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CHEMICAL, PHYSICAL, NUTRITIONAL AND SENSORY EVALUATION OF OSTRICH SAUSAGE

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ABSTRACT: *Quality attributes and nutritive value were investigated in ostrich sausage formulated from frozen ostrich lean trimmed meat and gizzards, heart and fat. All sausage samples, either fresh or frozen-stored, were acceptable and of high quality as indicated by feder value, chemical indices, amino acid composition and eating quality (sensory evaluation). From the economic point of view, the use of ostrich trimmed lean meat, fat and organs will minimize the cost of sausage and accordingly lower prices for consumers .*

The effect of frozen storage at –20 °C for 90 days on the quality of ostrich sausage was also investigated. Results indicated that moisture and protein contents, protein solubility, total amino acids content as well as water-holding capacity (WHC) and tenderness of ostrich sausage were found to decrease, while total volatile basic nitrogen (TVBN), thiobarbituric acid reactive substances (TBARS), free fatty acids (FFA), non-protein nitrogen (NPN) and cooking loss continuously increase with increasing frozen storage time. However, no undesirable changes were detected either chemically or sensory in ostrich sausage even after 90 days of frozen storage.

Keywords: ostrich sausage – giblets – trimmed lean meat – quality attributes – nutritive value.

INTRODUCTION

As a result of the linkage between diet and health, health-conscious consumers have created a demand for healthful meat products (Kirchner et al., 2000). In order to achieve "healthier" meat products, it is necessary to avoid undesired substances or reduce them to appropriate limits, and to increase the levels of other substances with beneficial properties (Jimenez-Colmenero et al., 2001).

Unfortunately, very little information is known about the products that come from ostrich, which include the hide, feathers, giblets as well as healthy red meat and meat products. On a live weight basis, hide and feathers represent 7.04 and 1.85 %; respectively, whereas 58.59 % is in the form of carcass. The carcass consists of 9.2 % fat, 26.9 % bone and 62.5 % lean meat, of which 41.3 % represents major muscles (fillet and steak), and 21.2 % lean trimming or factory meat (Harris et al., 1994; Morris et al., 1995).

Ostrich meat has a number of desirable nutritional and organoleptic properties. It is low in fat, cholesterol, calorie and sodium contents and has a high percentage of unsaturated fatty acids (Paleari et al., 1998; Moawad et al., 2000). Therefore, ostrich meat is desirable for the manufacturing of healthful meat products, especially after the incidence of bovine spongiform encephalopathy (BSE).

One of the major problems facing ostrich industry today is the formulation of meat products. In order to lower the cost of processed meat, especially under local condition of meat shortage and its high price, ostrich lean trimming and giblets must replace the major muscles (Harris et al., 1994). In this concern, Bohme et al. (1996), reported that good Italian-type salami can be produced from ostrich meat. Also, more health burger with the best flavor and taste can be obtained from ostrich trimmed lean meat in combination with 20 % gizzards and hearts (Moawad and Hemeida, 2002).

Changes of sausage quality during production and storage have been studied extensively (Gibriel et al.,1979; Abd El-Gawwad et al.,1986; Abu-Salem and Khalaf, 1988; El-Wakeil et al., 1994). As far as the present authors are aware, ostrich meat has never been used in the production of local-type sausage, although chicken and turkey meats have been used to manufacture such products (Sharaf, 1993; Pereira et al., 2000). Therefore, the present study aims to evaluate the chemical, physical, nutritional and sensory characteristics of sausages formulated from ostrich trimmed lean meat, gizzards and hearts. Stability of such meat emulsion during frozen storage at –20°C up to 90 days was also investigated.

Materials:

1. Meat source:

Frozen ostrich lean trim (factory meat), gizzards, hearts and fat were purchased from Golden Mak Trading Company, Nasr City, Cairo, Egypt, from 10 months old ostrich (*Strithio camelus*). Samples were thawed at 4-5°C for 4 hours, then visible bone and connective tissues were removed. Samples were cut separately into small pieces before processing into value-added products (ostrich sausage), as shown hereafter.

2. Spices mixture:

Spices were obtained from local market from Giza, Egypt. Each spice was powdered in the laboratory in an electric mill. Spices mixture was prepared according to El-Dashlouty (1978) as shown in Table 1.

3. Preparation of ostrich sausage:

As previously reported by (Moawad and Hemeida, 2002) replacement of lean trim by 20% organs in ostrich burger, in this study, such percentages achieved the best chemical, physical, functional and sensory properties.

Ostrich lean trim, giblets and fat (as seen in Table 1) were minced twice with 10 % water as ice flakes, aiming to keep the mixture smooth as well as to minimize temperature rise and microbial growth during shopping. The other ingredients (Table 1) were then added and mixed together, then meat mixture was ground for 10 minutes using a meat grinder. The obtained emulsion was then stuffed into previously cleaned and prepared natural mutton casings. All sausages were packed in polyethylene bags, placed in a cooler at 4-5 °C for 6 hours then part of sausages was examined (zero time analysis), while the rest of samples were frozen at –20 °C for different time intervals up to 90 days before analysis.

Analytical methods:

Ostrich sausage samples were analyzed before freezing (zero time) and after 30, 60 and 90 days of frozen storage at –20 °C for their chemical and physical properties, while organoleptic and amino acid evaluations were carried out only after processing (zero time) and after 90 days of frozen storage. At each time interval, the sausages were thawed at 4-5 °C for eight hours prior to analysis (Rhee et al., 1996) and the separated drip was removed in all cases before analysis. All analysis were performed at least in duplicate. Chemical determinations were carried out on finely ground ostrich sausages.

Moisture; protein; fat; ash and free fatty acids content were determined according to the methods recommended by the A.O.A.C (1995). Total volatile basic nitrogen (TVBN) and Feder (F) values were measured according to Pearson (1981). Thiobarbituric acid reactive substances (TBARS) numbers were estimated using the method reported by Vyncke (1975). The pH value was measured according to the method described by De-Freitas et al. (1997). Water-holding capacity (WHC), plasticity (tenderness) and bound water were measured by following the filter press method of Soloviev (1966). Total soluble nitrogen (TSN), soluble protein nitrogen (SPN) and non-protein nitrogen (NPN) were performed according to the methods of El-Ghrabawi and Dugan (1965). Cooking losses of ostrich sausages (boiling loss +frying loss) were determined after boiling them in water for 15 minutes then frying in cotton seed oil at 110°C for 5 minutes according to the method of Sharaf (1993). Amino acids, except for tryptophan, were determined in dried fat-free samples at the Central Laboratory for Food & Feed, Agricultural Research Center , Cairo, Egypt, using Beckman Amino Acid Analyzer (Model 7300) as described by Moore et al. (1958). Sensory panel evaluation of boiled and fried sausages was applied according to the method described by Watts et al. (1989) by 15 panelists. Judging scale was as follows: very good (8-9), good (6-7), fair (4-5), poor (2-3) and very poor (0-1).

Table (1): Constituents of ostrich sausage and spices mixture

Ingredients of ostrich sausage	g/kg	%	Ingredients of spices mixture	%
Minced trimmed lean	550	55	Black pepper	5.62
Minced gizzards & hearts	130	13	Cumin	11.22
Minced ostrich fat	150	15	Cubeb	22.44
Water (as ice flakes)	100	10	Cardamon	2.24
Sodium chloride	15	1.5	Clove	2.20
Sodium tripolyphosphate	3	0.3	Celery	56.28
Sodium caseinate	10	1		
Ascorbic acid	0.5	0.05		
Powdered Rusk	15.5	1.55		
Chopped fresh garlic	10	1		
Potato starch	10	1		
Powdered spices mixture	6	0.6		

RESULTS AND DISCUSSION

1. Proximate analysis of ostrich sausage:

Results of Table 2 show the proximate composition of ostrich sausage during frozen storage. Display of data reveals that the contents of moisture, protein, fat and ash of raw fresh ostrich sausage were 63.48, 16.32, 14.25 and 2.17 %; respectively (on fresh weight basis). In this respect, Pereira et al. (2000) reported that chicken, turkey and beef sausages contain 62.5, 70.9 and 56.3 % moisture; 13.2, 15.1 and 15.2 % protein; 11.4, 4.06 and 17.0 % fat and 3.34, 3.37 and 3.53 % ash (on fresh weight basis); respectively. Meanwhile, locally produced chicken sausage contain 65.2 % moisture, 12.9 % protein, 13.75 % fat and 1.7 % ash (on fresh weight basis) as reported by Abu Salem and Khalaf (1988). It is seen that , ostrich sausage exhibits the highest protein content as compared to other sausages reflecting its higher percentage of lean meat and organs (68%) in the sausage formula (Table 1). However, such a high degree of variability in chemical composition of the different sausage types could be explained on the basis that overall quality of sausage is affected by the method of processing and various formulated ingredients (Pereira et al., 2000). In this concern, it should be mentioned that the Egyptian Standards (E.S., – 1995) determined that, poultry products should contain at least 60 % lean meat as the main source of protein, while ash, fat and moisture contents should not exceed 2.5, 30 and 70 %; respectively.

Table (2): Gross chemical composition of ostrich sausage during frozen storage at –20 °C for 90 days (on fresh weight basis)

Frozen storage (in Days) / Constituents %	Zero Time	30 Days	60 Days	90 Days
Moisture	63.48	63.04	62.42	61.70
Protein	16.32	16.10	15.83	15.45
Fat	14.25	14.41	14.66	14.94
Ash	2.17	2.20	2.24	2.29

From the same given results of Table 2, it is also evident that as the time of frozen storage progressed, the moisture and protein contents of sausage samples gradually decreased, after 90 days at –20 °C sausage samples retained 97.20 and 94.65 % of their original moisture and protein contents; respectively. Such reduction leads to slight apparent increase in fat and ash contents (Table2). Sams and Diez (1991) achieved similar trend of changes in chicken sausages. However, the reductions in moisture and protein are explained on the basis of denaturation and aggregation of proteins during frozen storage, which cause a remarkable decrease in protein solubility and WHC. Consequently more drip loss and hence less moisture content, while the loss of protein might be attributed to proteolysis as well as to the loss of nitrogenous compounds either as volatile substances or separated in drip during thawing of frozen sausage samples (Miller et al., 1980; Moawad, 1995).

2. Chemical indices of ostrich sausage:

Chemical indices, together with organoleptic evaluation, have been used extensively to assess the quality and shelf life of meat products. Chemical indices of ostrich sausage are present in Table3. It is observed that pH value of raw fresh ostrich sausage (5.97) is in agreement with the value of 5.95

reported by Gibriel et al. (1979) for beef sausages. After 30 days of frozen storage slight increase take place (6.04) due to protein denaturation, while it decreases to 6.00 after 60 days due to the breakdown of glycogen with the formation of lactic acid. On the other hand, the increase of pH values at the late period of frozen storage is explained by the partial proteolysis, leading to the increase of alkaline groups and ammonia, hence pH value has been studied as an indication of proteolysis (Lawrie, 1968). In addition, meat pH is considered as one of the important technological properties as it alters protein solubility, WHC, cooking loss as well as pigment and lipid stability (Wittman et al.,1994)

Table 3 shows that total volatile basic nitrogen (TVBN) values of ostrich sausage gradually increased during frozen storage reaching 14.2 mg N/100 g flesh (on fresh weight basis) after 90 days at – 20 °C. Generally, these results are in harmony with Abu-Salem and Khalaf (1988), who reported that TVBN of chicken sausage increased from 9.95 to 13.98 after three months of storage at –18 °C. Such accumulation of TVBN in ostrich sausage indicates some protein breakdown by enzymes, which are not completely inactivated during frozen storage (Brake and Fennema, 1999). However, TVBN values are well bellow the critical limit value of 20 g N/100 g flesh as recommended by the Egyptian Standards (E.S., 1995).

Table (3): Chemical indices of ostrich sausage as affected by frozen storage at –20 °C for 90 days (on fresh weight basis)

Frozen storage (in Days) / Indices	Zero Time	30 Days	60 Days	90 Days
pH value	5.97	6.04	6.00	6.08
TVBN* (mg N/100 gm flesh)	11.40	12.10	13.00	14.20
TBARS** (mg Malonaldhyde/ kg flesh)	0.40	0.46	0.55	0.67
FFA*** % (as oleic acid)	0.35	0.38	0.44	0.52

* TVBN: Total Volatile Basic Nitrogen
** TBARS: Thiobarbituric Acid Reactive Substances
*** FFA: Free Fatty Acids

Lipid oxidation is a leading cause of quality deterioration (Rhee et al., 1996). Thiobarbituric acid reactive substances (TBARS) test has been widely used for measuring oxidative rancidity in fat-containing food. Results in Table 3 indicated that prolonged frozen storage of ostrich sausage was accompanied by an increase in values of TBARS as compared with fresh samples, possibly due to lipid oxidation. Sharaf (1993) reported similar observation in chicken sausage. However, ostrich sausage exhibits quite low and acceptable TBARS values (less than 0.9 mg malonaldehyde/kg flesh) as required by the Egyptian Standards (E.S., 1995) even after 90 days of frozen storage.

Free fatty acids (FFA) are often used as a general indication of the condition and edibility of fats (Pearson, 1981). Results in Table 3 further showed that FFA percentages of ostrich sausage increase steadily during frozen storage indicating that lipolysis might have taken place (Brake and Fennema, 1999). However, ostrich samples showed acceptable FFA percentages (less than 1.2% as oleic acid) even after 90 days of frozen storage at –20 °C. In this concern, Abu- Salem and Khalaf (1988) found that FFA of chicken sausage increase from 0.45 to 0.60 % (as oleic acid) after three months of frozen storage at – 18 °C.

Generally, from the previously mentioned results of Table 3 it could be concluded that the assumption that frozen meat products are immune to quality deterioration is false, since chemical reactions, enzymatic as well as non-enzymatic reactions , could proceed at temperatures below freezing. All of these reactions have the potential for reducing the quality attributes and nutritive value of frozen ostrich sausage.

3. Protein solubility:

Total soluble nitrogen (TSN), soluble protein nitrogen (SPN) and non-protein nitrogen (NPN) of ostrich sausage are illustrated in Fig. 1, from which it is apparent that TSN sharply decreased from 63.0 to 48.0 % of total nitrogen at the end of frozen storage time. In this respect, El-Wakeil et al. (1994) found that TSN of raw fresh chicken sausage was 57.26% of their total nitrogen and gradually decreased during frozen storage. However, ostrich sausage exhibited higher percentages of TSN than chicken sausage since ostrich meat exhibits higher protein solubility than chicken meat (Moawad et al., 2000). From the same results of Fig.1, it is apparent that SPN of ostrich sausage markedly declined from 52.80 to 34.54% of their total nitrogen after 90 days of frozen storage at –20 °C. These results generally agree with Miller et al. (1980) who reported that solubility of protein decreased after 25 weeks of frozen storage at –18 °C by 50 % in pork and by 36 % in beef. These reductions in protein solubility might be explained by protein denaturation and aggregation as well as to the reaction of alpha-amino acids of myosin, guanidine or arginine with polyunsaturated fatty acid oxidation products (Buttkus, 1967; Miller et al., 1980).

Figure 1 also showed that NPN percentage of ostrich sausage increased progressively from 10.2 to 13.6% of the total nitrogen after 90 days of frozen storage at –20 °C. NPN includes free amino acids, protein degradation products and other extractive nitrogenous compounds. Hence, NPN is inversely proportional to the biological value of meat products and has been studied as an indication of proteolysis (Hegsted et al., 1973).

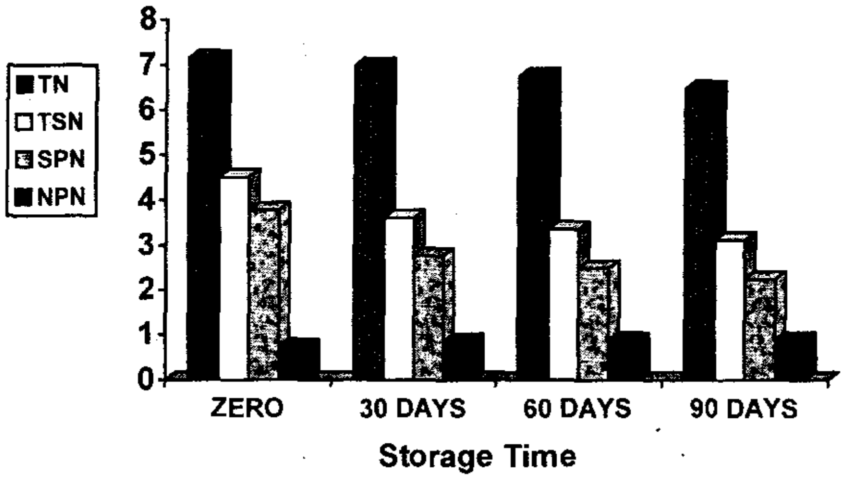

Figure (1): Total nitrogen (TN), Total soluble nitrogen (TSN), Soluble protein nitrogen (SPN) and non protein nitrogen (NPN) of ostrich sausage during frozen storage at – 20 °C for 90 days (% on dry weight basis).

4. Amino acids:

Amino acid composition (g/16 g N) of ostrich sausage is shown in Table 4. It was found that , in a similar way to other meat products, ostrich sausage is characterized by a high content of lysine, leucine, aspartic acid, histidine and glutamic acid. Data also indicated slight increases in phenylalanine, lysine and glycine, while proline, tyrosine and threonine remain unchanged, whereas, the rest of the amino acids (Table 4) show slight reductions after 90 days of frozen storage at –20 °C.

It is apparent from the results of Table 4 that total essential amino acids (TEAA) of ostrich sausage decreased from 38.83 to 36.88 (g/16 g N), while total non-essential amino acids (TNEAA) decreased from 58.28 to 53.44 (g/16 g N). Darweash (1996) achieved similar trend of changes in fish kobebah.

Concerning amino acid composition, Sharaf (1993) reported that TEAA and TNEAA of fresh chicken sausage were 38.34 and 60.13 (g/16 g N); respectively. However, the decrease in total amino acids during frozen storage of ostrich sausage could be attributed to proteolysis as a result of intrinsic enzymes that remain active at below freezing temperatures (Miller et al., 1980; Brake and Fennema, 1999). In the mean time, some of the structural proteins appear to be modified during frozen storage, due to proteolysis and are exuded in drip (Lawrie, 1968; Miller et al., 1980; Sklan and Tenne, 1983). Another most important explanation for decreasing total amino acids is the reaction of meat proteins with peroxidizing lipids or their secondary breakdown products during frozen storage (Wagner and Anon, 1986).

Table (4): Amino acid composition (g/16 g N) of ostrich sausage as affected by frozen storage at – 20 °C for 90 days

Amino acid (AA)	Fresh Sausages (zero time)	Frozen Sausages (90 days)
Theronine	2.91	2.86
Valine	4.96	4.25
Methionine	1.46	1.55
Isoleucine	4.30	4.05
Leucine	8.41	7.74
Phenylalanine	4.15	4.29
Histidine	3.47	2.62
Lysine	8.97	9.52
Total essential	38.63	36.88
Aspartic acid	13.90	12.38
Serine	3.88	3.09
Glutamic acid	16.82	14.52
Proline	3.59	3.57
Glycine	4.71	4.88
Alanine	6.28	6.19
Cystine	1.01	1.55
Tyrosine	2.26	2.26
Arginine	5.83	5.00
Total non-essential	58.28	53.44

5. Physical properties:

Physical properties of ostrich sausage as affected by frozen storage at –20°C for 90 days are presented in Table 5. WHC is considered as the most important technological properties as it affects the tenderness, juiciness, drip loss and cooking yield of meat and meat products (Fox et al., 1980). Data of Table 5 indicated that raw fresh ostrich sausage exhibited higher WHC and plasticity (tenderness) as compared to the frozen samples. This trend is similar to protein solubility changes and thus indicates that WHC increases with the increase in protein solubility and vice-versa. The WHC and plasticity decreased as a function of storage time indicating some biochemical changes and protein denaturation associated with frozen storage (Bhattacharya et al., 1988). Ameen (1976) and Sharaf (1993) reached the same findings in beef and chicken sausages; respectively. On the other hand, Abd El-Gawwad et al. (1986) reported that as the percentage of protein in beef sausage increased, WHC consequently increased.

Results in Table 5 also revealed that fresh raw ostrich sausage exhibited higher percentage of bound water (84.12 %) as compared to frozen samples (83.12, 82.51 and 81.85). This confirms the findings of WHC (Table 5). It is worth mentioning that WHC means the ability of tight meat to hold fast its own water even or added water during application of any force (Lawrie, 1968). However, the loss of bound water might be attributed to protein denaturation and WHC decline during storage. In this respect, Gibriel et al. (1979) came to the conclusion that pork sausage exhibited higher bound water (86.82 %) than beef sausage (78.41 %). They also reported that bound water percentages of all sausages were found to decrease as the time of storage progresses.

Table 5: Physical properties of ostrich sausage as affected by frozen storage at –20 °C for 90 days

Frozen storage (in Days) / Measurements	Zero Time	30 Days	60 Days	90 Days
Water- holding capacity* (WHC,cm^2/0.3 g meat)	3.60	3.80	3.90	4.00
Plasticity or tenderness* (cm^2/0.3 g meat)	2.30	2.10	2.10	2.00
Bound water %	84.12	83.12	82.51	81.85
Feder value (Moisture/protein ratio)	3.89	3.92	3.94	3.99
Cooking losses % (boiling and frying losses)	19.80	20.60	21.20	22.70

* The greater area (cm^2) indicates lower water holding capacity and higher plasticity

Feder value (Moisture/protein ratio) is used to assess the analytical quality of whole meat products. Feder value in good quality products should not exceed 4.0 as reported by Pearson (1981). Results in Table 5 revealed that Feder values of ostrich sausage slightly increased as a function of storage time indicating some undesirable biochemical changes during storage (Table 2). However, all sausage samples exhibit good quality since their Feder values are always below 4.

Results in Table 5 also demonstrated that the percentage of cooking losses (boiling loss + frying loss) was 19.8 % for fresh ostrich sausage (at zero time storage). In addition, cooking losses continuously increased with increasing frozen storage time reaching 22.7 % after 90 days. Concerning cooking loss, Salama et al.(1994) found that cooking losses in chicken sausage are influenced by the source of fat, soy flour and sunflower substitution as well as frozen storage time. Meanwhile, Regan et al. (1983) reported that fat percentages, grinding system, protein content and non-meat additives affect to a great extent the percentages of cooking losses. However, the reduction in cooking yield of ostrich sausage during frozen storage was parallel to the decrease in WHC and protein solubility (TSN and SPN) as a result of protein denaturation during frozen storage.

6. Organoleptic evaluation:

Taste panel evaluations for the cooked ostrich sausage (boiled and fried) are presented in Table 6. Overall acceptability scores indicated that all samples, whether at zero time or at the end of the frozen storage time, were organoleptically acceptable. Results in Table 6 also revealed that cooked fresh sausage samples attain slightly higher color, flavor, taste, texture and overall acceptability scores than cooked frozen sausage samples. Results in Table 6 further showed that taste of cooked fresh sausage exhibited the highest score (9.2), while flavor of cooked frozen samples showed the lowest score (8.0). However, all ostrich sausage samples rated as very good (8-9) and no evidence of spoilage or undesirable changes were detected in ostrich sausage samples even after 90 days of frozen storage at –20 °C. These results are in good agreement with those of chemical indices (Table 3). Therefore, chemical indices together with organoleptic tests are used to assess the quality and shelf life of meat products.

Table (6): Sensory characteristics of cooked ostrich sausage, either fresh (zero time) or frozen-stored at–20°C for 90 days (means ± SD, n= 15)

Sensory Panel	Cooked (boiled and fried) samples	
	Cooked-fresh sausage (zero time)	Cooked-stored sausage (90 days)
Color	8.5 ±1.12	8.1 ±0.71
Flavor	8.7 ±0.95	8.0 ±0.65
Taste	9.2 ±0.73	8.8 ±0.73
Texture	8.6 ± 0.81	8.2 ±0.80
Overall acceptability	9.0 ±0.87	8.6 ± 0.79

Concerning sensory evaluation of sausage, Regan et al. (1983) reported that sensory ratings for flavor acceptance and overall satisfaction in pork sausage were high up to 21 days of frozen storage at –18 °C. Abd El-Gawwad et al. (1986) found that tenderness of cooked beef sausage depends on its protein and fat contents. On the other hand, Salama et al. (1994) came to the conclusion that all sensory attributes of chicken sausage were influenced by the source of fat, soy flour and sunflower flour substitutions as well as frozen storage time.

Conclusions:

As indicated by gross chemical composition, amino acids, chemical indices (pH value, TVBN, TBARS and FFA), physical properties and eating quality (organoleptic test), a good and more health sausage can be manufactured from ostrich trimmed lean meat in combination with 20 % gizzards and hearts. The present results indicated that, although freezing is generally conceded to cause some quality loss; it remains the method of preference for keeping the quality attributes and nutritive value of ostrich sausage for human consumption.

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تقييم خصائص الجودة الكيماوية والطبيعية والغذائية والحسية لسجق النعام

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الملخص العربى :

تم تقييم خصائص الجودة و القيمة الغذائية في سجق النعام المنتج من لحم التصنيع Trimmed Lean مع ٢٠% من قوا نص و قلوب النعام. جميع عينات السجق سواء الطازجة أو المجمدة مقبولة و ذات جودة و قيمة غذائية عالية كما هو واضح من نتائج التحليل الكيماوي و الطبيعي و الأحماض الأمينية و كذا الاختبارات الحسية. من الناحية الاقتصادية فأن استخدام لحم التصنيع و دهن و أعضاء النعام قلل بالتأكيد من تكاليــف السجق و بالتبعية يقلل سعر منتجات النعام بالنسبة للمستهلك.

تم دراسة تأثير التخزين بالتجميد على ــ٢٠ °م لمدة ٩٠ يوم على جودة سجق النعام وقيمـــته الغذائية ووجد أن كل من المحتوى الرطوبى والبروتيني و ذوبان البروتين والأحماض الأمينـــية الكلـــية و مقدرة اللحوم على الاحتفاظ بالماء وكذا درجة طراوتها تقل في حين تزداد المركـــبات القاعديـــة الكلـــية الطـــيارة و قيم حمض الثيوباربتيوريك والأحماض الدهنية الحرة والمركـــبات النيتروجينـــية غير البروتينية وكذا الفقد بالطبخ مع زيادة زمن التخزين بالتجميد. وعلى أية حـــال لم يستدل كيماويا أو حسيا على تغيرات غير مرغوبة فى سجق النعام حتى بعد ٩٠ يوما من التخزين بالتجميد.