Studies on Curing, Aging and Smoking of Camel Meat

I- Chemical Changes

Salwa, B. El-Magoli, E.T. El-Ashwah and M. M. Ibrahim.
Dept. of Food Sci. & Tech. Collage of Agric. Cairo University, Egypt.

Introduction:

Camels are prevailing in abundance in the middle east especially in Egypt. However, the low consumption of their meats would be ascribed to their toughness. Therefore, the tenderization process of camel meat would encourage more consumption of the elder animals saving other types of livestock that are considerably highly expensive due to their better quality.

Tenderness of meat was associated with the solubility of different fractions of muscles proteins and on the other hand, the solubility of muscle proteins are influenced by the post mortem conditions (Hegarty et al., 1963). The most common method of improving fresh meat quality is aging. The correlation between increased tenderness and aging has been established (Davey and Gilbert, 1969 and Davis et al., 1975).

Prior to refrigeration techniques curing and smoking of meat and meat products was done essentially to increase its shelf-life (Lawrie, 1975). Meanwhile, with the progress in food preservation techniques, curing and smoking have been used to impart desirable flavor characteristics and improve the appearance of products (Jeremiah ., 1978). The effect of smoking process upon the functional groups of proteins has been examined by several workers. Kako (1968) observed a decrease in PH of smoked meat while Kido and Tomto,(1967) reported an interaction between various phenol components and individual amino acids.

Collagen is the major protein component of connective tissues and is found in all organs and tissues, including muscles. According to Harding (1975), the changes in collagen are due to the gradual intorduction of intramolecular and intermolecular crosslinks. Little information is available in the literature concerning camel meat. Therefore, the primary objective of the present study includes the identification of the favorable conditions which help intenderizing camel meat through aging, curing and smoking and to introduce a product with a distinctive characteristic, At the meantime this part of the study was concentrated on the followup of the changes that might occur in the different fractions of the nitrogenous components, the connective tissues and the pigments of camel meat due to the aformentioned process.

Materials and Methods:

Meat used in this study was taken from the muscular parts of male camel meat of 1.5 to 2 years old of both longissimus dorsi (L.D) and Bicepes femoris (B.F). Meat samples within 2 hours of slaughter were refrigerated at 4 C for 36 hours.before treatments. Each muscle was divided into five equal parts, with approximately the same dimension and weight (about 1.5 Kg.).

Treatments:
1- Curing process: Dry curing was done by applying the added curing recipe (which consisted of 100 gm. salt - 0.5 gm. $NaNO_3$: 0.3 gm. $NaNO_2$ in proportion of 100 gm. mixture to 1.0 Kg meat), to the surface of the fresh meat parts by rubbing.
2- Aging process: After curing meat cuts were hung in cold storage at 40 F for different periods. Thereafter, meat samples were taken periodically every week for smoking and chemical analysis until the fourth week of aging.
3- Smoking process: At the end of aging meat pieces were smoked in a smoking house using the moistened sawdust. Smoking periods were varied from 10.5 to 12 hrs. inversely with the aging periods of samples. Smoked meat samples were wrapped in cellophane and kept under refrigeration at 40 F for a period of 4 weeks.

Chemical analysis: Total soluble nitrogen (TSN), soluble protein nitrogen (SPN) and soluble non-protein nitrogen were determined as recomended by Weindberg and Rose (1960), while total nitrogen (TN) was determined according to the A.O.A.C. (1970). The free amino acids (FAA) were fractionated and determined as described by Block et al., (1958), while collagen and elastin were estimated according to the method of Vognarova, et al., (1968). The total Heam pigments (THP) and the nitric oxide were determined using the method of Hornsey, (1956).

Results and Discussion:

The moisture content of fresh camel meat was 77.5% and 77.1% in L.D. and B.F muscles respectively. During the aging process at 40 F, the loss in moisture content increased gradually to reach a maximum of 10.89% in L.D. and 11.64% in B.F. after 4 weeks of storage, which is mainly due to the lowering effect of aging on the water holding capacity as well as the effect of salting before aging. However, during smoking the loss in moisture content increased markedly reaching an average of 14% in L.D & 17% in B.F. muscles. It was found that L.D. muscles when aged for only one week before smoking could be preserved for 2 weeks at 40 F with a total loss in moisture of 15.56% of which 13.47% was lost during aging and smoking and represent the available product containing the highest moisture content i.e. 57.52%. Mean while B.F. muscle when aged for only one week before smoking could be preserved for 2- 4 weeks at 40 F with a total loss of moisture of 19.76 to 21.33% of which 17.18% was lost during aging and smoking and represent the available product with highest moisture content of 53.5 - 51.9%.

Fresh camel meat contained on the average TN 15% TSN 5.5%, SPN 3.4% and SNPN 2.1%. However, no differences were found among the two muscles under investigation. The results in table, I clearly indicated that the TN was not affected by the different process, i.e. curing, aging

Table. I: Changes in TSN, SPN and SNPN during aging, smoking and storage of cured camel meat

Aging period (Weeks)	L. Dorsi Aged	L. Dorsi Smoked	L. Dorsi smoked-stored for 2 wk.	L. Dorsi smoked-stored for 4 wk.	B. Femoris Aged	B. Femoris Smoked	B. Femoris smoked-stored for 2 wk.	B. Femoris smoked-stored for 4 wk.
				A- TSN				
0	5.642	5.507	5.498	5.472	5.591	5.440	5.438	5.412
1	5.668	5.519	5.490	5.467	5.617	5.457	5.445	5.413
2	5.682	5.545	5.527	5.508	5.638	5.492	5.468	5.439
3	5.700	5.571	5.554	5.522	5.649	5.511	5.549	5.455
4	5.722	5.591	5.565	5.535	5.678	5.516	5.498	5.469
				B- SPN				
0	3.478	3.417	3.411	3.394	3.430	3.394	3.383	3.370
1	3.623	3.546	3.538	3.532	3.552	3.490	3.481	3.474
2	3.782	3.705	3.690	3.683	3.683	3.628	3.611	3.591
3	3.812	3.755	3.741	3.720	3.713	3.662	3.640	3.623
4	3.836	3.768	3.748	3.719	3.747	3.671	3.662	3.633
				C- SNPN				
0	2.164	2.090	2.086	2.077	2.161	2.056	2.054	2.041
1	2.045	1.972	1.952	1.934	2.064	1.966	1.963	1.938
2	1.899	1.840	1.837	1.428	1.955	1.864	1.856	1.848
3	1.887	1.815	1.812	1.802	1.936	1.842	1.852	1.831
4	1.886	1.823	1.816	1.815	1.931	1.844	1.835	1.836

N.B.: Calculation as salt free meat on dry weight basis.

and smoking. A slight persisted increase in TN was noticed after smoking which could be due to the absorption of some nitrogenous compounds from smoke components. The results (Table. I) indicate an increasing trend in both TSN and SPN and a decreasing trend in SNPN during the aging process of camel meat. These trends reached their maximum after 4 weeks of storage. SPN increased by 10.32% in L.D and 9.24% in B.F., while SNPN decreased by 14.8% in L.D and 11.9% in B.F. These findings are supported by the results obtained by Kamal et al.,(1970) and Shihata, 1974) concerning the general trend of nitrogen compounds through the aging process of camel meat. Mean while the smoking process slightly decreased all the soluble protein and non-protein fractions, i.e. SPN, TSN and SNPN, which could be attributed to protein denaturation and aggregation as a result of the water loss and reaction between the smoke components and proteins (and not entirely due to heating, Randel and Bratzler, 1970).

The total free amino acids in fresh camel meat was found to be 6.41% in L.D. and 5.11% in B.F. muscles directly after the addition of curing salts. During aging, there was a pronounced increase during the first two weeks due the activity of proteolytic enzymes. Thereafter, the rate of increase was slowed down. The smoking process as well as storage thereafter resulted in more liberation of free amino acids (Fig. 1 & 2), as all samples showed an increase in total free amino acids after smoking and storage depending on the accumulative activity of proteolytic enzymes. The free amino acids were identified during the aging process of cured camel meat. The fresh camel meat in both L.D & B.F muscles was characterized by the presence of cystine, Histidine, Arginine, Aspartic acid and Alanine as the only free amino acids. After one week of aging, the presence of cysteine, lysine, glycine and Methionine were detected and could be ascribed to the break down of camel meat proteins which might occured naturally due to the presence of proteolytic enzymes (Locker, 1960). By the second week of aging more amino acids were identified i.e. phenylalanine, Isoleucine and leucine, which confirmed the continuity of the activity of proteolytic enzymes during the aging process, and also presents an explanation to the increasing concentration of other free amino acids (Motoc and Banu, 1968). During the third and fourth week of aging no new free amino acids could be identified but there was an increasing concentration of the free amino acids in both L.D & B.F. muscles. The amount of amino acids in both muscles was not varied greatly. However, the amount of arginine and aspartic acids in L.D was two fold of that in B.F. Cystine was found in fresh camel meat but upon aging it disappeared to give cysteine in a steady increasing rate. The increase of amino acid cystine indicates the aggregation of protein molecules (actin and Myosin) which is quite responsible for the stiffness of the muscles through actomyosin formation during rigor development which was expected to dissociate into actin and myosin with the disappearance of cystine and the presence of cysteine. However, no further free amino acids were identified either after the smoking proces or after storage for 4 wks. at 40 F, which emphasized the importance of the aging process in improving both meat tenderness and the quality of camel meat proteins.

Regarding the connective tissues, the results indicated that collagen percentage was two fold that of elastine in camel meat, and that the connective tissues percentage were slightly higher in B.F. than in L.D. muscles. Figs. 3, 4, 5 and 6, clearly revealed that aging has more pronounced effect on collagen reduction than both smoking and chill storage. However, the effect of aging started after the second week of storage and reached its maximum after the fourth week as the reduction percentage reached 12.3% in L.D. and 15.3% in B.F. On the other hand, elastin also was found to be affected by the different processing treatments, but to much lower extent (Figs. 4 & 5). The changes in connective tissues during aging may be due to the gradual introduction of intramolecular and intermolecular cross links as reported by Jeremiah, 1978.

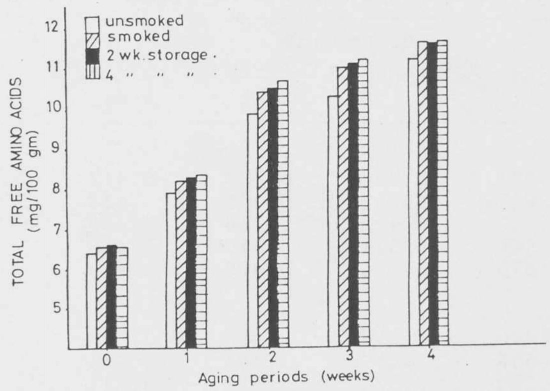

FIG. (1): TOTAL FREE AMINO ACIDS IN DIFFERENT PROCESSED CAMEL MEAT AT DIFFERENT AGING PERIODS (L.D)

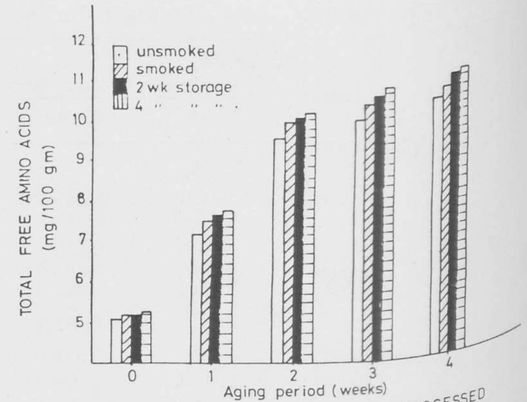

FIG. (2): TOTAL FREE AMINO ACIDS IN DIFFERENT PROCESSED CAMEL MEAT AT DIFFERENT AGING PERIODS (B.F)

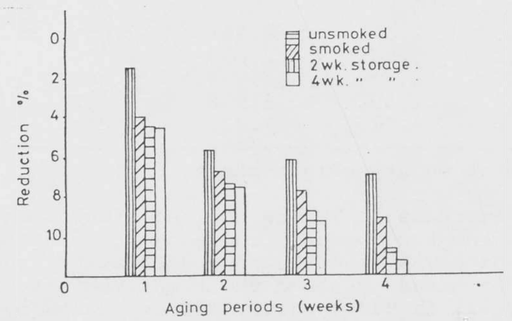

FIG. (3): PERCENTAGE REDUCTION IN COLLAGEN IN DIFFERENT PROCESSED CAMEL MEAT AT DIFFERENT AGING PERIODS (L.D)

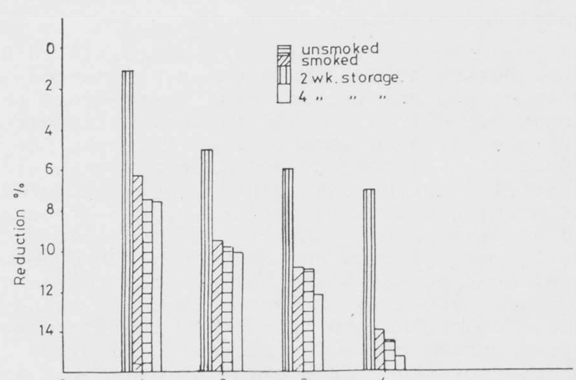

FIG. (4): PERCENTAGE REDUCTION IN COLLAGEN IN DIFFERENT PROCESSED CAMEL MEAT AT DIFFERENT AGING PERIODS (B.F)

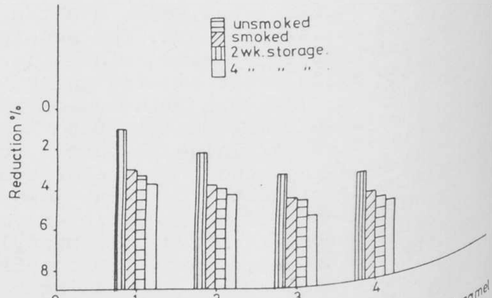

FIG. (5): Percentage reduction in Elastin in different processed camel meat at different aging periods (L.D).

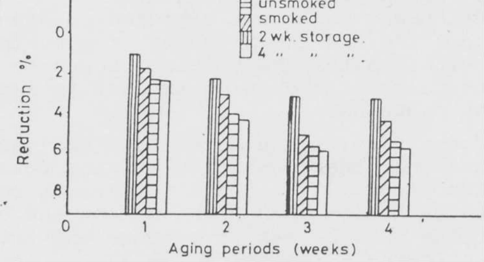

FIG. (6): PERCENTAGE REDUCTION IN ELASTIN IN DIFFERENT PROCESSED CAMEL MEAT AT DIFFERENT AGING PERIODS (B.F)

Table. 2: Changes in color of cured aged and smoked meat during storage at 40 F

Muscle / Aging period (Weeks)	Pigments concentration (nitroso-pigments N.P) Aged	smoked	smoked-stored for 2 wk.	smoked-stored for 4 wk.	Total pigments (THP) Aged	smoked	smoked-stored for 2 wk.	smoked-stored for 4 wk.
0	0.760	0.768	0.758	0.743	0.522	0.518	0.500	0.494
1	0.755	0.760	0.755	0.730	0.502	0.524	0.508	0.490
2	0.742	0.750	0.739	0.725	0.490	0.509	0.498	0.485
3	0.705	0.715	0.705	0.702	0.482	0.490	0.485	0.475
4	0.700	0.712	0.695	0.680	0.476	0.480	0.482	0.478
0	0.769	0.742	0.724	0.709	0.503	0.524	0.516	0.512
1	0.764	0.770	0.742	0.715	0.494	0.500	0.494	0.488
2	0.755	0.760	0.760	0.732	0.490	0.498	0.490	0.482
3	0.716	0.722	0.722	0.720	0.480	0.485	0.482	0.474
4	0.723	0.720	0.725	0.718	0.472	0.478	0.470	0.466

Table. 2 shows the changes in both nitroso-pigments (NP) and the total heme pigments (THP) during the different processing treatments i.e. curing,aging and smoking, no changes were detected in the NP during the aging process which was extended to 4 weeks. This could be attributed to the formation of either or the stable nitric oxide heamoglobin or nitric oxide myoglobin as reported by Mohler (1970). While on the other hand, there was a decreasing trend in the THP values during the aging process (Table. 2). The decreasing percentage reached 6.2% at the end of aging period (4 weeks), and could be expalined on the basis that this fraction of color includes other unstable pigments such as reduced haemoglobin, oxyhaemoglobin, and methaemoglobin which stay uncombined with NO as reported by Hornsey (1956). Mean while, the smoking process resulted in general improvement of color of smoked meat. The camel meat under investigation conserved in general, more than 90 % of its color in the end product. The effect of smoking process could be attributed to one/or the following: acheiving an acid condition (the PH value decrease from 6.3 to 5.7) which encouraged the decomposition of nitrite to yield nitric oxide, the low level of O_2 during smoking activates the formation of NO-MG and the reduction of Met-MG to NO-MG and in addition the prevailing temperature during smoking reached the optimum for nitrite reductose enzymes.

References

1- A.O.A.C. (1970). "Official Method of analysis of the Association Official Agriculture Chemists". 17th ed. A.O.A.C. Washington, D.C.
2- Block, R. J., Durum, F.L. and Zweig, G. (1958). " A manual of paper chromatography and electro phoresis" 2nd. Ed. Academic Press. Inc. New York.
3- Davey, C.L. and Gilbert, K. V. (1968). J. Food Sci. 33, 2.
4- Davis, K. A., Huffman, D.L., and corday, J. C. (1975). J. Food Sci. 40, 1222.
5- Harding , J. J. (1975). Adv. Protein chem. 30, 109.
6- Hegarty, G. R. Bratzler, L.J. and Pearson, A. M. (1963). J. Food Sci. 28, 525.
7- Hornsey, H. C. (1968). J. Sci. Food, Agric. 1, 534.
8- Jeremiah, L. E. (1978) Lacombe Res. st. Tech. Bull. No. 1, Locombe, Allberta.
9- Kako, Y. (1968). J. Food Sci. 35, 235.
10- Kamal, M. A., El-Hinnawy, S. El-Dashlouty M.S. and Zen El-Din, S. (1970). Ain Shams University press. Bulletin, 380, Egypt.
11- Kido, K. and Tomoto, K. (1967). Hokusuishi Geppo, 24, 374, Japan.
12- Lawrie R.A. (1975). "Meat components and their variability" 2 nd. Ed. The AVI Pub. Co. Inc. West Port. Conn.
13- Locker, R. H. (1960), J. Sci. Food Agric. 11, 520.
14- Mohler, K. I. (1970), Z. Alebensm, Unters, Forch 142, 69 Germany.
15- Motoc, C. and Banu C. (1968), Fleisch writchaft 48, 1045.
16- Shehata M.I. (1974), Ph. D. Thesis, Faculty of Agric. Ain Shams University, Cairo , Egypt.
17- Vognarova, I. Dvorak, Z. and Bohm, R. (1968), J. Food Sci. 33, 339.
18- Weindberg, B and Rose, D. (1960) Food Tech. 14, 376.