CHANGES IN PROTEINS AND FATS OF OLD HENS MEAT AS INFLUENCED BY PRE-FREEZING TREATMENTS

BY

M.M.ABD EL-BAKI[x] , R.A.TAHA[x] , F.M.M.EL-ZAYET[x] , A.A.EL-DASHLOUTI[xx] and Z.M.A.FOUDA[xx]

x Food Science and Techn. Dept. , Faculty of Agriculture , Suez Canal University .

xx Meat and Fish Techn. Res. Div. , Agric. Res. Centre .

INTRODUCTION

Deterioration in food products of animal source during storage at low temperatures occurs by the effect of bacterial activity and tissue enzymes which cause the undesirable changes in protein and fat leading to spoilage and loss of natural flavour , taste , colour and texture (Khan and Van Den Berg , 1965 ; Khlebnikov , 1973 ; Laurie , 1974 and George and Mountney , 1976) .

Concerning the tough meat , for example the meat obtained from old hens of egg laying flocks (Shrimpton , 1960) , many treatments may be used to increase its tenderness , specially that frozen storage increase the toughness of such meat (Dawson et al. , 1958 ; Khan , 1964 ; Khan and Van Den Berg , 1967 and El-Samahy and Shehata , 1977) . Other treatments were applied to reduce the oxidation of lipids during frozen storage (Tomson , 1964 ; Arnold , 1970 ; Altovieva and Oskalova , 1971 and 1972 and Rao et al. , 1970) .

This work was conducted to study the effect of some pre-freezing treatments used for increasing tenderness and decreasing lipids and protein changes during frozen storage of meat obtained from old hens .

MATERIALS AND METHODS

Habard chicken hens 2 - 3 years old (stewing) of live weight were obtained from General Poultry Company . These birds were slaughtered , bled for 5 minutes , scalded for 2 minutes at 55°C , plucked , eviscerated , rinsed with water , strained , then jointed to breast , thigh and wing base . Pre-freezing treatments included the following : a) Untreated samples (control) ; b) Breast and wing base breaded cuts with spiced fine crust , black pepper and salt ; c) Soaked samples for 4 hours in cold (4°C) 0.5% pyrophosphate solution or 1.0% Na Cl solution ; d) Glazed samples , by immersion three times (5 seconds each) in cold about (4°C) 0.2% ascorbic acid + 0.2% citric acid solution or in cold 0.1% propolis antioxidant * 0.1% citric acid solution , between successive immersions , the meat was held for 1 hour at 10°C ; e) Unsoaked or soaked samples for 4 hours in cold (4°C) 0.5% pyrophosphate solution and cold stored for 3 days at 4°C before freezing .

Frozen storage was carried out in polyethylene bags at -10°C . Samples were taken for analysis after 0 , 2 , 4 and 6 months of storage .

Total volatile nitrogen (TVN) and trimethylamine nitrogen (TMAN) were determined using the methods described by Winton and Winton (1958) . Amino nitrogen (AN) was determined by the formol titration method of Kolchnov (1952) . Total bacterial count (TC) was carried out according to Frazier and Foster (1958) . Thiobarbituric acid value (TBA) was determined following the method of Pearson (1970) . Fatty acid composition was carried out for selected samples of thigh after 6 months of frozen storage according to the method given by the A.O.A.C. (1970) . Methyl esters were prepared by the method of Ganglitz and Lehman (1963) and Pye-Unicum gas liquid chromatography apparatus was used .

RESULTS AND DISCUSSION

A- Protein degradation .

From tables (1 , 2 and 3) it could be noticed that fresh as well as frozen stored samples showed highest TVN and TC for breast followed by leg and wing base ; TMAN and AN were highest for the leg , followed by breast , being lowest for the wing base . This may indicate the effect of original properties of raw materials .

Total bacterial count (TC) decreased after 2 months storage then increased after 4 and 6 months . Sokolov (1965) reported that at -18°C , TC decreased progressively , while at -10°C , the decrease was noticed only at early periods of storage , followed by progressive increase in counts . Although after 2 months of storage TC decreased , survived bacteria were able to raise TVN , TMAN and AN which increased progressively during frozen storage with no reduction .

After 6 months of storage , highest TC , TVN , TMAN and AN were noticed for post-rigor freezing treatment (samples frozen after cold storage and the control sample) while were lowest for pre-rigor frozen pyrophosphate , citric + ascorbic and propolis samples . Other samples (post-riger pyrophosphate , Na Cl and fine crust samples) showed intermediate values . In case of AN , fine crust coated sample had the lowest values , possibly because of probable reaction of amine nitrogen groups with some fine crust constituents , presumably the reactive groups in carbohydrates . The reason , however , may be simple dilution of meat with fine crust .

Post-riger freezing accelerated the break-down of proteins , neverless the pre-treatment with pyrophosphate before cold storage followed by freezing reduced this change , possibly because of the antibacterial effect of pyrophosphate as mentioned by Alekceyev et al. (1958) . Citric + ascorbic acids treatment reduced the break-down of protein , possibly because of low ph value and its influence on micro-organisms . With regared to propolis effect , El-Bssary (1978) found that such resin had antibacterial effect during cold storage of irradiated camel meat .

B- Lipids changes :

1) Thiobarbituric acid value (TBA) .

From table (4) it could be observed that before and after frozen storage , TBA was highest for leg , intermediate for wing base , while was lowest for the breast .

Post-riger freezing samples showed highest lipids oxidation during frozen storage , because of initial higher malonaldehyde content by the effect of cold storage before freezing . Control samples followed the post-rigor frozen meat . Due to the antioxidation effect of pyrophosphate (Alekceyev et al. , 1958) , pyrophosphate post-rigor freezing samples had lower TBA values . Nevertheless , propolis samples had highest antioxidation effect in case of pre-rigor frozen meat , followed by pyrophosphate and citric + ascorbic acid treatments . Antioxidation effects of ascorbic and citric acids were reported by Sokolov (1965) and Arnold (1970) . Na Cl and fine crust treatments showed intermediate TBA values ; being between pyrophosphate post-rigor freezing and citric + ascorbic acid treatments .

The fatty acid composition of treatments which, as indicated by TBA value, proved to have antioxidation effect was studied during frozen storage of the leg muscle for 6 months . Results are given in table (5) .

Fresh lipids of hens showed higher contents of oleic , palmitic and linoleic acids ; 48.06 , 22.69 and 20.36 mol.% respectively . The fatty acid composition in general was similar to that given by Kosnetseva et al. (1971) working on chicken lipids . These authors found that total saturated and total unsaturated fatty acids of chicken lipids were 27.80 and 72.65 mol.% which was confirmed by the present data (Table , 5) ; being 27.99 and 72.01 mol.% respectively . This indicated that hens lipids may be less stable for oxidation due to higher unsaturation of fatty acids . For beef lipids , the reverse was found , where unsatusated fatty acids (41.41 mol.%) were lower than total saturated fatty acids (58.59 mol.%) as given by El-Dashlouty (1978) . Nevertheless , the biological value of chicken lipids are considered to be higher than for beef , due to higher contents of essential fatty acids which are unsaturated (linoleic , lenoleic and arachidonic) . Moreover , assimilation of chicken fat was higher than the beef fat (Sokolov , 1965) .

During frozen storage apparent increase of total saturated fatty acids was found . This increase was mainly due to the increase in C_{16} and C_{18} mainly . The contents of C_{12} and C_{14} also increased while C_{17} mostly decreased .

After 6 months of storage , the total unsaturated fatty acids decreased due to lipids oxidation which was mainly due to reduction of $C_{16:1}$ and $C_{18:2}$. Tetradecenoic acid ($C_{14:1}$) also decreased , while changes of $C_{16:1}$, $C_{17:1}$ and $C_{18:3}$ were less pronounced showing decrease in some treatments and increase in others .

The rate of total increase in saturated fatty acids and the rate of decrease of total unsaturated fatty acids were considered assumably as indications for lipids oxidation , propolis treated sample showed lowest rate of rancidity (17.27 , 6.72%) , followed by that of pyrophosphate (20.26 , 14.97%) and citric + ascorbic acids (29.12 , 11.32%) , while control sample showed the highest rate of rancidity (57.88 , 22.49%) . Such results were in accordance with data obtained for the TBA value (Tables , 4 and 5) .

* Commercial name , produced from Bee Hives' wax

REFERENCES

Alekceyev,N.G. , Volovinskaia,V.P. , Goldman,L.D. , Dindaling,D.S. , Bobashkina,S.Sh. , Stalmakhova,K.L. and Shegalyeva,C.P. (1958) .
"The use of phosphates in sausage production . All Union Scientific research institute of Meat Industry Pub. (In Rus.) .

Altovieva,K.A.and Oshkalova, V.N. (1971) .
A new method for treating the frozen Flyaci fish . Fish Technology , 47 , 11 , 69 - 72 (In Rus.) .

Altovieva,K.A. and Oshkalova,V.N. (1972) .
Retaining the quality of frozen fish . Food Technology , 48 , 5 , 62 - 65 (In Rus.) .

A.O.A.C. (1970) .
Official Methods of Analysis of the Association of Official Analytical Chemists , Eleventh ed. , Washington , D.C.

Arnold,M.H.M. (1970) .
Citric acid in food and drink . Food Manufacture , 15 - 16 , C.F. , F.D.T.A. , 2 , 7 , P 250 (1970) .

Dawson,L.E. , Dridson,J.A. , Prang,M. and Walters, S. (1958) .
The effects of time interval between slaughter and freezing on toughness of fryers . Poultry Science , 37 , 2 , 231 - 235 .

El-Lashlouty,A.A. (1978) .
Studies on the quality of some meat products . M.L. Thesis , Faculty of Agriculture , Ain Shams University .

El-Lzzary,M.M. (1978) .
Studies on the preservation of meat by irradiation . M.Sc. Thesis , Faculty of Agriculture , Tanasig University .

El-Samahy,S.K. and Shehata,M.M. (1977) .
Studies on camel meat tenderization . Annals of Agric. Sc. , Moshtohor , 2 , 105 - 116 .

Frazier,W.C. and Foster,L.M. (1950) .
Laboratory Manual for Food Microbiology . Burgess Publishing Co. Minnesota

George,J. and Mountney,T. (1976) .
Poultry products Technology . The AVI Publishing Company Inc. , West P. Connecticut .

Khan,A.W. and Van Den Berg,L. (1965) .
Biochemical and quality changes occuring during freezing of poultry meat . J. Food Science , 30 , 1 , 151 - 153 .

Khan,A.W. and Van Den berg,L. (1967) .
Changes in chicken muscle proteins during cooking and subsequent frozen storage and their significance in quality . J. Food Science , 32 , 2 , 148 - 156 .

Khlebnikov,V.A. (1973) .
Culinary , sausage , canned and half-finished products from poultry meat . Food Industry Pub. , Moscow .

Kolesov,V.V. (1962) .
Methods of Analysis of the Fish and Fish Products . Food Industry Pub. Moscow .

Kornetsova,Z. , Bolshakov,A. and Kagov,E. (1972) .
Changes in poultry meat lipids during its treatment in electromagnetic field of super-high frequencies . Meat Industry USSR , 28, 3 , 36 - 37 .

Lawrie,R.A. (1974) .
Meat Science . Oxford , New York , Toronto .

Pearson,D. (1970) .
The chemical Analysis of Food . National College of Food Technology , University of Reading , Weybridge , Surry , U.K. , Churchill Ocean Fishes .

Shrimpton,D.H. and Miller,W.S. (1960) .
Some causes of toughness in boiler , II. Effect of breed , management and sex , . British Poultry Science , 1 , C.F. Stadelman,W.J. , Relation of age , breed , sex and feeding practices on poultry meat tenderness . Proceeding of Conference , Meat Tenderness Symposium , Camden , New Jersey , (1961) .

Sokolov,A.A. (1965) .
Physico-chemical and biochemical basis of meat products technology . - Food Industry Pub. (In Rus.) .

Winton,A.L. and Winton,K.B. (1958) .
Okeleff magnesium oxide distillation volumetric method . The Analysis of Food , p. 348 , John Wiley , New York,and Chapman & Hall , London .

Table (1) : Total volatile nitrogen (T.V.N. mg/100 gm) and trimethylamine nitrogen (T.M.A.N mg/1 kg) of different parts of hens during frozen storage as affected by pre-freezing treatments.

Treatments		After 2 months			After 4 months			After 6 months		
		Wing base	Breast	Leg	Wing base	Breast	Leg	Wing base	Breast	Leg
Control	T.V.N. mg/100 g	62.52	116.64	82.02	83.25	158.12	109.44	107.55	187.13	128.58
	T.M.A.N. mg/1 kg	24.63	42.54	31.07	44.75	52.13	45.35	45.39	76.25	61.36
Pyrophosphate 0.5%	T.V.N. mg/100 gm	43.29	82.42	68.57	64.56	128.63	89.65	88.68	149.75	109.95
	T.M.A.N. mg/1 kg	18.53	37.43	29.55	38.55	45.85	53.15	52.25	66.25	77.75
Nacl 1.0%	T.V.N. mg/100 gm	55.18	95.63	76.98	70.56	138.59	99.59	90.35	156.57	120.45
	T.M.A.N. mg/1 kg	21.63	40.13	40.97	41.23	48.32	50.13	57.15	69.85	80.19
Propolis + citric acid 0.1%	T.V.N. mg/100 gm	48.13	71.35	62.25	58.42	119.89	70.75	70.10	135.83	92.15
	T.M.A.N. mg/1 kg	20.11	33.01	44.35	40.11	47.51	55.29	54.83	68.35	79.15
Citric acid 0.2% + ascorbic acid 0.2%	T.V.N. mg/100 gm	45.05	69.19	71.55	67.58	134.85	92.93	91.75	152.81	112.85
	T.M.A.N. mg/1 kg	19.87	30.78	42.82	39.65	46.78	54.20	53.35	67.53	78.83
Fine crust	T.V.N. mg/100 gm	50.16	90.61	-	65.54	134.50	-	85.33	153.35	-
	T.M.A.N. mg/1 kg	20.55	39.03	-	40.50	47.25	-	54.05	68.83	-
Cold storage + freezing	T.V.N. mg/100 gm	93.19	166.15	126.65	123.83	183.85	143.50	143.78	216.15	169.13
	T.M.A.N. mg/1 kg	59.65	68.24	83.65	81.50	92.52	96.53	95.35	113.32	121.95
Pyrophosphate 0.5% + cold storage + freezing	T.V.N. mg/100 gm	75.50	120.30	109.75	105.35	158.36	139.57	125.45	178.32	159.65
	T.M.A.N. mg/1 kg	28.42	40.83	45.55	31.56	52.82	56.18	61.56	68.46	75.13

Zero time

Before freezing		Wing base	Breast	Leg
Fresh	TVN	3.77	12.86	6.73
	TMAN	2.81	2.92	3.79
3 days of cold storage	TVN	73.18	146.11	106.64
	TMAN	39.66	48.25	64.02
0.5% Pyrophosphate + 3 days of cold storage	TVN	55.55	108.60	89.78
	TMAN	23.40	26.24	35.61

Table (2) : Amine nitrogen (A.N) of different parts of hens during frozen-storage as affected by different pre-freezing treatments (mg/100 gm).

Treatments	After 2 months			After 4 months			After 6 months		
	Wing base	Breast	Leg	Wing base	Breast	Leg	Wing base	Breast	Leg
Control	665.93	720.13	750.87	1101.50	1342.20	1490.10	1102.13	1428.30	1730.19
Pyrophosphate 0.5%	570.13	665.61	700.11	837.50	871.30	1030.50	917.30	1000.10	1238.60
Nacl 1.0%	596.12	697.53	725.25	856.40	893.61	1052.32	939.63	1025.30	1258.90
Propolis 0.1% + citric acid 0.1 %	580.15	675.52	710.25	847.30	882.54	1041.32	928.45	1010.35	1205.92
Citric acid 0.2% + ascorbic acid 0.2%	585.19	670.65	709.15	842.10	876.45	1036.30	922.85	1008.25	1203.75
Fine Crust	623.20	532.50	--	680.11	733.36	--	760.96	833.87	--
Cold Storage + freezing	785.23	845.85	875.55	1303.43	1544.13	1675.35	1295.15	1635.50	1820.25
Pyrophosphate 0.5% + cold-storage + freezing.	683.52	782.35	816.38	895.48	953.65	1095.85	973.36	1101.48	1485.25

Zero time

Before freezing	Wing base	Breast	Leg
Fresh	254.10	317.60	390.20
3 days of cold storage	684.00	739.70	762.90
0.5% pyrophosphate + 3 days of cold storage	588.40	683.00	714.10

Table (3) : Total bacterial counts of different parts of hens during frozen storage as affected by different pre-freezing treatments (counts $X10^6$/gm).

Treatments	After 2 months			After 4 months			After 6 months		
	Wing base	Breast	Leg	Wing base	Breast	Leg	Wing base	Breast	Leg
Control	0.6	15.0	1.0	1.0	19.0	1.4	2.5	22.0	3.3
0.5% pyrophosphate	0.4	10.0	0.65	0.5	12.5	1.1	1.6	14.0	2.5
Nacl 1.0%	0.5	12.0	0.8	0.8	16.0	1.4	1.9	15.0	2.9
Propolis 0.1% + citric acid 0.1%	0.48	7.0	0.75	0.7	9.0	0.95	1.7	11.0	2.2
Citric acid 0.2% + ascorbic acid 0.2%	0.35	9.5	0.6	0.45	12.0	0.72	1.4	10.5	1.8
Fine crust	0.8	15.0	-	0.9	19.0	-	2.3	22.0	-
Cold storage + freezing	0.9	1.3	1.9	1.1	19.0	2.5	2.9	23.0	3.9
Pyrophosphate 0.5% +cold storage + freezing	0.7	11.0	1.7	0.65	13.5	1.9	1.8	16.5	3.5

Zero time

Before freezing	Wing base	Breast	Leg
Fresh	2.0	62.0	4.0
3 days of cold storage	4.9	15.9	9.5
0.5% pyrophosphate + 3 days of cold storage	3.4	16.0	4.5

Table (4) : Thiobarbituric acid value (TBA) of different parts of hens during frozen-storage as affected by pre-freezing treatments. (O.D. at 538 mμ).

Treatments	After 2 months			After 4 months			After 6 months		
	Wing base	Breast	Leg	Wing base	Breast	Leg	Wing base	Breast	Leg
Control	0.290	0.208	0.352	0.322	0.300	0.490	0.460	0.350	0.680
Pyrophosphate 0.5%	0.218	0.150	0.230	0.224	0.150	0.260	0.235	0.225	0.310
NaCl 1.0 %	0.265	0.300	0.380	0.324	0.310	0.500	0.480	0.380	0.660
Propolis 0.1% + citric acid 0.1%	0.150	0.138	0.250	0.0195	0.146	0.255	0.200	0.154	0.240
Citric acid 0.2% + ascorbic acid 0.2%	0.220	0.152	0.233	0.220	0.155	0.257	0.235	0.247	0.305
Fine Crust	0.240	0.171	--	0.270	0.210	--	0.300	0.200	--
Cold storage + freezing	0.395	0.333	0.485	0.405	0.361	0.515	0.475	0.492	0.750
Pyrophosphate 0.5% + cold-storage + freezing.	0.212	0.182	0.315	0.295	0.218	0.365	0.450	0.350	0.600

Zero time

Before freezing	Wing base	Breast	Leg
Fresh	0.195	0.195	0.212
3 days of cold storage	0.262	0.235	0.425
0.5% pyrophosphate + 3 days of cold storage	0.218	0.145	0.290

Table (5) : Fatty acid composition of fresh and frozen stored lipids for 6 months of leg (mol.%)

Fatty acids \ Treatments		Fresh	Control	Propolis 0.1% + Citric acid 0.1%	Citric acid 0.2% + ascorbic acid 0.2%	Pyrophosphate 0.5%
C_{12} (lauric)		-	0.24	0.19	--	--
C_{14} (Myristic)		0.45	0.52	0.58	0.55	0.33
$C_{14:1}$ (tetradecenoic)		0.20	Trace	0.14	0.13	0.12
C_{16} (Palmitic)		22.69	26.35	26.67	27.93	28.31
$C_{16:1}$ (Palmitoleic)		3.40	2.60	4.32	3.45	2.85
C_{17} (Heptadecenoic)		0.36	0.25	0.31	0.42	0.09
$C_{17:1}$ (Heptadecenoic)		Trace	Trace	0.11	0.15	Trace
C_{18} (Stearic)		6.48	6.43	5.08	7.23	7.17
$C_{18:1}$ (Oleic)		48.06	43.68	44.82	43.45	47.14
$C_{18:2}$ (Lenoleic)		20.36	9.53	17.78	16.11	14.50
$C_{18:3}$ (Lenolenic)		--	Trace	---	0.57	0.10
Total Saturated Fatty acid	mol.%	27.99	41.15	32.83	36.14	35.9
	% increase		57.88	17.29	29.12	28.26
Total unsaturated Fatty acid	mol.%	72.01	55.81	67.17	63.86	64.11
	% decrease		22.49	6.72	11.32	10.97