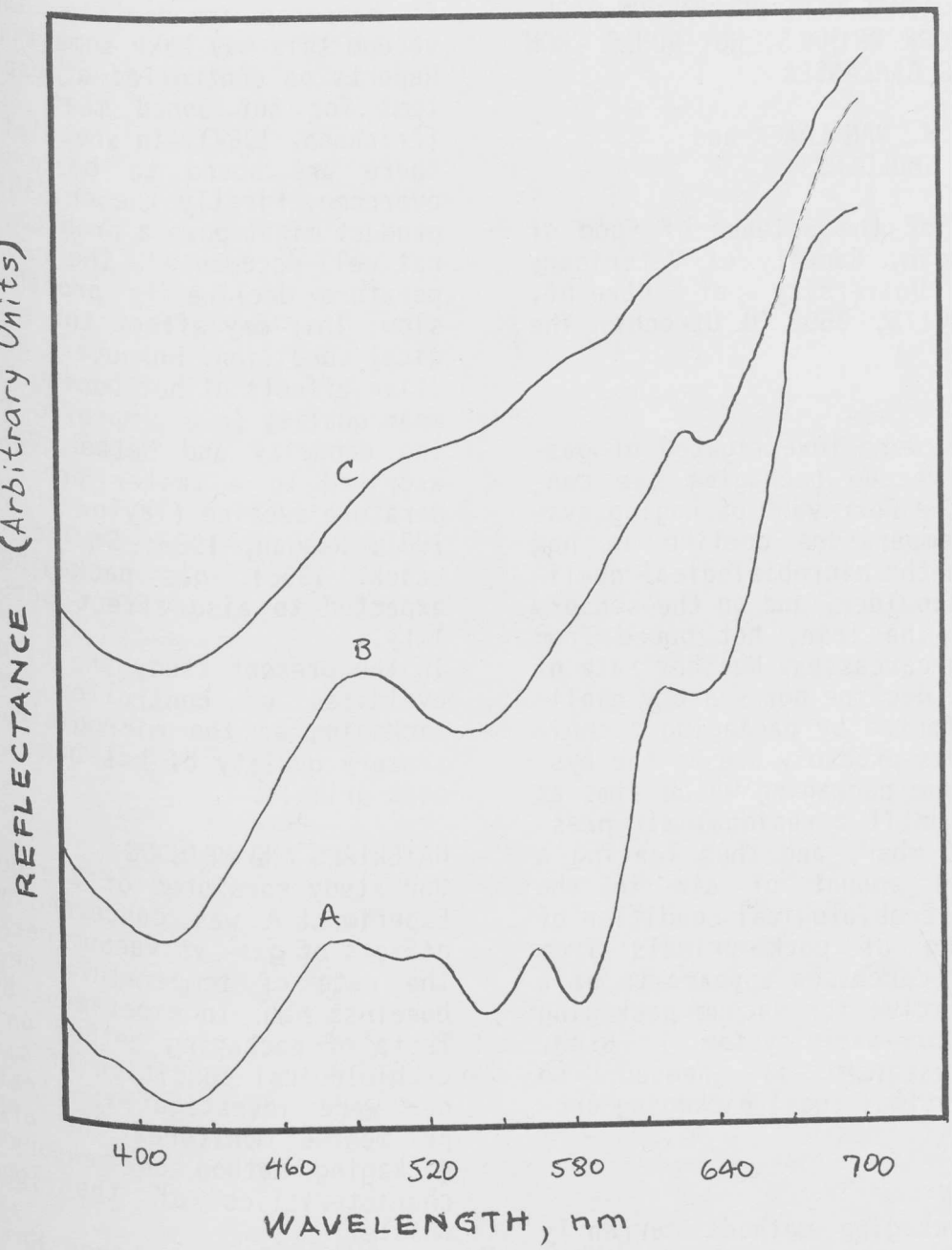

Fig. 1.- Reflectance spectra of raw lean meat (A), dried salted meat immediately after processing (B) and the outer portion of a cake stored at 30 ºC, in vacuum, for 60 days (C). Spectra of vacuum packed cakes held in vacuo at 2ºC for 60 days were similar to B whilst cakes stored in air at 30 ºC for 60 days were similar to C at all locations within the sample.