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Studies on Curing, Aging and Smoking of Camel Meat.

II- Microbiological and Sensory Evaluation.

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Introduction:

Camel meat is considered as one of the toughest meat in Egypt. If camel meat could be tenderized by aging, smoking and chill storage treatments while conserving other quality and nutritional attributes, its consumption would increase especially from elder animals.

Meat structure can be considered in its simplest form to be a collection of parallel fibers, the myofibrillar structure bound together by a connective tissue network of collgen fibers. The physical properties of the myofibrillar fibers could be affected by (a) aging which weakens myofibrillar per se (Davez and Dickson, 1970), while producing small and insignificant concomitant changes in the connective tissue (Bouton et al., 1973); (b) loss of moisture and other changes produced by cooking (Bouton and Harris, 1972) and (c) increased myofibrillar contraction which increased muscle fiber diameter (Herring et al., 1967 b). The connective tissue would be affected by factors including: (a) changes in spatial orientation of the collagen fibers in the connective tissue network related to myofibrillar contraction state (Rowe, 1974) and (b) changes in the collagen produced by cooking and related to animal age (Herring et al., 1967 a). Bouton et al., 1975 found that shear force values were more influenced by the muscle fiber properties than by the connective tissue properties, while teste panel would be influenced by connective tissues as well as by the fiber properties. Correlations between subjectively determined tenderness and shear force measurements show great variability such results are obtained if shear values don't adequately indicate the contribution of the connective tissues.

The numbers and types of microorganisms existing on meat surface during processing would be considered of great importance since it would influence the shelf-life of the processed meat. However, ample evidence has been established that the majority of the psychrophilic meat spoilage bacteria (about 90 % of the population) are of the gram-negative type. Gardener and Stewart (1966) and Stringer et al., (1969) are among several other research workers who also concluded that Pseudomones, Achronobacter group consititute the most predominant microflora in fresh beef under refrigeration. Meanwhile, Mikhailova et al., (1967) indicated that during short time curing-(6 days)-rod shapped types of lactic acid bacteria predominated, while during long term curing, cocci forms were the predominant. Curing of meat provides an important degree of protection against botalism (Walter and Casselden, 1973). There are clear indication of a salt/nitrite interrelation and preservative action in curing as reported by Wood and Evans, 1972. On the other hand, smoking was found to prevent the germination of Pseudomonas, clostridium, and micrococcus spores in sausages during 21 days storage (Kerskens, 1974).

The aim of this part of investigation is to evaluate microbiologically and organolyptically the ready to eat product of Camel meat, that has been prepared by curing, aging and smoking.

Materials and Methods:

Muscular parts of male Camels 1.5 to 2 years old both Longissimus Dorsi (L.D.) and Biceps Femoris (B.F.) were dry cured and aged at 40 F for one to four weeks. Samples were drawn weekly from aging to be smoked. All smoked samples were wrapped in cellophane and stored at 40 F for periods up to 4 weeks.

1- Microbiological examination: Total counts, yeasts and molds were enumenated according to Sharf (1966). Lactic acid bacteria were counted using Tween agar 80 medium (T.A) as described by Rogosa et al., (1951). The PH value was determined in meat samples according to the method of Aitken et al., (1962). while the lactic acid content was determined according to the method in A.O.A.C. (1970).

2- Rheological examinations and Organolyptic tests:

A-Shear-test measurements: Representative samples of 200 grm. were drawn from cured, aged, smoked cuts and were boiled in 250 ml. of water for 12 minutes, then a core of one inch diameter was used to test for tenderness by a Warner-Bratzler shear device. An average of four shear values were determined for each core.

B- Organolyptic tests: Color, flavour, tenderness and overall acceptability of the ready-to eat product were sensorily evaluated at the end of the smoking process by 25 college staff members, using a nine-point hedonic scale rating from 9 to 1 where 9 "Excellent and 1 "Rejected". Whereas for tendereness, values were rated on a similar nine point system from 9 "Extremely tender" to 1 "Extremely tough". Replicate samples were used from each sample in order to check repeatability among panel members. Analysis of variance as described by Snedecor, (1956) was used to make comparisons on all factors between the samples.

Results and Discussion:

The total microbial count, the lactic acid bacteria molds and yeasts were counted in both aged cured camel meat as well as cured aged smoked ones. The data in Table (I) clearly indicated that total bacterial counts decreased slightly after the addition of curing salts due the effect of salt, nitrite and the adaptation period during the first week of aging at 40 F. Thereafter, the types adapted to this environment started a gradual increase during aging reaching a maximum of million per gm. after 4 weeks. Meanwhile, it is worth mentioning here that, the shelf life of meats bear a positive relationship with its pH values during aging

Table I: Total bacterial counts, yeasts and molds (per gm.) of cured camel meat during aging at 40 F and after smoking and storage (Dry basis).

Aging Period (Weeks)	L. Dorsi				B. Femoris			
	Aged	Smoked	Smoked-stored for 2 wk.	Smoked-stored for 4 wk.	Aged	Smoked	Smoked-stored for 2 wk.	Smoked-stored for 4 wk.
				A- Total Bacterial Counts.				
0	$5.3x10^5$	$2.3x10^5$	$3.4x10^5$	$4.7x10^5$	$5.5x10^5$	$2.5x10^5$	$3.5x10^5$	$4.9x10^5$
1	$4.0x10^5$	$1.0x10^5$	$2.1x10^5$	$3.8x10^5$	$4.2x10^5$	$1.0x10^5$	$2.1x10^5$	$3.9x10^5$
2	$6.3x10^5$	$3.0x10^5$	$3.2x10^5$	$5.8x10^5$	$6.4x10^5$	$3.1x10^5$	$3.7x10^5$	$5.1x10^5$
3	$8.3x10^5$	$4.0x10^5$	$5.7x10^5$	$7.9x10^5$	$9.8x10^5$	$4.8x10^5$	$5.3x10^5$	$1.7x10^6$
4	$1.6x10^6$	$5.0x10^5$	$8.7x10^5$	$9.8x10^5$	$1.7x10^6$	$6.2x10^5$	$9.7x10^5$	$1.1x10^6$
				B- Yeasts counts.				
0	4200							
1	11200	0000	1200	3800	4900	0000	1400	3900
2	6800	0000	1400	4200	11700	0000	1700	5200
3	7700	0000	1300	3500	7100	0000	1200	4000
4	8300	0000	1800	4000	8500	0000	1800	4800
		0000	1500	4400	8900	0000	2100	6100
				C- Molds Counts.				
0	220							
1	870				250			
2	520				910			
3	680				640			
4	730				760			
					820			

process as it is clearly shown in Fig. 1, when the aged meat samples were smoked, the total bacterial counts decreased due to the heating, drying and preserving effects of the smoking process. The average decreasing percent was 61.6% for L.D. muscle and 58.6% for B.F. muscle, and could be mainly attributed to the bactericidal effect of smoke components which reduced the number of surface bacteria approximately 4 times the number present before. During storage of the smoked product, there was an increasing trend in total bacterial count with the extension of storage period. The increasing reached 33% and 51.8% in L.D. and 27.3% and 44.5% in B.F. on the average after 2 and 4 weeks of storage respectively. This might be due to the diminishing effect of the antibacterial properties of the smoking process. However, the total bacterial counts were always kept within the level of the initial numbers in cured aged samples (Table I).

Lactic acid bacteria in fresh camel meat were $3.6x10^4$/gm. and $3.2x10^4$/gm. in L.D. and B.F. muscles respectively. During the first week of aging at 40 F, lactic acid bacteria sharply increased i.e., $2x10^5$/gm. in both muscles. Comparing the decrease in total bacterial counts during the first week of aging with the increase in lactic acid bacteria. It could be stated that the selective environmental conditions resulting after the addition of curing salts and their inhibitory effect especially during the first week of aging was in favor of the desirable lactic acid bacteria to predominate and exhibit their activity. This was easily detected by its increase in numbers, the falling of PH to a minimum after one week of aging and the increase of lactic acid concentration to a maximum (Fig. 2). Meanwhile, a gradual decrease in the numbers of lactic acid bacteria occured upon extending the aging period up to four weeks. The results also indicated that the lactic acid bacteria diminshed directly after smoking, followed by a gradual increase during the storage of the smoked product. However, their numbers at the end of storage period were below the initial count in aged meat i.e. $6.3x10^3$ in both L.D. & B.F. muscles.

Regarding the counts of yeasts and molds (Table. I), it is clear that in fresh Camel meat the counts of yeasts were higher than the counts of molds. However, the changes in counts of molds and/or yeasts revealed the same trend during the aging process for both L.D. & B.F. muscles. These counts increased after the first week of aging, then decreased during the subsequent period of storage. This increase could be ascribed to the favourable PH for their activity which is predominant during the first week of aging. On the other hand, no yeasts and/or molds could be recovered directly after the smoking process in the aged cured meat which emphasized the effect of wood-smoke and heat (Kersken, 1974). During the storage period at 40 F, the conditions were not in favor for molds (as it is mainly aerobic), so no molds were identified till the end of storage (4 weeks). While yeasts were recovered in small numbers after 2 & 4 weeks of storage (Table. I).

Results in (Table. II) revealed that shear force values decreased during the aging process in Camel meat muscles. However, the values of shear force were not statistically significant between the aging periods, as the decreasing percent did not exceed 9.2% in L.D & 10.7% in B.F. muscles after 4 weeks of aging. After smoking shear force values had the same decreasing pattern. However, the decrements indicated that the aged Camel meat became more tender after being smoked. These decrements in shear force values were significant in samples aged for 2 to 3 weeks but they were insignificant after one week of aging. On the other hand, no significant effect on tenderness could be observed, concerning the storage of the smoked product in both L.D as well as B.F. muscles (Table. II). The aforementioned data demonestrated the paramount

Table. II: Average readings of shear force values of cured aged and cured aged smoked Camel meat during storage at 40 F.

Aging period (weeks)	L. Dorsi				B. Femoris			
	Aged	smoked	smoked-stored for 2 wk.	smoked-stored for 4 wk.	Aged	smoked	smoked-stored for 2 wk.	smoked-stored for 4 wk.
0	16.2*	13.4**	12.8**	12.6**	17.7*	12.1**	11.5**	11.0**
1	15.5	12.7	12.4	12.0	16.8	11.4	11.1	10.48
2	15.1	11.88	12.0	11.4	16.5	10.7	9.67	9.90
3	15.0	10.6	9.68	9.14	16.1	9.3	9.6	9.2
4	14.7	9.7	9.36	8.64	15.8	8.9	8.8	8.4
L.S.D 1%	1.34	* nonsignificant			L.S.D. 1%	1.19		
5%	1.01	** significant.			5%	0.90		

Table. III: Average score of organoleptic evaluation of cured aged smoked Camel meat directly after smoking adn during storage at 40 F.

Aging Periods (Weeks)	QUALITY ATTRIBUTES: Color			Aroma			Taste			Tenderness			Overall accept.		
	STORAGE PERIOD: 0	2	4	0	2	4	0	2	4	0	2	4	0	2	4
0	8.5	8.4	8.4	7.4	7.8	8.1	5.8	6.0	6.4	4.9	4.8	4.7	6.0	5.8	5.7
1	8.1	8.0	7.8	8.3	8.6	8.9	8.4	8.7	8.9	8.0	7.8	7.6	8.4	8.2	8.0
2	8.3	8.1	8.1	8.8	9.0	9.3	8.1	8.6	8.9	8.4	8.3	8.2	8.1	8.0	8.0
3	7.6	7.3	7.3	6.1	6.7	7.2	6.3	6.8	7.1	6.1	5.9	5.8	6.4	6.3	6.1
4	6.9	6.7	6.6	5.4	5.4	5.5	4.7	4.8	4.8	6.0	5.8	5.7	5.2	5.1	5.1
L.S.D 1%	1.0364			1.0323			1.0246			0.9302			0.7226		
5%	0.7525			0.7445			0.7438			0.7754			0.5246		

* In all cases differences among values obtained during storage of smoked camel meat were not significant.

importance of aging process of Camel meat beofre smoking as it affects the tenderness of the final product rather than the chill storage of Camel meat after being smoked. However, three weeks of aging seemed to be quite sufficient to present noticeable tender meat.

The overall acceptability tests revealed that smoked cured Camel meat aged for one to two weeks attained significantly (1% level) the maximum quality attributes in respect to color aroma, taste and tenderness in all samples of aged smoked Camel meat storaed for different periods (Table. III).

In general, smoked, cured Camel meat could be aged for one to two weeks. However, meat aged for two weeks scored higher than one week aged meat in respect to color aroma and tenderness with no significant differences between the two treatments on any level. In conclusion, the aging process of cured meat seemes to be of prime importance since it affected color, aroma, taste and tenderness rather than storage after smoking, as no significant differences were detected among different aged smoked meat samples stored for different periods up to 4 weeks at 40 F.

It is worthy to mention that there was an insignificant improvement in aroma and taste only through storage of the aged smoked camel meat for different periods extending to one month which was the end of the experiment. This improvement although it is meagre yet it has an importance since it affect the flavor and could be attributed to the formation of flavoring compounds due to the interaction of different smoking residues and/or nitrite with meat constituents.

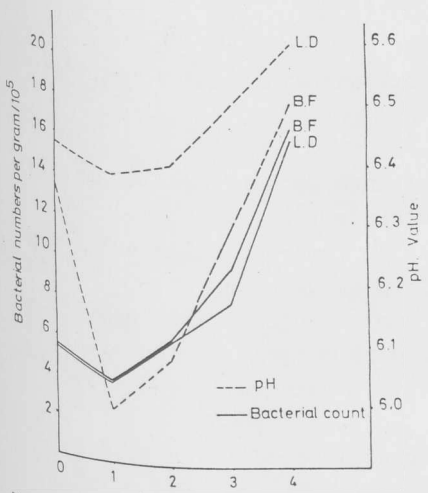

FIG.(1): THE RELATIONSHIP BETWEEN pH VALUE & TOTAL BACTERIAL COUNT IN CURED CAMEL MEAT DURING AGING PROCESS (L.D & B.F MUSCLES)

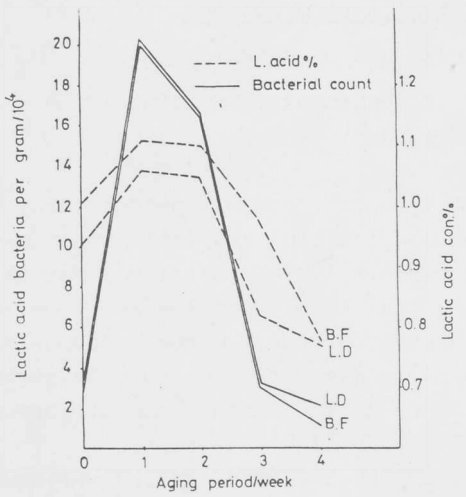

FIG.(2): THE RELATIONSHIP BETWEEN LACTIC ACID BACTERIA & LACTIC ACID CONCENTRATION IN CURED CAMEL MEAT IN BOTH L.D & B.F MUSCLES DURING AGING PROCESS.

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