STUDIES ON THE PHYSICO-CHEMICAL AND FUNCTIONAL PROPERTIES OF OSTRICH MEAT DURING FROZEN STORAGE

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Abstract:

The quality of ostrich meat during frozen condition has received little attention. The purpose of this research was to study the changes in physical parameters (cooking loss, color, pH, tenderness, MFI) and functional properties (water holding capacity (WHC), nitrogen solubility index (NSI), foaming capacity (FC), buffering capacity (BC), emulsifying capacity (EC), emulsifying stability (ES)), and SDS-PAGE pattern) of ostrich meats (M. iliofibularis) during frozen storage. The Warner Bratzler shear force values decreased (p<0.05) by increasing storage time at -18°C. As freezing storage period increased, colorimetric parameters L*, a*, b* decreased. pH and WHC significantly decreased while BC, EC, ES, FC, cooking loss and MFI increased during 6 months storage (p<0.05). NSI values increased after 3 months and decreased thereafter. SDS-PAGE results showed little change in protein bands during frozen storage. It is concluded that freezing does not significantly change many functional properties and even can improve the tenderness of ostrich meat.

Keywords: ostrich; frozen storage; functional properties; physico-chemical properties

INTRODUCTION:

Frozen storage is one the most important preservation methods for meat and meat products. The ostrich (*struthio camelus*) industry markets fresh and frozen meat cuts as well as processed meat products to variety of markets. Most ostrich meat is marketed as individual muscles (Mellett, 1996). Ostrich muscles typically are chilled for 24h postmortem, fabricated, and meat immediately chub packaged and frozen currently, limited in formation is available on the effect of frozen on ostrich meat. During frozen storage changes in texture, water-holding capacity, emulsifying capacity and cooking yields during frozen storage have been reported in beef (Awad et al., 1968, Sebranek et al., 1979). Functional changes during frozen storage have been related to myofibrillar protein insolubilization in the intact muscle of beef (Wagner and Anon, 1986). Protein denaturation during frozen storage of meat may be caused byone or more of the following factors:(1) ice crystal damage to cells and membranes, (2) dehydration of protein molecules, (3) increase in solute concentration in the unfrozen water phase, (4) enzymatic activities, (5) reaction of protein with free fatty acids and other intact lipids, and (6) reaction of protein with oxidizing lipids (Matsumoro, 1980; shenouda, 1980). All of these changes occurring during frozen storage can affect the functional properties of meat proteins (Borderias, Jimenez-Colmenero & Tejada, 1985). To be competitive in marketing fresh meat products, it is important that the physico-chemical and functional properties of meat be determined during frozen storage. No references have been found on functional properties or change in it during frozen storage. The present work therefore sets out to identify the behavior of ostrich meat during frozen storage.

MATERIALS AND METHODS:

Ostrich meat was obtained from 12 to 14 months old Blue Neck male birds slaughtered at a local Shiraz abattoir (Fars, Iran). Muscles were separated after removing feather and skin. Fan fillets (*M. iliofibularis*) were obtained from 3 carcasses of ostrich and *Longissimus dorsi* muscles obtained from 3 carcasses of 3-5 years old male Holstein cattle. Meats were kept at -18°C and at 0, 3, and 6 months post-mortem, samples were separated, visible fat and connective tissue removed and samples were used for subsequent studies. Chemical parameters (protein, ash, fat, moisture, and collagen, hydroxy-proline, myofibrillar and sarcoplasmic proteins), physical parameter (cooking loss, color, pH, tenderness, myofibrilar fragmentation index (MFI)) and functional properties (water holding capacity (WHC), nitrogen solubility index (NSI), foaming capacity (FC), buffering capacity (BC), emulsifying capacity (EC) and emulsifying stability (ES)) were determined and SDS-PAGE was performed.

RESULTS & DISCUSSION

Table 1 shows changes in some physical parameters of ostrich meat during frozen storage. pH values significantly decreased during frozen storage. Must and MacNeil (1976) reported a slight decrease in pH of mechanically deboned poultry meat stored at -18ºC for 15weeks. The liberation of inorganic phosphate and ammonia due to the enzymatic degradation of ATP can be associated with the changes in pH. A decreasing trend was observed in L*, a*, b* indexes during freezing period ($p<0.05$). This results is in agreement with results reported by Vieira et al. (2009). Lipid oxidation could have taken place in meat stored under frozen condition for 90 days (Vieira et al; 2009). Oxidative processes are associated with discoloration of meat, as lipid oxidation results in the formation of pro-oxidants capable of reacting with oxymyoglobin, which lead to metmyoglobin formation (Farouk & Swan, 1998a; Frankel, 1998). Color deterioration is related to higher contents of metmyoglobin and changes in colorimetric parameters. Our results agree with several studies (Abdallah, Marchello, & Ahmad, 1999; Farouk & Swan, 1998b; Farouk et al., 2003; Vieira et al., 2009). Table 1 shows that shear force decreased and cooking loss increased significantly during 6 months storage. Whereas some researches (Farouk et al; 2003; Lagersted et al; 2008; Shanks et al; 2002) have found that freezing causes tenderization in beef, other (Pearson &Miller, 1950) have shown a progressive decrease in beef tenderness during frozen storage. As had been reported by (Crouse & Koohmaraie, 1990; Reid, 1999; Shanks et al., 2002) the increase in tenderness could be due to the break down of muscle fibers caused by enzyme activity and by ice crystal formation. Vold (1968) noted an increase in tenderness of lamp with prolonged frozen storage at -20ºC. The percentage of cooking loss in creased ($p<0.5$) with time. Winger and Fennema (1976) observed that meat frozen post rigor did not appreciably release an exudates during thawing. After frozen storage, various meats showed increase cooking losses (Jeremiah, 1980, Miller et at.1980, Sebranek et at., 1978). Denatured proteins formed during frozen storage could be susceptible to heat denaturation, causing the severe aggregation of protein (Benjakul, & Sutthipan, 2009). Table 2 shows the effect of freezing on several functional properties of ostrich meat. Foaming capacity (FC) values increased significantly over storage time of freezing ($p<0.05$) ostrich meat. This emulsifying characteristic could be due to the denaturation of proteins of muscle, which probably increased during storage time. Kato et al. (1981) showed that heat denaturation of protein causes increase in FC, emulsion capacity (EC), and emulsion stability (ES) of meat muscles undergoing physicochemical changes during frozen storage at -20 ºC for 12 weeks (Benjakul, & Sutthipan, 2009). The data on protein functionality of ostrich meat during freezing indicate protein denaturation and subsequent orientation of denatured molecules at the interface of water and oil. Buffering capacity (BC) values increased significantly over storage time ($p<0.05$). The increase in BC of meat after 6 month of frozen storage could be due to proteolytic activities (Sayre. et al, 1963). Rao and Gault reported a relationship between the total nitrogen contents of muscle and their buffering capacity. Protein solubility (NSI) increased in the first three months of frozen storage and then decreased thereafter with time of storage ($p<0.05$). These results confirm the results of Farouk and Swan (1998a) and Farouk and Wielizko (2003a, 2003b) who reported initial increase in solubility of total proteins in the first three month of frozen storage which can be attributed to the proteolytic activities resulting in formation of short peptides and free amino acids as proposed by those by these authors (Zhang et al; 2005). The overall decrease in solubility at longer storage times is probably due to protein denaturation (Miller et

al., 1980, Serbranke, Sang, Topel, & Rust, 1979). WHC values significantly decreased over storage time ($p<0.05$). Farouk et al. (2003) indicated that frozen storage of cattle meat decreased the WHC slightly, but after 9 months WHC has a rapid fall. This phenomenon has been attributed to the mechanical loosening of muscle tissue by the formation of ice crystals. Also, decreasing pH due to freezing may account for reduced WHC. Our results are in agreement with the general belief that claims a progressive decrease in water holding capacity of beef during frozen storage (Ngapo et al., 1999, farouk&weliczko, 2003; Damen & Steenbekkers; 2007). A recent study (Lagersted et al., 2008) reported that Water loss was significantly higher in meat kept frozen at -20ºc for two months than in chilled meat. Farouk et al. (2003) reported that the water holding capacity tended to decrease gradually with the strong time up to 9month. Indicating an increase in protein denaturation and the attendant loss of ability to hold water.

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Table 1. Physical parameters variation in ostrich meat (*M. iliofibularis*) during frozen storage.

parameter	Storage at -18 ºC (Months)			
	0	3	6	P values
Color a*	14.36±0.15[a]	12.56±0.30[a]	11.53±0.34[a]	0.006
Color b*	6.57±0.02[a]	6.55±0.28[a]	5.62±0.30[a]	0.030
Color L*	31.47±0.15[a]	26.37±0.30[a]	23.47±0.25[a]	0.000
pH	6.21±0.02[a]	5.94±0.0[a]	5.75±0.02[a]	0.002
Shear force	6.65±0.08[a]	4.85±0.13[a]	4.65±0.13[a]	0.000
Cooking loss	35.45±0.75[a]	41.59±0.79[a]	43.51±0.74[a]	0.000

[*]Results are mean (± SD) of triplicate samples
Values with different superscripts differ significantly ($p<0.05$).

Table 2. Changes in the functional properties of ostrich meat during freezing storage

Parameter	Frozen storage (months)			
	0	3	6	P value
Foam Stability (%) After 60 min	12.27±0.85 [a]	44.27±0.86 [b]	53.30±1.11 [c]	0.000
Emulsion Stability (%)	64.30±0.95 [a]	73.20±1.11 [b]	75.73±0.47 [c]	0.002
Emulsion Capacity (ml/g)	56.07±1.16 [a]	62.33±0.96[b]	63.97±0.68 [c]	0.001
Buffering capacity (pH 4.7) mmol/pH*100gmeat	5.40± 0.06 [a]	6.20±0.10 [b]	6.10±0.10 [c]	0.005
Buffering (pH 7.0) mmol/pH*100gmeat	5.53 ± 0.03 [a]	6.10±0.10 [a]	4.18±0.03 [a]	0.000
Nitrogen Solubility Index (%)	38.38±1.13 [a]	34.41±1.11 [b]	37.63±0.91[b]	0.028
WHC (%)	40.34±0.14 [a]	34.62±0.94 [b]	30.53±0.71[b]	0.002

*Results are mean (± SD) of triplicate samples
Values with different superscripts differ significantly ($p<0.05$).