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GROUNDNUT OIL IMPROVES TENDERNESS, JUICINESS AND CONSISTENCY OF BEEF SAUSAGES

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ABSTRACT: *This study was conducted to determine the effects of crude groundnut oil (GO) on the storability and sensory characteristics of comminuted beef sausages. Boneless beef was thoroughly trimmed of all visible fatty and connective tissues, minced and freshly prepared GO was added during comminution to formulate sausages at three levels (5%, 10% and 15%) of oil inclusion, and compared with products formulated with only lean beef. Sensory and laboratory analyses were conducted weekly for 3 weeks. The results indicated that the GO products were more tender, juicier and smoother than sausages formulated with only lean beef. The GO products had intense groundnut flavour, no effect on flavour liking but enhanced product acceptability. In addition, the GO increased the unsaturated fatty acid content of the products, had no significant effect on lipid per-oxidation and product stability in storage. It is recommended that groundnut oil is used in beef sausages up to 15% inclusion, on weight basis for improved sensory and acceptability of the products.*

ORIGINAL ARTICLE

Keywords: *Beef sausages, vegetable fats, beef fat, sensory*

INTRODUCTION

Products from meat processing firms are widely accepted by meat consumers due to the increasing demand for convenient meals. Beef products however, have not caught on well with most consumers although such products have limited religious and tribal barriers compared with pork (Teye, 2010). This is because beef cattle in Ghana are sold at their later stages of productivity, making their meat tough and dry with little or no marbling fats. Secondly, the fat of beef is reported to be high in saturated fatty acids, which are believed to be directly related to cardiovascular risk factors (Hongbao, 2006; Sharma et al., 2011). Moreover, when the fat of beef cools, it solidifies and exhibits a "greasy" sensation in the mouth of consumers when such products are consumed (Warriss, 2010). Technologically, the hard fat has high tendency of separating from the muscles to form fat-pockets in the casings of sausages (Teye, 2010); a condition which is aesthetically not appealing.

In view of these, beef products in Ghana are made using only lean beef without fat (Teye, 2010). Meanwhile, fat is reported to play a major role in the texture, juiciness and flavour of comminuted meat products (Crehan et al., 2000). Drewnowski (1992) also reported that the sensory properties of fat make a diet flavourful and rich. Elsewhere, the fats of pork and chicken are used to substitute beef fat in comminuted beef products, as these have lower levels of saturated fatty acids than beef fat (Ambrosiadis et al., 1996). However, religious barrier against the consumption of pork hinders the use of pork fat in beef products especially in northern Ghana, as most meat consumers here are Moslems. Chicken fat is not available in large quantities for use as a substitute for beef fat.

There is therefore the need to find alternative fats which are less saturated and with better sensory characteristics than beef fat, for use in beef sausages to improve the sensory characteristics. One of such with potential for use is groundnut oil (a vegetable fat).

Vegetable fats are relatively higher in unsaturated fatty acids (65%), compared with beef fats (46%) and therefore have fewer health concerns (Paneras and Bloukas, 1994). Groundnut oil is locally extracted by market women in northern Ghana, and is used in most homes on daily basis for the preparation of various meals. The potentials of vegetable oils as fat substitutes were realized when used to substitute pork fat in low-fat frankfurters (Paneras and Bloukas, 1994).

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This work was therefore aimed at investigating the potentials of groundnut oil as fat substitute on the storability, sensory characteristics and overall acceptability of beef sausages.

MATERIALS AND METHODS

The research was conducted at the Meat Processing Unit and Laboratories of the University for Development Studies, Tamale. The Iodine Value (IV) of the fatty acids in the products was determined at the Food Laboratories of the Ghana Standards Board, Accra, Ghana.

Acquisition of vegetable oil

formulated with only lean beef (T1) as control. obtained from the local market for use. The oil was used to formulate

Sausage preparation

The single factor research design was employed in this study. Fresh boneless beef from the hindquarters of mature bulls was obtained from the Meat Processing Unit of the University for Development Studies, thoroughly trimmed of all visible connective tissues and fats, cut into smaller sizes and minced using a 5mm-sieve table top mincer (Talleres Rommon, Spain). The minced meat was divided into groups of 4kg and the oil was randomly assigned to the meats to formulate the products. Each treatment was replicated twice. The minced meat in the T2, T3 and T4 were mixed with the apportioned oils in a 10-litre plastic bowl and allowed to stand for 10 minutes before comminution, to enable the meat to absorb the oil. The following ingredients were also added in equal amounts (g/kg) to the various formulations of sausage meat: 15.0g curing salt, 0.5g red chillies, 1.0g black pepper, 1.0g white pepper and 2.0g "adobo" (pre-formulated spices). Crushed ice (1.0kg) was added during comminution to regulate the temperature, as well as attain desired consistency of meat batter. The mixture was comminuted in a 3-knife bowl chopper (Talleres Rommon, Spain) until a meat-batter temperature of 17°C was attained. The meat batter was immediately stuffed into natural casings, using a hydraulic stuffer (Talleres Rommon, Spain) and manually linked into similar length of about 10cm. The sausages were weighed and then hung on smoking racks and smoked for an hour after which they were scalded to a core temperature of 70°C. The sausages were cooled in cold water and hung on the racks again for excess water to drain. The sausages were packed in transparent polythene bags and vacuum-packed, labelled and stored in a refrigerator at 2°C for sensory and laboratory analyses at later dates.

Sensory evaluation

A total of twenty (20) panellists, comprising staff and students were randomly selected and trained according to the British Standard Institution (BSI, 1993) guidelines to evaluate the products. The sausages were thawed and warmed in an oven (Turbofan, Blue seal, UK), sliced into uniform sizes (about 2cm in length) and wrapped with coded aluminium foils and presented to the panellists. Each panellist was provided with water and pieces of bread to serve as neutralizers between the products. An eight-point category scale, as described by Keeton (1983), was used to rate the sensory characteristics of the products.

Internal colour: 1=extremely pale red; 2=very pale red; 3=moderately pale red; 4=slightly pale red; 5=slightly dark red; 6=moderately dark red; 7=very dark red; 8=extremely dark red

Tenderness: 1=extremely tough; 2=very tough; 3=moderately tough; 4=slightly tough; 5=slightly tender; 6=moderately tender; 7=very tender; 8=extremely tender

Juiciness: 1=extremely juicy; 2=very juicy; 3=moderately juicy; 4=slightly juicy; 5=slightly dry; 6=moderately dry; 7=very dry; 8=extremely dry

Consistency: 1=extremely smooth; 2=Very smooth; 3=moderately smooth; 4=slightly smooth; 5=slightly coarse; 6=moderately coarse; 7=Very coarse; 8=extremely coarse

Groundnut flavour intensity: 1=extremely strong; 2=very strong; 3=moderately strong; 4=slightly strong; 5=slightly weak; 6=moderately weak; 7=very weak; 8=extremely weak

Flavour liking/ acceptability: 1=Like extremely; 2=Like very much; 3=Like moderately; 4=Like slightly; 5=Dislike slightly; 6=Dislike moderately; 7=Dislike very much; 8=Dislike extremely;

Chemical analysis and pH of products

The sausages were analyzed for lipid per-oxidation (peroxide value), moisture, crude protein and fat contents according to the methods of the AOAC (1999). In addition, Iodine Value of the products was determined according to the methods of the ISO (1996). Analyses were conducted in triplicates; all reagents were of analytical grade. For determination of the pH, 10g samples were homogenized with 50 ml distilled water and pH value was measured with a digital pH-meter (CRISON, Basic 20).

The data obtained were analyzed using the General Linear Model (GLM) of Analysis of Variance (ANOVA) of the Minitab Statistical Package, version 15 (MINITAB, 2007). Where significant differences were found, the means were separated using Tukey Pair Wise comparison, at 5% level of significance.

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RESULTS AND DISCUSSION

Sensory evaluation of products

Table 1 - Sensory characteristics of the sausages

Parameters	T1	T2	T3	T4	SED	Sig.
Color	4.35	4.50	4.10	4.30	0.67	Ns
Tenderness	4.25^{b}	4.05^{b}	4.60^{b}	5.85^{a}	0.86	***
Juiciness	4.45^{a}	3.70^{ab}	2.8^{b}	3.40^{b}	0.74	***
Consistency	5.90^{a}	4.55^{b}	3.95^{b}	1.85^{c}	0.66	***
G'nut flavor intensity	6.25^{a}	5.20^{ab}	4.80^{b}	3.95^{c}	0.82	***
Flavor liking	2.70	2.35	2.70	2.50	0.66	ns
Overall Acceptability	3.85^{a}	3.05^{ab}	2.25^{bc}	2.05^{c}	0.85	***

SED= Standard error of difference, ^{abc}Means in the same row with different superscripts are significant ns= not Significant, *** = Significant (P<0.001), G'nut=Groundnut

The products were offered to the panellists for sensory evaluation and the results are presented in Table 1. There were no significant differences (P>0.05) in the color and flavor liking of the products (Table 1). Meat purchasing decisions are influenced more by product appearance than any other quality factor (Lawrie and Ledward, 2006); color and flavor represent perceived freshness and are of vital importance to the meat industry and meat science research (Mancini and Hunt, 2005). The similar color of the products is an indication that the use of GO will not result in beef sausages which are different from the standard products.

The GO resulted in sausages which were tenderer, juicier and with smoother consistency (P<0.001) than those formulated with only lean beef (Table 1). Tenderness is regarded as the most important sensory attribute affecting meat acceptability (Warkup et al., 1995). Tenderness has also been identified as the most critical eating quality characteristics, which determines whether consumers are repeat buyers (Lawrie and Ledward, 2006). Several research works reported an increased juiciness and tenderness with an increase in fat content in meat products (Berry and Wergin, 1993; Troy et al., 1999). Fat in meat products plays a major role in improving water holding capacity and binding properties, forming rheological and structural properties that trap moisture in the products to improve juiciness (Hughes et al., 1997; Pietrasik and Duda, 2000).

Some consumers of beef sausages describe it as tough and dry, hence do not patronize it. The GO improved the tenderness and juiciness of these products. The acceptability of the products with GO products was consequently enhanced (P<0.001).

Proximate compositions of products

Table 2 - Proximate composition of the sausages

Parameters	T1	T2	T3	T4	S.e.d.	Sig.
Moisture	76.91$_{a}$	75.69$_{a}$	71.71$_{b}$	67.98$_{c}$	0.46	***
Crude protein	20.31$_{ab}$	22.06$_{a}$	18.54$_{ab}$	17.06$_{b}$	0.96	*
Fat (ether extract)	6.44$_{b}$	10.37$_{a}$	10.61$_{a}$	11.07$_{a}$	1.49	***

^{abc}Means in the same row with different subscripts are significantly different. S.e.d=standard error of difference. sig=significance. *=significant (P<0.05). ***=significant (P<0.001)

The moisture, crude protein and fat (ether extract) contents of the products are presented in Table 2. There was a reduction in the moisture (P<0.001) and crude protein (P<0.05) contents of the products with an increase in oil inclusion. Serdaroglu and Rmencioglu (2004), observed a significant reduction in moisture content with an increase in fat level in meatballs. Dzudie et al., (2002), also reported a reduction in moisture and protein contents with increasing levels of fat in ground beef formulations.

During the comminution of meat, the muscle proteins form 3-dimensional matrices that trap moisture and fat to minimize their loss (Xiong, 1997; Warriss, 2010). Fat and moisture compete for space in the protein matrices, and therefore a higher fat content in meat will leave few muscle protein-matrices to bind water, and that could have resulted in the lower moisture content of products with GO. However, when some of the moisture is trapped in products with higher fat contents, the fat acts as a barrier to prevent the rapid loss of moisture during product storage (Pietrasik and Duda, 2000). This might have accounted for the higher level of juiciness in the experimental products, although they had lower moisture contents.

The fat levels were significantly increased with increase in oil inclusions (Table 2). The rate of increase however, did not reflect the quantities added during the product formulation. The T3 and T4 products were expected to have fat

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levels exceeding 10 and 15 percent respectively, but these were quite lower than what was expected (Table 2). This might be due to losses during cooking of the products.

Cooking of meat and meat products results in losses of fats from them (Dzudie et al., 2002). Serdaroglu and Rmencioglu (2004) reported a decrease in fat retention with an increase in fat levels in meatballs, and higher fat (Tornberg et al., 1989).

pH of products

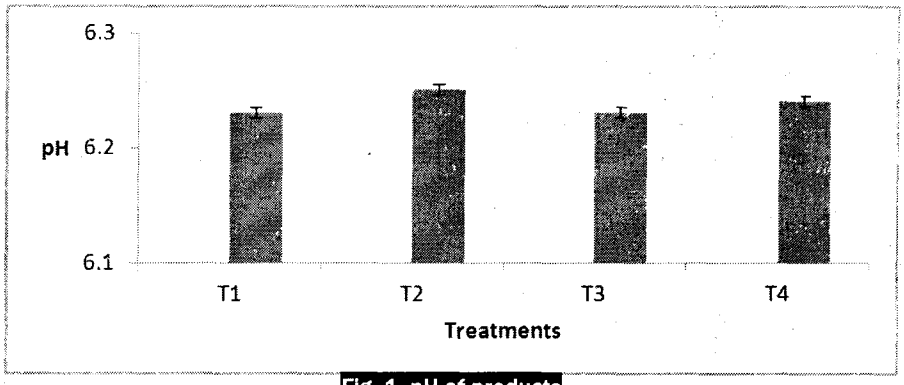

Fig. 1. pH of products

The pH of the products was taken and presented in Fig. 1. The pH of the products was not significantly different ($P>0.05$) at the various levels of GO inclusions (Fig. 1).

Several research works reported the significance of pH on microbial stability of meat products. Higher pH makes meat products susceptible to microbial attack and multiplication (Warriss, 2010). Lower pH of meat is a result of anaerobic glycolysis, where glycogen reserves in the muscles are channelled in to the production of lactic acid in cells of muscles (Incze, 1992; Lawrie and Ledward, 2006). This makes the muscles acidic and hence creates an unfavourable condition for microbial activities, thus improves their storability (Lawrie and Ledward, 2006). Since the pH of the products did not vary considerably, it is not expected that the use of groundnut oil will have an adverse effect on the microbial stability of the products.

Iodine value of fatty acids in the products

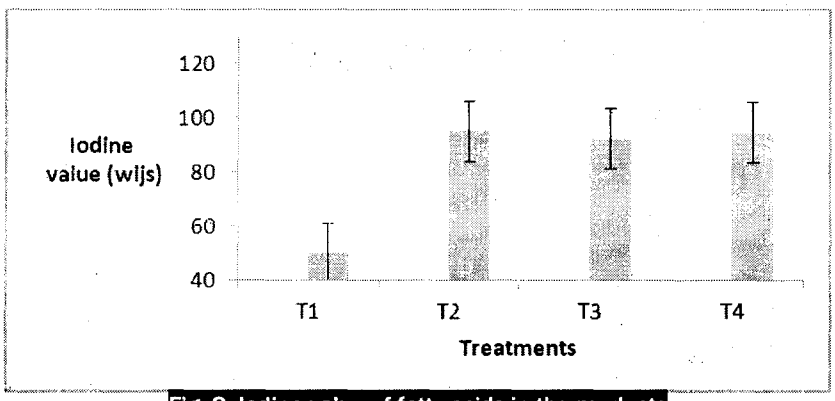

Fig. 2. Iodine value of fatty acids in the products

The iodine value (IV), which is the degree of unsaturation of fatty acids in the fats of the prepared sausages, was analyzed and the results are presented in Fig. 2. The IV of the fatty acids in the GO products was higher ($P<0.05$) than the Control products (Fig. 2). According to Wood (1984), vegetable fats are higher in unsaturated fatty acids than animal fats. The GO therefore increased the level of unsaturated fatty acids in the product.

Excessive intake of dietary saturated fatty acids has been associated with the development of hypertension, cardio-vascular diseases and obesity (Bruhn et al., 1992; Hongbao, 2006). A diet containing fats of the unsaturated fatty acids on the other hand, has been shown to be beneficial in the prevention of atherosclerosis and coronary heart

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disease (Wolfram, 2003; Russo, 2009). Long-term diets containing monounsaturated fatty acids have been shown to reduce platelet aggregation and decrease plasma LDL-cholesterol levels (Smith et al., 2003). Unsaturated fatty acids are also very essential in the body for balancing of hormones, keeping of skin and arteries supple, lubrication of joints as well as forming a component of body cells (Tabas, 2002).

Lipid per-oxidation (Per-oxide value) in the products

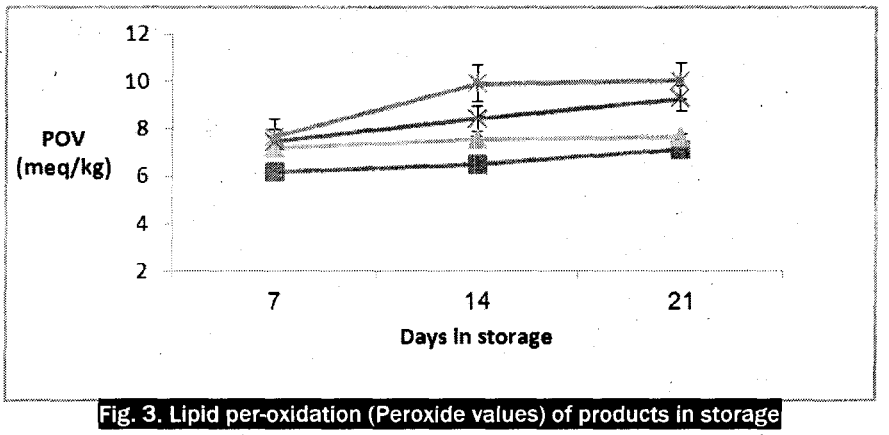

Fig. 3. Lipid per-oxidation (Peroxide values) of products in storage

The peroxide values (POVs) of the products were determined on the 7th, 14th and 21st days of storage, and the results are presented in Fig. 3. The POVs of the products ranged between a minimum of 6.17 and 10.02 mill equivalent/kg products. The POVs increased with an increase in GO inclusion in the products. The values also increased with an increase in the duration of storage.

Lipid per-oxidation in food is of importance, in that it progresses at faster rates in fats rich in unsaturated fatty acids, than those high in saturated fatty acids (Warriss, 2010). The unsaturated and polyunsaturated fatty acids present in these, react with oxygen to form fatty acid hydro-peroxides. Hydro-peroxides are unstable, and breakdown into various compounds which can produce off-flavors; leading to a stale, rancid flavor in foods (Kerler and Grosch, 1996).

Among the products however, the peroxide values were significantly lower than 25 mill equivalent/kg sausage, which is considered as the limit of acceptability in fatty foods (Evranuz, 1993; Narasimhan et al., 1986). The acceptability of the products was also not adversely affected, indicating that rancidity in the products was not pronounced.

CONCLUSIONS

The use of GO in beef sausages resulted in products which were more tender, juicier, smoother and with higher acceptability than those formulated with lean beef. The GO products had higher levels of unsaturated fatty acids, and no adverse effect on the storability of the products. It is recommended that groundnut oil is used in beef sausages up to 15% inclusion for improved product acceptability.

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REFERENCES

Ambrosiadis J, Vareltzis KP and Georgakis SA (1996). Physical, chemical and sensory characteristics of cooked meat emulsion style products containing vegetable oils. International Journal of Food Science and Technology, 31: 189-194.

AOAC International (1999). In P. Cunniff (Ed.), Official methods of analysis of AOAC International (16th ed.) Gaithersburg, MD, USA: AOAC International.

Berry BW and Wergin WP (1993). Modified pre-gelatinized potato starch in low fat ground beef patties. Journal of Muscle Foods, 4: 305–320.

British Standard Institution (1993). Assessors for sensory Analysis. Guide to Selection, Training and Monitoring of Selected Assessors. BS 17667. British Standard Institute, London, United Kingdom.

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Bruhn MC, Cotter A, Diaz-Knauf K, Sutherlin J, West E, Wightman N, Williamson E and Yaffee M (1992). Consumer Attitudes and Market Potential for Foods using Fat Substitutes; Food Technology, 46: 81–86.

Crehan CM, Hughes E, Troy DJ and Buckley DJ (2000). Effects of fat level and Maltodextrin on the functional properties of frankfurters formulated with 5, 12 and 30% fat. Meat Science, 55: 463-469.

Drewnowski A (1992). Sensory properties of fat and fat replacement. Nutrition Reviews 50(4), 17-20.

Dzudie T, Scher J and Hardy J (2002). Common bean flour as an extender in beef sausages. Journal of Food Engineering, 52: 143–147.

Evranuz ÖE (1993). The effects of temperature and moisture content on lipid peroxidation during storage of unblanched salted roasted peanuts: shelf life studies for unblanchedsalted roasted peanuts. International Journal of Food Science and Technology, 28: 193–199.

Hongbao M (2006). Cholesterol and Human Health. The Journal of American Science, 2 (1): 46-50.

Hughes E, Cofrades S and Troy DJ (1997). Effects of fat level, oat fiber and carrageenan on frankfurters formulated with 5%, 12% and 30% fat. Meat Science, 45 (3): 273–281.

Incze K (1992). Raw fermented and dried meat products. Fleischwirtschaft 72: 58–62.

ISO (1996). International Organization for Standardization. Experiment number, 3961.

Keeton JT (1983). Effect of fat and NaCl/phosphate levels on the chemical and sensory properties of pork patties. Journal of Food Science, 48: 879-881.

Kerler J and Grosch W (1996). Odorants contributing to warmed-over flavour (WOF) of refrigerated cooked beef. Journal of Food Science, 61: 1271–1274.

Lawrie RA and Ledward DA (2006). Lawrie's Meat Science, 7th edition, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge CB1 6AH, England. 442 pages.

Mancini RA and Hunt MC (2005). Current research in meat colour, Meat Science, 71 (1): 100–121.

MINITAB (2007). Minitab Statistical Software, release 15 for Windows 95/98/2000/XP and Windows NT. Minitab Inc, USA.

Narasimhan S, Raghuver KG, Arumngham C, Bhat KK and Sen DP (1986). Oxidative rancidity of groundnut oil evaluation by sensory and chemical indices and their correlation. Journal of Food Science and Technology, 23: 273–277.

Paneras ED and Bloukas JG (1994). Vegetable oils replace pork back fat for low-fat frankfurters. Journal of Food Science, 59: 725–728, 733

Pietrasik Z and Duda Z (2000). Effect of fat content and soy protein/carragenan mix on the quality characteristics of comminuted, scalded sausages. Meat Science, 56: 181–188.

Russo GL (2009). Dietary n-6 and n-3 polyunsaturated fatty acids: From biochemistry to clinical implications in cardiovascular prevention, Biochemical Pharmacology, 77 (6): 937–946.

Serdaroglu M and Rmencioglu OD (2004). Effects of fat level (5%, 10%, 20%) and corn flour (0%, 2%, 4%) on some properties of Turkish type meatballs (koefte). Meat Science, 68 (2): 291-296.

Sharma K, Mendiratta SK and Sharma BD (2011). Physico-chemical, sensory and lipid profile of low-fat chicken nuggets incorporated with carrageenan as fat replacer. International Journal of Meat Science, 1: 70-76.

Smith RD, Kelly CN, Fielding BA, Hauton D, Silva KD, Nydahl MC, Miller GJ and Williams CM (2003). Long-term monounsaturated fatty acid diets reduce platelet aggregation. British Journal of Nutrition, 90: 597-606.

Tabas I (2002). Cholesterol in Human Health and Disease. Journal of Clinical Investigations, 110: 583-590

Teye GA (2010). The Meat Processing Industry in Ghana. Development Spectrum, Vol. 3(1) 21-31.

Tornberg E, Olsson A and Persson K (1989). A comparision in fat holding between hamburgers and emulsion sausages. In Proceedings of the 35th International Congress on Meat Science and Technology (pp. 753–757), Denmark: Kopenhagen.

Troy DJ, Desmond EM and Buckley DJ (1999). Eating quality of low-fat burgers containing fat replacing functional blends. Journal of Food Science and Agriculture, 79: 507–516.

Warkup CC, Marie S and Harrington G (1995). Expression of Tissue Proteinases and regulation of Protein degradation as related to Meat Quality. Ed. A. Quali D., Demeyer and F.J.M. Smulders. Eccainst. Ultrechit. The Netherlands, pp: 225-231.

Warriss PD (2010). Meat Science, An Introductory Text (2nd Edition). CAB International, Wallingford Oxfordshire, OX10 8DE, UK. 234 pages

Wolfram G (2003). Dietary fatty acids and coronary heart disease. European Journal of Medical Research, 8: 321-324.

Wood JD (1984). Fat Deposition and the Quality of Fat Tissue in Meat Animals. In: Fats in Animal Nutrition (ed J. Wiseman) Butterworths, London, pp 407–435.

Xiong Y (1997). Structure-function relationships of muscle proteins. In: Damodaran, S. and Paraf, A., Editors. Food proteins and their applications, Marcel Dekker, New York, pp. 341–392.

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