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Influence of some pre-freezing treatments on the chemical and physical properties of chicken meat

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Abstract :

Some treatments were investigated to find out the best method which may reduce the toughness of frozen-stored meat of old hens . These treatments included soaking in 0.5% pyrophosphate solution , glazing with 0.1% propolis antioxidant + 0.1% citric acid solution , 0.2% ascorbic acid + 0.2% citric acid solution and post-rigor freezing , of aged meat for 3 days at 4°C either with or without pyrophosphate soak . Storage was carried out at -10°C for 6 months and samples from breast , wing-base and leg parts were taken at different intervals for analysis of protein solubility , pH value , water holding capacity , tenderness as measured by plasticity and organoleptic evaluation of tenderness . It was found that pyrophosphate-post-rigor freezing gave meat of highest tenderness and may be suggested as a good treatment for frozen-stored meat of old hens .

Introduction :

During frozen storage of poultry meat protein solubility and water holding capacity (WHC) decreased which lead to a marked increase in the drip loss and toughness of meat , specially when meat of old birds was used (Khan , 1964 and Mohamed , 1974) . Muscles of old birds were significantly more tough than for the young ones (Polczynska , 1974) . Some treatments were suggested to improve the tenderness of frozen-stored meat such as cold-storage before freezing , i.e. post-rigor freezing (Dawson et al. , 1958 and Goddard and Heath , 1978) , and treatment with sodium chloride or pyrophosphate solutions (El-Samahy and Shehata , 1977 and Grey and Robinson , 1978) . Substances which have antioxidative effect increased the solubility of proteins and consequently the meat tenderness due to low level of lipids oxidation products which renders the muscle protein insoluble (Arnold , 1970 and El-Ebzary , 1978) .

This work was conducted to find out the most suitable pre-freezing treatment which reduces the increase of toughness during frozen-storage of meat from different parts of old chicken hens .

Materials and methods :

Old chicken hens 3 kg live weight each (stewing) type Habard , 2 - 3 years of age were obtained from the General Poultry Company . Chickens were slaughtered , bleeded , scalded for 2 minutes at 55°C , plucked , eviscerated , rinsed with water and strained then after jointing to obtain breast , thigh and wing-base samples were subjected to one of the following treatments :

a) Untreated samples (control) .
b) Breaded cuts in spiced fine crust with black pepper and kichen salt (only breast and wing-base) .
c) Soaked samples for 4 hours in cold (4°C) 0.5% pyrophosphate solution or in cold 1.0% Na cl solution .
d) Glased samples , by immersion three times (5 seconds each) in cold (about 0°C) o.2% ascorbic acid + 0.2% citric acid solution or in cold o.1% propolis antioxidant + o.1% citric acid solutions ; between successive immersions , the meat was held for one hour at -10°C .
e) Samples aged by cold storage for 3 days at 4°C without previous treatment or after soaking for 4 hours in cold (4°C) o.5% pyrophosphate solution (post-rigor freezing) .

Samples were then kept in polyethylene bages and frozen-stored at -10°C . Analysis was carried out after 2 , 4 and 6 months storage .

The moisture content and total nitrogen were determined according to the A.O.A.C. (1970) . The pH value was measured according to the method described by Krilova and Liskovskaia (1961) . Total extractable nitrogen (TEN) was extracted by 5% sodium chloride solution and total soluble protein nitrogen (TSPN) was precipitated in this extract using trichloracetic acid solution (20%) according to the method mentioned by El-Gharabawi and Dugan (1965) . Water holding capacity (WHC) and plasticity (as an indication for tenderness) were determined using the method cited by Soloviev (1966) while drip loss was estimated according to the method worked by Awad (1967) . The tenderness of boiled meat (for 60 minutes at 100°C) was evaluated organoleptically according to the method cited by Sorour (1978) .

Results and discussion :

A) Chemical changes :

1- Protein solubility :

From table (1) it could be noticed that by frozen-storage for 4 months , protein solubility progressively decreased . This was explained by the effect of concentrated solutes in tissues as well as the association of lipids oxidation products with proteins (Mohamed , 1974 and Abd El-Salam , 1978) . Slight increase in protein solubility was noticed after 6 months storage , which may be due to resolution of rigor mortis as mentioned by Sokolov (1965) . Post-rigor frozen samples did not show this increase .

After 6 months storage , the highest protein solubility was recorded for pyrophosphate-post-rigor freezing samples , followed by post-rigor freezing , pyrophosphate propolis , citric + ascorbic acids , Na cl , control and fine-crust samples . Hence all treatments increased the solubility of proteins when compared with the control sample , except for fine-crust treatment . Treatment with pyrophosphate before cold storage which was followed by freezing , showed highest solubility of proteins .

Proteins solubility was highest for breast , followed by wing-base ; being lowest for the leg part .

2- pH value :

It was found (Table 2) that during frozen-storage of hens meat at -10°C (pre-rigor freezing samples) for 4 months , the pH value decreased possibly because of glycolysis and accumulation of some lactic acid , then increased at the 6 th month storage , probably due to partial proteolysis leading to the increase of free alkaline groups as mentioned by Mohamed (1978) . For post-rigor freezing samples the pH value increased progressively between 2 and 6 months storage , in as much as glycogen breakdown was complete before frozen storage .

During frozen storage , specially at 4 - 6 months , post-rigor freezing samples showed higher pH value than the pre-rigor freezing meat , because no decrease of pH value occurred in the first case ; for post-rigor freezing meat pyrophosphate treatment increased the pH value . Similarly , in case of pre-rigor freezing meat , pyrophosphate samples also showed highest pH value after 6 months storage , followed by the control samples , propolis , Na cl and citric + ascorbic acid samples . Fine-crust tended to raise the pH value slightly when compared with the control sample , possibly due to dilution of the acid content of tissues .

The pH value of fresh as well as stored samples was low for breast , intermediate for wing-base , while was high for the leg muscle .

B) Physical properties :

1- Water holding capacity (WHC) :

From tables (1 and 3) it could be observed that with increasing of storage-time the level of WHC was influenced by the protein solubility of the frozen-stored meat . This may be explained on the basis that denaturation and insolubility of proteins reduced the WHC of muscle tissues , while proteolysis (as in aging) improved this property as shown by Sokolov (1965) . During frozen-storage of pre-rigor samples for 2 - 4 months the WHC decreased , while after 6 months some improvement was recorded . For post-rigor samples WHC progressively decreased along with the continuous decrease of protein solubility .

After 6 months storage , the lowest WHC was recorded for post-rigor frozen samples in contrast to pre-rigor ones ; in this connection pyrophosphate improved the WHC of post-rigor freezing samples , but not up to the level characteristic for pyrophosphate-pre-rigor

frozen meat . In as much as post-rigor frozen meat had higher protein solubility the lower WHC of such samples when compared with pre-rigor frozen meat may be possibly attributed to marked looseness of tissues .

Pyrophosphate improved markedly the WHC of pre-rigor freezing samples , followed by propolis + citric , citric + ascorbic acid , Na cl , control and fine-crust samples which was mostly influenced by the levels of protein solubility for such samples .

Before and after freezing the WHC was highest for the leg , followed by wing-base , while was lowest for the breast muscle .

2- Drip loss :

Drip loss followed the changes of WHC of hens meat (Tables 3 and 4) . The best WHC and lowest drip loss were recorded for the leg , followed by wing-base and breast . Post-rigor frozen meat showed larger amounts of drip loss than pre-rigor frozen meat . Pyrophosphate reduced the drip loss for post-rigor frozen meat but not to the level found for pyrophosphate pre-rigor freezing samples . Among pre-rigor frozen samples , pyrophosphate treatment showed the low drip loss , followed by citric + ascorbic , propolis , Na cl and control samples . Fine-crust samples showed lowest drip loss , possibly because of fluids absorption in the fine-crust layer .

3- Plasticity :

Plasticity measured as indication for meat tenderness decreased progressively as the time of frozen storage increased (Table 5) . Plasticity of fresh as well as frozen-stored samples showed that the breast was tenderest , while wing-base was toughest ; legs samples showed intermediate tenderness . The decrease of tenderness due to frozen storage may be ascribed to the insolubility and denaturation of proteins as well as the decrease of WHC (Khan , 1964) .

Post-rigor freezing , specially when pyrophosphate was applied before cold-storage may be considered as good means for increasing the tenderness of old hens meat stored by freezing . Pyrophosphate post -rigor frozen meat showed highest tenderness , followed by post-rigor freezing without pyrophosphate ; these two samples were of highest tenderness compared with any of the pre-rigor treatments . Such results were in accordance with Dawson et al. (1958) who reported that cold storage of chickens prior to freezing gave meat of higher tenderness when compared with pre-rigor frozen meat . On camel meat , Abd El-Baki et al. (1957) found similar results , when shearing value of meat cold stored for 3 days before being frozen for 30 days was lower than the meat frozen stored without previous cold storage ; being 65 and 72 respectively . From table (5) it could be noticed that cold stored meat for 3 days before frozen storage had higher tenderness after 6 months storage even than the pyrophosphate pre-rigor frozen meat . Pyrophosphate-post-rigor freezing meat showed highest plasticity , suggesting this treatment as a good mean for improving the tenderness of frozen-stored meat of old hens . This was confirmed by the organoleptic evaluation of meat tenderness after cooking as given in table (6) .

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Table (1) : The total extractable nitrogen (TEN) and total soluble protein nitrogen (TSPN) of different parts of hens during frozen storage as affected by pre-freezing treatments (% of total solids).

Treatments		After 2 months			After 4 months			After 6 months		
		Wing base	Breast	Leg	Wing base	Breast	Leg	Wing base	Breast	Leg
Control	TEN	2.49	2.52	2.09	2.28	2.31	1.88	2.36	2.42	2.01
	TSPN	1.35	1.45	0.83	1.15	1.23	0.76	1.26	1.35	0.80
Pyrophosphate 0.5%	TEN	2.95	2.98	2.54	2.75	2.79	2.35	2.86	2.91	2.45
	TSPN	1.85	1.93	1.46	1.65	1.73	1.28	1.76	1.85	1.40
Na cl 1.0%	TEN	2.65	2.66	2.24	2.44	2.47	2.04	2.54	2.58	2.17
	TSPN	1.46	1.54	0.96	1.26	1.34	0.87	1.39	1.47	0.91
Propolis 0.1% + citric acid 0.1%	TEN	2.63	2.86	2.42	2.62	2.65	2.22	2.74	2.79	2.38
	TSPN	1.93	2.01	1.49	1.74	1.82	1.35	1.77	1.93	1.50
Citric acid 0.2% + ascorbic acid 0.2%	TEN	2.72	2.75	2.31	2.51	2.54	2.11	2.63	2.67	2.26
	TSPN	1.73	1.81	1.29	1.53	1.61	1.16	1.66	1.74	1.21
Fine crust	TEN	2.42	2.45	-	2.21	2.24	-	2.33	2.35	-
	TSPN	1.16	1.26	-	1.01	1.09	-	1.12	1.20	-
Cold storage + freezing	TEN	3.20	3.56	2.60	2.15	3.45	2.55	3.11	3.40	2.50
	TSPN	2.02	2.19	1.50	1.98	2.10	1.45	1.96	2.05	1.42
Pyrophosphate 0.5% + cold storage + freezing	TEN	3.70	4.01	2.85	3.60	4.00	2.80	3.30	3.95	2.78
	TSPN	2.43	2.58	1.93	2.60	2.50	1.84	2.36	2.45	1.65

Before freezing (zero point)		Wing Base	Breast	Leg
Fresh	TEN	2.61	2.64	2.20
	TSPN	1.41	1.52	0.93
3 days of cold storage	TEN	3.44	3.60	2.84
	TSPN	2.22	2.39	1.57
Pyrophosphate 0.5% + 3 days of cold storage	TEN	3.95	4.20	3.06
	TSPN	2.65	2.91	2.05

Table (2) : The pH value 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	5.95	5.85	6.15	5.8	5.7	6.0	6.0	5.8	6.2
Pyrophosphate 0.5%	6.2	6.1	6.4	6.0	5.9	6.2	6.1	6.0	6.3
Na cl 1.0%	5.9	5.7	6.0	5.7	5.5	5.8	5.9	5.7	6.0
Propolis 0.1% + citric acid 0.1%	6.0	5.8	6.05	5.8	5.7	5.9	5.9	5.8	6.0
Citric acid 0.2% + ascorbic acid 0.2%	5.8	5.7	5.9	5.6	5.45	5.7	5.7	5.6	5.6
Fine crust	6.2	6.0	-	5.95	5.8	-	6.1	5.9	-
Cold storage + freezing	6.0	5.9	6.05	6.15	6.05	6.2	6.2	6.1	6.3
Pyrophosphate 0.5% + cold storage + freezing	6.2	6.1	6.3	6.3	6.2	6.4	6.45	6.35	6.6

Before freezing (zero point)	Wing base	Breast	Leg
Fresh	6.3	6.4	6.6
3 days of cold storage	5.8	5.7	5.9
Pyrophosphate 0.5% + 3 days of cold storage	6.0	5.9	6.3

Table (3) : The water holding capacity (WHC) of different parts of hens during frozen storage as affected by pre-freezing treatments (cm^2) .

Treatments	After 2 months			After 4 months			After 6 months		
	Wing base	Breast	Leg	Wing base	Breast	Leg	Wing base	Breast	Leg
Control	6.4	7.1	6.3	7.1	7.6	7.0	6.5	6.9	6.4
Pyrophosphate 0.5%	5.2	6.8	5.1	5.9	7.5	5.8	5.6	6.6	5.5
Na cl 1.0%	6.5	6.8	6.4	7.3	7.8	7.2	5.2	5.7	6.5
Propolis 0.1% + citric acid 0.1%	5.3	6.9	5.2	6.2	7.6	6.0	5.7	6.7	5.6
Citric acid 0.2% + ascorbic acid 0.2%	6.03	7.03	6.02	6.3	7.3	6.2	5.6	6.9	5.5
Fine crust	1.5	2.5	-	2.0	3.05	-	1.4	2.4	-
Cold storage + freezing	6.6	7.4	6.5	7.3	7..	7.1	7.4	8.2	7.3
Pyrophosphate 0.5% + cold storage + freezing	5.6	6.9	5.3	6.1	7.8	6.0	6.3	7.9	6.4

Before freezing (zero point)	Wing base	Breast	Leg
Fresh	4.2	5.5	4.1
3 days of cold storage	5.6	6.8	4.9
Pyrophosphate 0.5% + 3 days of cold storage	4.6	5.8	4.3

Table (4) : The drip loss of different parts of hens during frozen 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	1.9	2.8	1.5	2.8	3.5	2.3	4.3	4.4	3.8
Pyrophosphate 0.5%	0.9	1.5	0.55	1.65	2.25	1.3	2.15	2.75	1.8
Na cl 1.0%	1.8	2.7	1.4	2.7	3.4	2.2	4.1	4.3	2.9
Propolis 0.1% + citric acid 0.1%	1.8	2.7	1.57	1.95	3.6	1.9	3.8	4.0	2.1
Citric acid 0.2% + ascorbic acid 0.2%	1.6	2.5	1.3	2.6	3.4	2.2	2.9	3.6	2.5
Fine crust	0.29	0.9	-	1.19	1.8	-	1.65	2.0	-
Cold storage + freezing	2.2	3.0	1.9	3.1	3.9	2.8	4.5	4.6	4.1
Pyrophosphate 0.5% + cold storage + freezing	0.98	2.7	0.7	1.78	3.6	1.6	4.4	4.5	3.9

Table (5) : Plasticity of different parts of hens during frozen as affected by pre-freezing treatments (cm^2) .

Treatments	After 2 months			After 4 months			After 6 months		
	Wing base	Breast	Leg	Wing base	Breast	Leg	Wing base	Breast	Leg
Control	2.05	3.02	3.0	2.9	2.95	2.9	1.6	2.0	1.75
Pyrophosphate 0.5%	3.01	3.05	3.02	3.0	3.02	3.01	2.2	2.5	2.3
Na cl 1.0%	3.0	3.04	3.01	2.95	3.0	2.95	1.8	2.1	1.9
Propolis 0.1% + citric acid 0.1%	2.6	2.8	2.7	2.6	2.8	2.7	2.0	2.4	2.2
Citric acid 0.2% + ascorbic acid 0.2%	2.5	2.7	2.4	2.1	2.4	2.2	1.9	2.2	2.0
Fine crust	1.6	1.7	-	1.3	1.4	-	1.5	1.9	-
Cold storage + freezing	2.6	2.85	2.7	2.55	2.7	2.55	2.3	2.6	2.4
Pyrophosphate 0.5% + cold storage + freezing	3.17	3.25	3.2	3.1	3.2	3.15	2.8	3.15	2.9

Before freezing (zero point)	Wing base	Breast	Leg
Fresh	3.2	3.5	3.3
3 days of cold storage	2.7	2.9	2.8
Pyrophosphate 0.5% + 3 days of cold storage	3.0	3.2	3.1

Table (6) : Average tenderness scores of meat , stored by freezing for 6 months .

Treatments	Wing base	Breast	Leg
Control	1.5	2.5	2.0
Pyrophosphate 0.5%	3.5	5.0	5.0
Na cl 1.0%	2.5	3,5	3.0
Propolis 0.1% + citric acid 0.1%	3.0	4.5	4.0
Citric acid 0.2% + ascorbic acid 0.2%	3.0	4.0	4.0
Fine crust	1.0	2.0	-
Cold storage + freezing	5.0	6.5	7.0
Pyrophosphate 0.5% + cold storage + freezing	6.5	7.0	8.0