Vet.Med.J.,Giza. Vol.49, No.2. (2001): 199 - 210.

THE TRADITIONAL EGYPTIAN LUNCHEON 1-QUALITY ATTRIBUTES OF MARKET PRODUCT

T. NOUMAN*, A. DARWISH*, ZINAB NIAZI** and HODA AIEDIA**

* Dept. of Food Hygiene, Fac. Vet. Med. Cairo Univ.

**Dept. of Food Hygiene, Animal Health Research Inst, Giza.

Received: 15. 5. 2000.

Accepted: 20. 12. 2000.

SUMMARY

Sixty samples of the market traditional luncheon sausage filled into permeable cellulose casing were examined. The normal accepted organoleptic attributes as regard, colour, flavour, surface skin, and the slice properties were determined as; normal cure, fleshy cure, fine and fine with good binding respectively. Deviations were also defined and discussed.

The p. H. value, degree of fat oxidation and the TVBN could be taken collectively as a measure for the freshness attributes of the product.

The chemical analysis of the samples for their nutritional contribution revealed that 100% of them were adultrated when compared with the criteria listed in the Egyptian standard specification No. 1114/1991. Under the light of the same specification; 66.6% of the examined samples failed to comply microbiologicaly.

Except for the intentional adultration with starches, the overall product quality is affected with the producing plant grade as sorted by visual inspection.

INTRODUCTION

The term luncheon is usually referred in the literature to a canned meat, ready to eat, finely ground or chopped product. In the Egyptian market, the term is usually applied to a very traditional long known loaf item. On the bases of its final moisture content, Nouman (1997) had defined the product as being a large diameter, non fermented, cooked, semidry, emulsion Sausage. Two basic characters are common to the product, its slicing ability to very thin slices with high binding and when the product is skillfuly made can keep sound at room temperature for weeks under rea-

sonable circumstances.

The raw beef used for processing over the last three decades is the imported deboned deep frozen one . Formerly local beef was used specially the carcasses which do not find a market as table meat but still sound for consumption.

The processing starts by meat comminution, in this operation squeezing should be avoided specially for a very fine diameter of one or two m.m. After comminution, the raw beef should be formulated i. e. correction of the lean, fat and collagen content. Chopping of beef in the bowel cutter, common salt, polyphosphate and then ice or cold water, followed by nitrites and spices addition. The chopper is then set at the high speed to emulsify the ingredients to a fine batter. Starch as an emulsion stabilizer is added at the end. the final temperature of the batter must end at or little before 12°C . In the former time and in small scale plants a baddle mixer is used instead of the chopper but the raw beef must be ground fine (1-2 m.m.).

The filling operation comes next. In this very Egyptian product, regenerated permeable cellulose casing is used. Formerly celophan papers formed into tubes were used. The filled sausage is then subject to a long term heat treatment (6-8 hours) at 90°C to core 80°C-85°C., followed by cold shower. The product is then left to cool at room temperature in a well aerated space to dry the casing surface, then go to the market.

It is important to note that; producers, distributors and selling shop handlers are used to store that product hanged at room temperature. Keeping the product in cool cabinets allow moisture to accumulate on and under the casing because it is permeable and hence the product may deteriorate due to mould growth and development of bacterial slime.

Some invistigators had studied the microbiological and the Nutritional contribution of the product (Abd Elrahman, 1984; Hemeida et al., 1986; Refaei and Nashed 1989; Mousa et. al, 1993 a & b; Abd Elall 1993; Edris 1993; Fathi et. al 1994 and Tolba et al., 1995). Non had studied the professional characteristics and the organoleptic landmarks of the product. Therefore the objectives of the present study is to find out the product attributes as available in the market, in particular the organoleptic and deteriorative ones, beside the nutritional and microbiological attributes.

MATERIALS AND METHODS:

Twenty meat processing plants located allover Cairo and North Egypt had been visited and evaluated visually for their sanitation, organization and machinary up-dating, beside having or not any quality certification. Then being sorted into 3 classes I, II, and III.

Their products of traditional luncheon sausage (filled into permeable casing) had been looked for in the market. Twenty intact units had been collected for every class (total 60) . Transferred to the laboratory for further investigation.

A- The organoleptic attributes:

Price and Schweigert, (1971); Frazier and Westhoff (1978); Bacus, (1984); Pearson and Tauber , (1984) and Varnam and Sutberland, (1995).

The parameters looked for in this examination are a collection from the above listed references as related more or less to similar European and American meat products together with the overviews collected at interviews with local professional persons in the industry. Moreover, the technological properties and errors due to processing faults had been looked for.

B- Freshness attributes

Included ; PH value of the product (ISO, 1974), and for the extracted fat the acid value (Kates, 1972; Pikul et al, 1983 and Metcalf, 1979)., Peroxide number (A. O. A. C., 1990), Thiobarbituric acid reacitive substances TBA, Malonaldehyde content/gm fat, MD/ gm fat according to Tarladgis et al., 1960; Pikul et al., 1983, Sinnhuber and Yu, 1958 and Yu et al. 1986. Also the total volatile base nitrogen (TVBN) according to (FAO, 1980) was determined.

C- Nutritional Contribution

Included; the determination of ; moisture content (ISO 1973 a), total protein (AOAC 1990), fat content (ISO 1973 b), Total carbohydrate (Dubois, et al 1956), sodium chloride (AOAC 1990), ash content (ISO 1978) and nitrite (ISO 1975 a).

D- Microbiological attributes

The following microbial counts were determined, total aerobic (ISO, 1976), total thermoduric (Harrigan and Mc Cane 1976; and Collins and Lyne, 1984), anaerobes (Brewer and Allgeier, 1966), Staphylococcus aureus (FAO, 1992) and total yeast and mould count (Bailey and Scott, 1974) Beside; a test for Salmonellae (ISO, 1975 b and Harvey and Prico, 1981) and for enteropathogenic E. coli (ICMSF, 1978).

RESULTS AND DISCUSSION

Table (1), illustrates the different normal organoleptic attributes of the product, as well as the deviated forms and there incidence among the market samples.

Deviation from the normal attributes were more frequents in products of low graded factories. The *fading* discolouration could be due to the use of

beef with oxidized fat with high organic peroxide which results in the instability of the cured meat colour (Price & Schweigert 1971). The browning discolouration could be due to the incorporation of much straches, sugars or caramel (Smith, 1991) or the lack of antioxidant in the product and the further development of denatured metmyoglobin (M. B. 1983). Greening may result from over cure or much collagen-nitrite reaction (Diebel and Evans 1957). It could also be microbial specially lactics (Niven et al., 1949).

The shrink appearance of the casing may be due to the use of primitive filling machines lacking a vacuum control, which results in minute air spaces in the filled batter, the air expands during cooking, then shrink during showering, distribution and storage. The condition may also happen in conjunction with gellation, fat separation or due to loss of moisture during marketing and long storage (Pearson and Tauber 1984).

The starchy or milky appearance is common in the Egyption traditional luncheon when stored stuck together with insufficient air between. This problem is commonly followed by mould growth whenever enough humidity is available . In fact the problem is more frequent when the product contains much starch (more than as a stabilizer). Because the product is cooked above 90°C., degradation of starch occur (above gelatinization temperature) (Dencate 1963). The other two discolourations reported, slime & green core are of microbial origin and reflect the bad hygiene during production (Nevin et al., 1959).

The appearance of rancid flavour in the market product is not uncommon. The use of long stored frozen beef is usually the basic cause of the problem (Thornton and Gracey, 1974). On the other hand, the putrid and sour flavour are of microbial origen . The high carbohydrate in the product provide a reasonable substrate to the fermentative contaminants (Bacus, 1984).

The surface skin which developes under the casing as a result of the thermal protein coagulation during the dry phase of cooking, may be thin or thick. Thin surface skin is more acceptable and is usualy reported for fresh product. The thick skin may denote an old product, specially when accompaned by casing shrink. Some factories use traditional brick cooking ovens heated by gasoline, the surface skin of the product cooked in such ovens is usually thick. So the thickness of the surface skin in fresh product is a reflection of the cooking system.

Heat break down is a mild form of surface fat separation and is due to the use of high cooking temperature from the very beginning . the problem does not alter the product quality, but only when

Table (1-a) Organoleptic Attributes of market luncheon samples

Factory grade	Product Appearance									Flavour			
	Norumal Cure	Discoloured								Normal Fleshy	Deviated		
		Fading	Browning	Greening	Shrinkage	Starchy	Mouldy	Slimy	Green core		Rancid	Putrid	Sour
I	15	2	2	1	2	3	1	0	0	18	1	0	1
II	13	4	3	3	4	3	3	2	1	15	4	0	3
III	9	8	3	6	7	5	3	3	3	14	7	2	4
Total	37	14	8	10	13	11	7	5	4	47	12	2	8
%	61.6	23.3	13.3	16.6	21.6	18.3	11.6	8.3	6.6	78.3	20	3.3	13.3

Table (1-b) Organoleptic Attributes of market luncheon samples

Factory grade	General Technical							Slice Properties								
	Surface Skin		Fat			Pockets		Colour				Emulsion			Binding	
	Fine	Thick	H.B.D	Fat Cap	Separated	Jelly	Air	Normal Cure	Fading	Browning	Charry	Fine	Coarse	Impure	Good	Bad
I	17	3	2	0	1	0	2	17	2	3	1	18	2	1	17	3
II	15	5	4	1	3	3	5	13	5	3	3	14	6	3	16	4
III	12	8	5	4	6	3	7	9	6	4	3	6	14	5	11	9
Total	44	16	11	5	10	6	14	29	13	10	7	38	22	9	44	16
%	73.3	26.6	18.3	8.3	16.6	10	23.3	48.3	21.6	16.6	11.6	63.3	36.6	15	73.3	26.6

H. B. D.= Heat Break Down

Freshness Attributes

Table (2): Mean value of examined market Luncheon samples

Factory grade	PH value		Fat oxidation criteria					TVBN
	Outer	Core	Acid Value	Peroxide number	Malonaldhyde Concentration			
					Fat %	Ug MD/ gm Fat	TBA Value	
I	5.6	5.3	2.4	10.0	17.0	28.9	0.489	13.8
II	5.5	5.1	2.4	13.4	17.9	32.8	0.58	17.9
III	5.4	5.1	3.1	20.6	17.7	44.1	0.80	19.3
Total mean	5.5	5.1	2.6	14.6	17.5	35.2	0.62	17.0
Maximum	5.8	5.6	4.1	27.0	21.1	63.0	1.05	28.1
Minimum	5.1	4.7	1.2	5.9	13.5	15.0	0.30	10.1

Nutritional contribution

Table (3): Mean value of examined market Luncheon samples

Factory grade	Moisture	Protein	Fat	Carbohydrate	Na cl	Ash	Moisture Protein ration	Nitrite (p.p.m)
I	51.0	15.9	17.0	11.9	2.5	4.0	3.1	111
II	52.2	13.0	17.9	12.6	2.38	4.1	4.0	121
III	53.5	11.1	17.7	13.5	2.4	4.0	4.8	124.7
Total mean	52.2	13.3	17.5	12.6	2.4	3.9	3.96	118.9
Maximum	59.3	18.2	21.1	20.7	3.7	5.5	5.8	160
Minimum	44.7	9.4	13.5	7.0	1.8	2.0	2.6	75
No. of Accepted Samples According to ES.S. 1114-1991	44.0 (73.3%)	21.0 (35%)	57.0 (95%)	0 (0%)	54.0 (90%)	--	27 45%)	40.0 (66.6%)
No. of Non Accepted Samples Ac-cording to E.S.S. 1114-1991	16.0 (26.6%)	39.0 (65%)	3.0 (5%)	60 (100%)	6.0 (10%)	---	33 (55%)	20.0 (33.4%)

it is sliced, it has a greesy touch (Pearson and Tauber 1984). Fat cap, is another but more severe case of fat separation is due to under or over chopping of the batter, or the raw beef was poor in myocin (M. B. 1983). Gelatin pockets, is another reported problem. It is mainly due to the use of beef with high collagen content. When being higher than requested and upon the mechanical tenderization, it shares myocin in fat coating. Upon cooking converts to gelatin and separate . Its danger is if undetected from outside, gelatin supports anaerobic microbial growth (Swift et. al., 1961 and M. B. 1983). Air pockets, is another problem detected during the survey. The use of primitive filling machines lacking a vacuumizing facility usually results in the problem. The danger is that, inside microbial deterioration is possible without being vessible from outside.

Microbiological Attributes

Table (4): mean value of examined market Luncheon samples

Factory grade	Microbial counts/gm								Test For	
	Total Aerobic	Thermoduric		Anaerobic	Staph. aureus	Enterobacteriaceae	Mould	Yeast	Salmonellae	E.P.E.C
		55C°	63C°							
I	$9.4x10^4$	$5.5x10^2$	$6.2x10^3$	$5.1x10^2$	$3.2x10^2$	$1.5x10^2$	$8.7x10^2$	$1.7x10^2$	0	2
II	$2.5x10^5$	$5.8x10^2$	$7.7x10^3$	$1.8x10^3$	$5.2x10^2$	$7.6x10^2$	$9.1x10^2$	$1.8x10^2$	0	3
III	$3.9x10^5$	$7.6x10^2$	$9.4x10^3$	$4.0x10^3$	$6.0x10^2$	$1.2x10^3$	$1.0x10^3$	$3.4x10^2$	0	4
Total mean	$2.4x10^5$	$6.3x10^2$	$7.7x10^3$	$2.1x10^3$	$4.8x10^2$	$7x10^2$	$9.2x10^2$	$2.3x10^2$		
Maximum	$9x10^5$	$3x10^3$	$9.4x10^3$	$4x10^3$	$3x10^3$	$4x10^3$	$3x10^3$	$6x10^3$		
Minimum	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$		
No. of Accepted Samples According to ES.S. 1114-1991	20 (33.3%)	--	--	27 (45%)	38 (63.3%)	--	--	--	60 (100%)	51 (85%)
No. of Non Accepted Samples According to E.S.S. 1114-1991	40 (66.6%)	--	--	33 (55%)	22 (36.6%)	--	--	--	0	9 (15%)

- - Not reported in E.S.S. 1114-1991. E.P.E.C. Enteropathogeinc Echerichia coli

Studying the properties of the sliced product, the expected cure colour was only reported for 48.3% of the samples. Deviations were fading, browning and the charry colours. The slice appearance (fine or coarse) is another attribute. Both are acceptable so far the visual observation do not reveal impurities as pieces of cartilage, fibers, cellophane etc. (Church and Wood 1992). The sliced product could also be tested for the degree of binding as good or bad. Bad binding reported is due to a mistake in formulating the raw beef (Gerhardt 1976), or the use of much starches.

The freshness attributes including, pH value, fat oxidation criteria (acid value, peroxide number, TBA) and TVBN as an estimate of protein degradation were looked (Table 2). despite the pH value is more reasonable in products of better grade factories than those from factories of lower grade, yet it is not determintal of product quality. Hence the final pH of the product is influenced by the presence or the other wise of acid additives and the alkaline ones. Alkaline polyphates tend to increase the pH. On the contrary; organic acids addition tends to lower the value. However only extreme values together with deviations in the organoleptic attibutes as observed during the investigation could be indicators of product deterioration.

The acid value, peroxide number and TBA value seem higher in products of category III factories than those of I & II. The same observation also apply to TVBN values. The proposal given by Pikul et al., (1989) to calculate the malonaldehyd content per gram of extracted fat was also applied . Out of 60 market samples, 20 had malonaldehyd higher than 41 ug/gm fat. Fourteen of them had been noted rancid by the senses. Therefore a value of MA higher than 40µg/gm fat could be considered nonaccepted.

Table (3), summarizes the nutritional contribution of the market samples. Evaluating the listed values on the bases of the E. S. S. 1114-1991, it is noted that all the examined samples contained higher carbohydrates than should be. It is also noted that 65% of the samples contained lower protein content. The involvement of much starches in the formulation of the product is not only a mean of adultration, but also masks the real fat content in the raw beef and hence the final value in the market product. Therefore the interpritation of fat % should not be handled alone, but together with the carbohydrate content as a guide line for adultration detection.

Another mean for evaluating the product, nutritionally could be the calculation of the moisture: protein ratio (Bacus, 1984). Considering the product a semidry sausage, a value of 3.5 or lower could be reasonable.

Table (4), provides the microbiological attributes of the market product. It is evident that 66.6%, 55%, 36.6% and 15% of market samples do not comply with the E. S. S. 1114 - 1991 as regard the total bacterial count, anaerobic, Staphylococcus and E. P. E. coli counts. In general, the microbiological quality of the products produced by factories of grade I is more better than those of the other two classes II & III. This observation is explained by the availability of updated machinery by the first group, specially the cooking units and the available multi phase cooking programme. When humidity cooking is a part of the thermal treatment schedule, more bacterial destruction in the product is insured.

The enteropathogenic E. coli was recovered from 15% of the market samples, being more frequent with grade III factories and less with II & I. The serotypes were , O_{111}: K_{58} (B_{14}), O_{26}:K_{60} (B_6) and O_{157}:H_7 . Similar serotypes were reported by Doyle and Schoeni (1984) in ground beef associated with haemorrhagic colitis in man. Similar cases were reported by Mac Donald (1985) associdated with the consumption of burgers. Since the organism is sensitive to the thermal treatment usually used for luncheon processing, its recovery denotes under processing and/or the use of unclean water for cooling post processing.

REFERENCES

Abd El-All, F. A. (1993): Contamination of meat and meat products with human bacterial pathogens. M. V. Sc. Thesis, Fac. of Vet. Med., Assiut Univ.

Abd El-Rahman, A. A.; Youssef, H. and Hefnawey, Y. (1984): Mycological quality of meat products in Egypt . Assiut Vet. J., 12:24.

A. O. A. C. (1990): "Association of Official Analytic Chemists" Official methods of analysis, 15th Edition.

Bacus, J. (1984): Utilization of Microorganisms in meat processing. John-Wiley and Sons, Inc., New York.

Balley, W. R. and Scott, E. G. (1974): "Diagnostic Microbiology". A text book for the isolation and identification of pathogenic microorganisms. 4 th Ed., the C.V., Mosby Co., Saint Louis.

Brewer, J. H. and Allgeier, D. L. (1966): Self contained carbon dioxide hydrogen anaerobic system. Appl. Microbiol., 14: 985.

Church, P. N. and Wood, J. M. (1992): The Manual of Manufacturing Meat Quality. El-Sevier Science Publishers Ltd., England.

Collins, C. H. and Lyne, P. H. (1984): Microbiological Methods. 5th Ed., Butter and Tanner Ltd., London, Boston.

Deibel, R. H. and Evans, J. B. (1957): Nitrite burn in cured meat products particularly in fermented sausages. Am. Meat Inst. Found . Bull., No., 32.

Dencate, L. (1963): Starch and amylase in meat products. Fleischwirtschaft, 15: 1021.

Doyle, M. P and Schoeni, J. L. (1984): Survival and growth

characterisitics of Escherichia coli associated with hemorrhagic colitis. Appl. environ. Microbiol., 48: 855.

Dubois, M.; Gilles, K. A.; Hamilton, J. K.; Robert, P. A. and Smith, F. (1956): Colorimetric method for determination of sugars and related substances. Anal. Chem., 28 (3): 350.

Edris, A. M. (1993): Isolation and identification of E. coli and Salmonella in ready to eat meat products Zagazig Vet. J., 12 (2): 187.

F.A.O. (1980): Food and Agriculture Organization of United Nation. Manual of food quality control, United Nation, Rome.

F. A. O. (1992): Food and agriculture Organization of United Nation. Manual of food quality control. 1- Microbiological Analysis. Staphylococcus counts, P. 131.

Fathi, S.; El-Khateib, T.; Mostafa, S. and Hassanin, K. (1994): Salmonella and Enteropathgoenic Escherichia coli in some locally manufactured meat products. Assiut Vet. Med. J., 31 (61): 190.

Frazier, W. C. and Westhoff, D. C. (1978): Food Microbiology. 3rd., Tata McGraw-Hill puiblishing Co., Lid.

Gerhardt, U. (1976): Fleischver-Marktungs-Systeme. Karl HeinzHack, Frankfurt.

Harrigan, W. F. and McCance, M. E. (1976): Laboratory methods in food and dairy microbiology. Academic Press, Inc., London, Lid.

Harvey, R. W. and Price, T. H. (1981): Comparison of selenite F, Müller kauffmann tetrathionate and Rappaport medium for Salmonella isolation from chicken giblets and after pre-enrichment in buffered peptone water. J. Jyg. Camb., 87:219.

Hemida, H. H.; Hallabo, S. A. and El-Wakeil, F. A. (1986): Chemical and microbiological evaluation of some cured meat products. Bull. Fac. Agric. Cairo Univ., 37 (1): 289.

ICMSF (1978): International Committee on Microbiological Specifications for Foods. 2nd Ed., Univ. of Toronto Press, Toronto, Buffalo nd London.

ISO (1973): a. International Standard ISO 1442-1973. Meat and Meat Products: Determination of Moisture Content.

ISO (1973): b. International Standard ISO 1443-1973. Recommended Methods: Determination of Total Fat Content of meat and meat Products.

ISO (1974): International Standard ISO 2917-1974. Meat and Meat Products: Measurement of pH (Reference method).

ISO (1975): a. International Standard ISO 2913-1975. Meat and Meat Products: Determination of Nitrite Content (Reference method).

ISO (1975): b. International Standard ISO 3565-1975. Meat and Meat Products. Detection of Salmonella (Refernce method).

ISO (1976): International Standard ISO 2293-1976. Meat and Meat Products: Aerobic Count at 30 C (Reference method).

ISO (1978): International Standard ISO 936-1978. Meat and Meat Products: Determination of Ash (Reference method).

Kates, M. (1992): In"Laboratory Techniques in Biochemistry and Molecular Biology" Work, T. S. & Work, E. Eds.; North-Holland Publishing Co.; Amesterdam, 192; 347.

MacDonald, K. (1985): Outbreak of Escherichia coli O157: H7 diarrheal illnes in a mursing home , Nebraska. Abst. Food Research Institute Ann. Spring Mtg., Madison, WI.

M. B. (1983): Published by National Livestock and Meat Board, U. S. A. No. 6-305/8835.

Metcalf, L. D. (1979): Traditional analytical chemistry of fatty acids and their J. Am. Oil Chemists Soc., 56: 786 A.

Mousa, M. M.; Samaha, L. A. and Edris, A. M. (1993 a): Chemical composition of some locally mamfactured meat products. Alex. J. Vet., 9 (3): 123.

Mousa, M. M.; Awad, H. A.; Yassien, M. M. and Gouda, H. I. (1993 b): Microbial quality of some meat products. Vet. Med. J. 41 (31): 59.

Niven, C. F. Jr.; Castellani, A. C.; and Allanson, V. (1949): A study of the lactic acid bacteria that cause surface discoloration of sausage. J. Bacteriol., 58: 633.

Niven, C. F. Jr.; Deibel, R. H. and Wilson, G. D. (1959): Production of fermented sausage. U. S. Patent, 2 , 906, 661.

Nouman, T. (1997): The further processing of Beef. in Notes on meat technology and preservation. Cairo, Univ., Fac. Vet. Med. Press.

Pearson, A. M. and Tauber, F. W. (1984): Processed Meats. 2 nd Ed., AVI Publishing Company, Inc.

Pikul, J.; Leszczynski, D. E. and Kummerow, F. (1983): Elimination of sample autoxidation by butylated hydroxytoluene additions before thiobarbituric acid assay for malonaldehyde in fat from chicken meat. J. Agric. Food Chem., 31: 1338.

Pikul, J.; Leszczynski, D. E. and Kummerow, F. (1989): Evaluation of three modified TBA methods for measuring lipid oxidation in chicken meat. J. Agric. Food Chem., 37: 1309.

Price, J. F. and Schweigert, B. C. (1971): The Science of Meat and Meat Products 2nd Ed., W. H. Freeman & Co., San Francisco.

Refaie, R. S. and Nashed, S. M. (1989): Bacteriological studies on Enterobacteriaceae in some meat products. Assiut Vet. Med. J., 23: 45.

Sinnhuber, R. O. and Yu, T. C. (1958): characterization of the red pigment formed in the 2- thiobarbituric acid determinator of oxidative rancidity. Food Res., 23: 626.

Smith, J. (1991): Food additive User's. Hand Book, published int he USA by AVI.

Swift, C. E.; Lockett, C. and Fryer, A. J. (1961): Comminuted meat emulsions: The capacity of meat for emulsifying fat. Food Technol 15:468.

Tarladgis, B. G.; Watts, B. M.; Younathan, M. T. and Dugan, L. R. (1960): A distillation method for the quantitative determination of malonaldehyde in rancid foods. J. Am. Oil Chem. Soc., 37: 44.

Thornton, H. and Gracey, J. F. (1974): Text Book of Meat Hygiene. 6th Ed., The Macmillan Publishing Co., Inc., New York.

Tolba, K. S.; Abdel-Aziz, A. S. and Niazi, Z. (1995): Chemical analysis of locally manufactured meat products. Vet. Med. J., 42 (3): 79.

Varnam, A. H. and Sutberland, P. S. (1995): Meat and Meat Products. Technology, Chemistry and Microbiology. Chapman and Hall Press Co.

Yu, L. W.; Latriauo, L.; Duncan, S.; Hartwick, R. A. and Witz, G. (1986): High-performance liquid chromatography analysis of the thiobarbituric acid abducts of malonaldehyde and trans-muconaldehyde. Anal Biochem., 156 : 326.