3:34 Some physical and chemical studies on buffalo and camel meat during cold storage

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Introduction

Buffaloes and camels are important sources of meat consumed in Egypt. Most of the studies concerned with physical and chemical changes during aging were carried out, however, on beef meat. Some of these studies were concentrated on the effect of aging on tenderness (Valin et al., 1975), color (Lanier et al.,1977), and water holding capacity of beef meat (Dumont and Valin,1973). Other studies were deduced to the effect of aging on the chemical composition of the meat (Jeremiah and Martin, 1980).

The object of this investigation was to study the effect of aging by cold storage on some physical and chemical properties of buffalo and camel meat.

Materials and Methods

Materials: The meat samples used in this investigation were obtained from the longissimus dorsi muscle of three years old males of buffalo and camel animals. These samples were taken from the slaughter-house of Kafr El-Sheikh within two hours from slaughter. The samples were immediately brought to laboratory where fat and thick connective tissues were removed from the lean meat and were kept in cold storage at 4°C for 7 days and then analyzed.

Methods:(A) physical analysis: (1) Tenderness and water holding capacity: Tenderness and water holding capacity were determined according to the method described by Grau and Hamm (1957) as modified by Volovinskaia and Kelman (1962). (2) Color intensity: The color intensity of meat-water extract was determined according to the method described by Hussaini et al., (1950).
(B) Chemical analysis: (1) Main chemical composition: Moisture, ash and crude protein contents were determined according to the methods described by A.O.A.C. (1975). (2) pH value: pH value was measured by pH-meter with glass electrode as described by Aitken et al., (1962). (3) Total soluble nitrogen(TSN),soluble protein nitrogen (SPN) and soluble non protein nitrogen(SNPN): The TSN was determined according to the method of El-Gharbawi and Dugan (1965) using cold 0.6 molar KCl solution for extraction. The extracted nitrogen was used for the determination of TSN using Micro-Kjeldahl method of the A.O.A.C. (1975). The SNPN was determined in the KCl extract supernatant obtained during the determination of TSN using 20% trichloroacetic acid solution according to the method described by El-Gharbawi and Dugan (1965). The percentage of SPN was calculated by substracting the percentage of SNPN from the percentage of TSN value of the same extract. (4) Collagen and elastin: Collagen and elastin were determined according to the method of Lowary et al., (1941). (5) Free amino acids: The method proposed by Mengel and Hetal (1968) was used. Partition paper chromatography was employed for detection of free amino acids separation and the development was achieved according to Block et al., (1958).

Results and Discussion

A- Physical properties: (1) Tenderness and water holding capacity (WHC): Data presented in Table 1 show the effect of cold storage at 4°C for 7 days on the tenderness and WHC for buffalo and camel meat. It could be noticed that, after cold storage the tenderness increased and reached 112.00 - 113.04% of the original value indicating that the increase of tenderness was continued through aging. Such results are in accordance with those of Soloviev (1966). The marked toughness of camel meat could be expected to lower protein solubility (Table 4), lower WHC (Table 1) as well as the more thick muscle fiber diameter and the presence of appreciable amounts of firm connective tissues. Such results are in agreement with those reported by Ghoneim (1974) who mentioned that the WHC and tenderness of buffalo meat were better than for the camel meat during cold storage which could be due to the higher protein solubility of buffalo meat.

Table (1): The effect of cold storage at 4°C for 7 days on the tenderness and water holding capacity(WHC) of buffalo and camel meat.

Treatments	Buffalo		Camel	
	Tenderness	WHC	Tenderness	WHC
Raw samples	2.50	5.90	2.30	6.90
% retention	100.00	100.00	100.00	100.00
7 days at 4°C	2.80	6.00	2.60	8.60
% retention	112.00	101.69	113.04	124.64

It could be also noticed that the WHC was better in the fresh buffalo meat than in camel meat. This could be attributed to higher total soluble nitrogen in buffalo meat. Moreover, buffalo meat tissues contained relatively higher percentage of proteins which may increase WHC as compared with camel meat. By aging, the WHC decreased slightly and this could be due to the decrease of pH value towards the isoelectric point of muscle proteins as well as the association of actin and myosin leading to the decrease of protein solubility and decrease of free chemical groups that are able to bind water (Soloviev, 1966; and El-Sanafiry, 1974).

For samples aged at 4°C, the rate of WHC deterioration was higher for camel meat than buffalo meat. This could be due to that the buffalo meat had higher pH value than the camel meat.

(2) Color intensity: Data presented in Table 2 show the color intensity of buffalo and camel meat as affected by cold storage at 4°C for 7 days. It was noticed that buffalo meat was darker due to more myoglobin content than that of camel meat. This agreed well with the findings obtained by Ragab et al., (1966). After aging by cold storage the intensity of desirable red color continuously decreased in both buffalo and camel meat.This could be attributed to meat pigments oxidation as well as the loss of some pigments (water soluble proteins) with drip.

Table (2): The effect of cold storage at 4°C for 7 days on the color intensity of buffalo and camel meat(absorbance at 542 mμ).

Treatments	Buffalo	Camel
Raw samples	0.640	0.252
% retention	100	100
7 days at 4°C	0.600	0.240
% retention	93.750	95.240

B- Chemical analysis : (1) Main chemical composition:Data of moisture content, ash, protein, collagen, elastin and pH value of buffalo and camel meat as affected by cold storage at 4 °C for 7 days are presented in Table 3. It was observed that the moisture content of fresh buffalo and camel meat were 76.06 and 79.57%, respectively. Such differences depends mainly on the species and the chemical composition of meat. During aging process at 4°C for 7 days the moisture content decrease reached its maximum 97.67% of the original value in the buffalo meat, while reduced to 96.59% of the original value of the camel meat. The decrease of moisture content could be due to the water loss by evaporation and separation of some fluids at the stage of rigor mortis as a result of contraction and decrease of the water holding capacity.

The initial crude protein contents (as % dry weight) of fresh buffalo and camel meat were 87.25 and 85.50%, respectively. It could be noticed that the total protein (%) in proportion to the original value after 7 days of refrigeration was 86.25 and 83.47% in the buffalo and camel meat, respectively. This could be ascribed to the loss of a part of nitrogeneous compounds either as volatile substances or a soluble nitrogen such as amino acids, purine and pyrimidine, ...etc with the separated fluids especially at the stage of rigor mortis (Pavlovski and Palmin, 1963; and Shehata, 1974).

Table (3): The effect of cold storage at 4°C for 7 days on some chemical composition of buffalo and camel meat.

Treatments	Moisture	Crude protein*	Ash*	Collagen	Elastin	pH value
Buffalo:						
Raw samples	76.06	87.25	3.38	1.25	0.94	6.50
% retention	100	100	100	100	100	100
7 days at 4°C	74.29	86.25	4.00	1.04	0.73	5.95
% retention	97.67	98.85	118.34	83.20	77.66	91.54
Camel:						
Raw samples	79.57	85.50	3.44	2.04	1.26	6.40
% retention	100	100	100	100	100	100
7 days at 4°C	76.86	83.47	4.08	1.75	1.12	5.90
% retention	96.59	97.63	118.60	85.78	88.89	92.19

* dry matter.

It could be noticed that the pH value of fresh samples were 6.5 and 6.4 in the buffalo and camel meat, respectively. The results pointed out that after cold storage the pH value decreased reaching 5.95 and 5.90 in the buffalo and camel meat , respectively (Table 3). The decrease of pH value could be ascribed to the breakdown of glycogen with the formation of lactic acid (Hamm, 1958).

The results showed that the collagen percentage of fresh buffalo and camel meat was 1.25 and 2.04%, respectively,whereas the elastin percentage was 0.94 and 1.26 % in the buffalo and camel meat , respectively. The results indicated that the collagen and elastin percentages were high in fresh camel meat , while buffalo meat have low percent. At the stage of aging by cold storage the collagen value decreased slightly which was 1.04 and 1.75% in buffalo and camel meat, respectively. With elastin the same trend occurred after aging. These results , go in parallel with those given by El-Magoli et al., (1981) . The changes in connective tissues at the stage of aging might due to the gradual introduction of intramolecular and intermolecular cross links as reported by Jeremiah (1978). It could be also reported that the alkali in soluble protein decreased gradually during aging of meat at 4°C which indicated the decrease of connective tissues by aging (Abd-El-Baki et al., 1957) or due to the destruction of the ground substances of the connective tissues (Saied et al., 1972). It was also noticed that the decrease of collagin and elastin was accompanied by the drop in pH. Such results agreed well with the findings obtained by Bodalia et al.,(1970).

(2) Total soluble nitrogen (TSN), soluble protein nitrogen(SPN) and soluble non protein nitrogen (SNPN): The changes in TSN, SPN and SNPN of buffalo and camel meat as affected by cold storage at 4°C for 7 days were illustrated in Table 4. It could be observed that the initial TSN content of fresh buffalo and camel meat was 3.18 and 2.32% , respectively. It is clear that the TSN in camel meat was lower than in buffalo meat. After refrigeration storage of meat samples at 4°C , both TSN and SPN increased, while SNPN decreased. These findings are supported by the results obtained by Kamal et al., (1970); Shehata (1974) and El-Magoli et al., (1981) concerning the general trend of nitrogen compounds. On the other hand, the results of NPN disagree with those of Soloviev et al., (1962) who reported that the amount of NPN increased in cow meat tissues by 14.6% after 6 days of aging by storage at 8 - 10°C , which indicates proteolysis and destruction of protein by cathepsins.

Table (4): Total soluble nitrogen (TSN), soluble protein nitrogen (SPN) and soluble non protein nitrogen (SNPN) of buffalo and camel meat as affected by cold storage at 4°C for 7 days.

Treatments	Buffalo			Camel		
	TSN	SPN	SNPN	TSN	SPN	SNPN
Raw samples	3.18	2.61	0.57	2.32	1.99	0.33
% retention	100	100	100	100	100	100
7 days at 4°C	3.29	2.75	0.54	2.40	2.10	0.30
% retention	103.46	105.36	94.74	103.45	105.53	90.19

The increase of protein solubility could be due to the breakdown and proteolysis of the muscle proteins to other nitrogen forms, as well as the dissociation of actomyosin into actin and myosin (Sokolov, 1965; and Shehata, 1974). Changes in SPN during autolysis are mainly due to the changes of salt soluble proteins namely actomyosin (Soloviev, 1966).

(3) Free amino acids:(FAA): Table 5 show the identified FAA of buffalo and camel meat as affected by cold storage at 4°C for 7 days. It was clear that the following amino acids were detected in the fresh buffalo meat: threonine, histidine, lysine, arginine, cystine and cysteine. After one week of cold storage the presence of methionine , tryptophan, alanine, glutamic acid, aspartic acid and serine were detected. In the fresh camel meat the following amino acids were detected: lysine, arginine, alanine, aspartic acid , cystine and cysteine. After one week of cold storage the presence of methionine, threonine, tryptophan, glutamic acid, tyrosine and serine were detected.

It was noticed that the presence of FAA in the fresh samples were not varied greatly and depends on the nature of the meat and their sources. After cold storage, there was a pronounced increase in the number of FAA and this could be ascribed to breakdown of meat proteins which might occur naturally due to the presence of proteolytic enzymes (Locker, 1960; Motoc and Bonu, 1968;and Kamal et al., 1970).

Table (5): The free amino acids (FAA) of buffalo and camel meat as affected by cold storage at 4°C for 7 days.

FAA	Buffalo		Camel	
	Storage time		Storage time	
	0	7 days	0	7 days
Arginine	+	+	+	+
Methionine	-	+	-	+
Threonine	+	+	-	+
Histidine	+	+	-	-
Lysine	+	+	+	+
Tryptophan	-	+	-	+
Alanine	-	+	+	+
Glutamic acid	-	+	-	+
Tyrosine	-	-	-	+
Aspartic acid	-	+	+	+
Serine	-	+	-	+
Cystine	+	+	+	+
Cysteine	+	+	+	+

\+ present
\- absent

It was clear that autolytic process continued occur in the samples during storage at 4°C for 7 days but at various rates, the explained the increase of the number of FAA which was dependent on the pre aging conditions of meat. The presence of glutamic acid was related to bacterial numbers, while that of tryptophan was related to time and storage temperature (Gardner and Stewart, 1966), the relationship between the tryptophan level and the time of storage suggested that its increase may be due to autolysis. Locker (1960) thought that amino exopeptidase of muscle, which act only on N-terminal groups and remove amino acids stepwise, contributed to the increase in amino acids in general and glutamic acid in particular. In the autolysis of meat stored at 4°C, Pavlovskii (1965) found that of the FAA glutamic acid, phenylalanine and tyrosine increased most and alanine and aspartic acid to a lesser extent. He thought that the acidification of the tissues owing to the accumulation of lactic, phosphoric and other acids created conditions which favoured high acidity to the cathepsins A and C, which split the peptide bonds formed by mono amino dicarboxylic and aromatic amino acids.

References

Abd El-Baki, M.M.; Hussein, A.A.; Ashmawi, H. and Foda, I.O. (1957). Bull. No. 110, Fac. Agric., Cairo Univ., Egypt.

Aitken, A.; Casey, J.C.; Penny, I. F. and Voyls, C.A. (1962). J. Sci. Fd. Agric., 13, 439.

A.O.A.C. (1975). Official Methods of Analysis. 12th Ed., Washington, D.C.

Block, R.J.; Durrum, E.L. and Zweig, G. (1958). A Manual of Paper Chromatography and Paper Electrophorasis. 2nd Ed., Academic Press in Publishers, New York.

Dumont, B.L. and Valin, C. (1973). Proc. of the European Meeting of Meat Res. Workers., 19, (Part 1), 249.

El-Gharbawi, M.I. and Dugan, L.R. (1965). J. Fd. Sci., 30,5,817.

El-Magoli, S.B.; El-Ashwah, E.T. and Ibrahim, M.M. (1981). Proc. Kongress. Dokumentation, 1, Wissenschaftliche Betrage, C: 8, 234.

El-Sanafiry, M.Y. (1974). Technological Studies on Tenderization and Packaging of Meat. M.Sc. Thesis, Fac. Agric., Ain Shams Univ., Egypt.

Gardner, C.A. and Stewart, D.J. (1966). J. Sci. Fd. Agric.,17, 11, 491.

Ghoneim, S.I.M. (1974). Comparative studies on the Freshness Indices of Fish. M.Sc. Thesis, Fac. Agric., Ain Shams Univ., Egypt.

Grau, R. and Hamm, R. (1957). Zeitschrifs fur laben smittel, Untersuchung und Forschung, 105, 6, 446.

Hamm, R. (1958). Fleisch Wirtschaft, 10,2, 80.

Hussaini , S.A., Deartherage, F.B. and Kunkle, L.E. (1950). Fd. Technol., 4, 9, 366.

Jeremiah, L.E. (1978). Lacombe Res. Sta. Tech. Bull., No.1, Lacombe, Allberta.

Jeremiah, L.E. and Martin, A.H. (1980). Proc. European Meeting of Meat Res. Workers, 26, 1, F 12, 296.

Kamal, M.A.M.; El-Hinnawy, S., El-Dashlouty, M.S. and Saied, S.Z. (1970). Res. Bull. No. 380, Fac. Agric., Ain Shams Univ., Egypt.

Lanier, T.C.; Carpenter, J.A. and Toledo, R.T. (1977). J. Fd. Sci., 42, 4, 860.

Locker, R.H. (1960). J. Sci. Fd. Agric., 11, 9, 520.

Lowary, O.H.; Gilligan, D.R. and Katersky, E.M. (1941). J. Biol. Chem., 139, 795.

Mengel, K. and Hetal, M. (1968). Z. Pflanzenernaker, Bondenkunde 12, 120.

McClain, P.E.; Greed, G.J.; Wiley, E.R. and Hornstein, I.(1970). J. Fd . Sci., 35, 258.

Motoc, C. and Bonu, C. (1968). Poly Tech. Inst. Calatz, Roma, 48, 1045.

Pavlovski, P.E. and Palmin, V.V. (1963). Biochemistry of Meat and Meat Products. Fd. Industry Pub., Moscow.

Pavlovskii, P.Y. (1965). Izv. Vyssh. Ucheh. Zaved. Pishch. Tekh., 44, 47.

Ragab, M.T., Darwish, M.Y.H. and Malak, A.G.A. (1966). J. Anim. Prod., U.A.R., 6,1, 31.

Saied, S.Z., El-Dashlouty, M.S. and Heikal, H.A. (1972). Agric. Res. Rev., Cairo, 50, 5, 347.

Shehata, M. (1974). Studies on some Physical and Chemical Changes in Meat during Storage. Ph.D. Thesis, Fac. Agric., Ain Shams Univ., Egypt.

Sokolov, A.A. (1965). Physico-Chemical and Biochemical Basis of Meat and Meat Products. Fd. Industry Publ., Moscow.

Soloviev, V.E. (1966). The Meat Aging. Fd. Industry Publ.,Moscow.

Soloviev, V.E.; Adotskerich, V.A.; Aglit, G.H.; Volkova, A.G. and Krakova, V.Z. (1962). Proc. of V.N.I.I.M. Pa, 16,20,Moscow.

Valin, C.; Palanska, O. and Goutefongea, R. (1975). Annales de Technologie Agricole, 24, 1, 47.

Volovinskaia, V.P., and Kelman, B.Y. (1962). Fd. Industry,11, 80, Moscow.