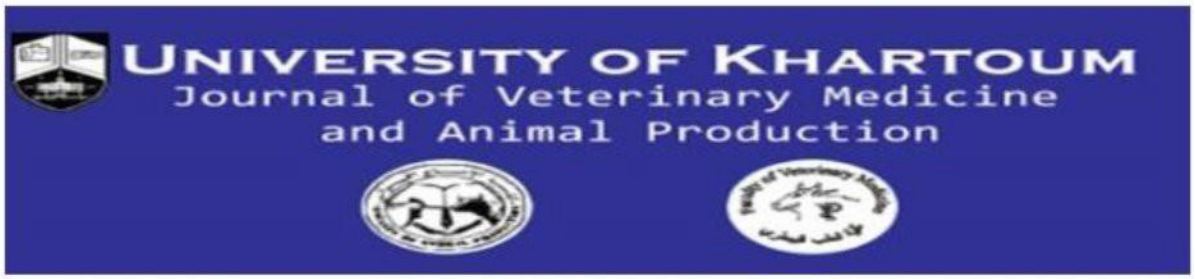
U. of K. J. Vet. Med. Anim. Prod., Vol.8, Issue 2 (2017) p 106 -111
ISSN: 243456



Fat Content and Fatty acid Composition of Goat Meat at Retail Outlets in Khartoum state, Sudan

Kamal. M. Abuelfatah*, Mayada. F. Ibrahim, Salih. A. Babiker

Department of Meat Production, Faculty of Animal Production, Khartoum University, Sudan

*****Corresponding Author: kamalabu@hotmail.com

Abstract

The objective of this study was to evaluate fat content and fatty acid (FA) composition of goat meat and adipose tissues at retail outlets in Khartoum State. A total of 25 carcasses of goat were involved in this study. Samples from *longissimus dorsi* muscle (LD), kidney fat (KF), and subcutaneous fat (SF) were obtained from each carcass for fat extraction and FA analysis. The fat contents were 78.21, 73.76 and 3.6% for KF, SF and LD, respectively. The most abundant FA were oleic, palmitic, and stearic. Oleic was higher (P<0.05) in LD (30.04%) than in SF (25.29%) and KF (17.86%). The stearic was greater (P<0.05) in KF (28.04%) compared to SF (27.29%) and LD (25.37%). Palmitic was higher (P<0.05) in KF (29.54%) than in SF (25.32) and LD (20.8%). The linoleic acid and α-linolenic acids were higher (P<0.05) in LD to compared SF and KF. The total desirable FA, which comprise of stearic acid plus total unsaturated FA were greater (P<0.05) in LD (72.05%), followed by SF (60.86%), and the least proportion (50.7%) was found in KF.

Key words: *Fat, fatty acids, goat*

المستخلص

أُجريت هذه الدراسة لتقييم محتوى الدهن و الأحماض الدهنية في اللحم و الإنسجة الدهنية للماعز في منافذ بيع اللحوم بالتجزئية في ولاية الخرطوم. أخذت عينات من الجزء الصدري العضلة الطولية الظهرية و من النسيج الدهني تحت الجلد و حول الكلى من عدد 25 ذبيحة لتحديد محتوها الدهن و الاحماض الدهنية. أوضحت النتائج أن نسبة الدهن كانت 78.21 و 73.76 و 3.60% فى النسيج الدهوني حول الكُلى و تحت الجلد و في العضلة الظهرية على التوالي. أكثر الاحماض الدهنية شيوعاً في الانسجة المختلفة كان الاوليك و البالمتيك و الاستيريك. أعلى نسبة لحمض الاوليك (30.04%) كانت في العضلة الظهرية ثم فى بالدهن تحت الجلد (25.29%) واقل نسبة كانت في دهن حول الكلى (17.8%) مع وجود فروقات معنوية ($p < 0.05$) بين الانسجة المختلفة. نسبة الإستيريك كانت أعلى معنوياً في الدهن حول الكُلى (28.08%) مقارنة بدهون تحت الجلد (27.29%) و العضلة الظهرية (25.37%). نسبة حمض البالمتيك كانت أعلى فالدهن حول الكُلى (29.54%) مما في الدهن تحت الجلد (25.32%) و العضلة الظهرية (20.8%) مع وجود فرقات معنوية بين الانسجة المختلفة. كانت نسبة حمض اللينوليك والفا- لينولينيك أعلى ($P < 0.05$) في العضلات مقارنة بالدهن تحت الجلد و حول الكُلى. المجموع الكلي للأحماض الدهنية المرغوب فيها والتي تتألف من حمض الأستيريك بالاضافة الى الاحماض الدهنية غير المشبعة، كان أعلي ($P < 0.05$) في العضلة الطولية الظهرية (72.05٪)، ثم في الدهن تحت الجلد (60.86٪)، وأقل نسبة (50.7٪) وجدت في الدهن حول الكُلى مع وجود فروقات معنوية بين الانسجة المختلفة.

كلمات مفتاحية: *الدهون، الاحماض الدهنية، الماعز*

Introduction

Sudan has large goat population, which is estimated in the year 2015 to be about 31.3 million heads. A bout 12.9 million heads of goats are slaughtered annually for local consumption and export (MARF., 2015). The mentioned numbers showed the important role of goat meat in the diet. Although goat meat is considered inferior to mutton and beef, it is widely consumed in the tropics and sub-tropics. In fact, in recent decades, goat meat has gained a growing demand due to its preferable nutritional features, as its low levels of fat and cholesterol (Madruga and Bressan, 2011), and a higher level of polyunsaturated fatty acids (PUFA) compared to beef or lamb (Banskalieva *et al.,* 2000).

Fat is an important constituent of animal tissues, and has significant effects in both nutritional value and quality of meat. Fatty acids (FAs) are the main component of fats. Type of FAs (saturated, monounsaturated or polyunsaturated) determines the physical properties and nutritional importance of fat. The carbon chain length and degree of saturation affect the solderability and palatability. Saturated fatty acids (SFA) are solid at room temperature and unsaturated fats (USFA) readily oxidize causing rancidity.

Animal fat has a bad reputation, and associated with obesity, cardiovascular disease (CVD), and inflammatory diseases (McAfee *et al.*, 2010). However, the effect of fat in diet depends much upon its FA composition rather than the fat quantity. Saturated and *trans*FAs are a risk factor for CVD, and promote inflammation (Garg and Wood, 2013). On the other hand, PUFA have been associated with physiological and health benefits, such as reducing the incidence of CVD, atherosclerosis, hypertension (Adkins and Kelley, 2010), some cancers, inflammatory diseases (Laviano *et al.*, 2013); in addition to improve eye and brain development (Hooper *et al.*, 2006).

Many factors affect the FA composition of animal tissues, such as: genetic variability (Werdi Pratiwi *et al.*, 2006), sex (Mahgoub *et al.*, 2002) and anatomical locations of tissues (Abuelfatah *et al.*, 2014). However, diet is generally considered to be the most important factor affecting the FA composition of animal tissues (Banskalieva *et al.*, 2000; Raes *et al.*, 2004; Woods and Fearon, 2009). In spite of the importance of goats as meat animals in Sudan, there is no available information about FA composition of their meat. Therefore, the objective of this study was to evaluate fat content and FA composition of goat meat at retail outputs in Khartoum State, Sudan.

Materials and Methods

Samples Collection

A total of 25 goat carcasses, obtained from Khartoum state markets during October and November 2016, were used in this study.
Samples were taken from *longissimus dorsithoracis* muscle (LD*)*, kidney fat (KF) and subcutaneous fat (SF) (from the back between the 11^{th} and the 12^{th} ribs) were taken from each carcass. All the tissues were then packaged and kept at -18 °C.

Lipid extraction and fatty acids analysis

The total FAs were extracted from samples based on the method of Folch *et al.,* (1957) using chloroform–methanol 2:1 (v/v). About 1 g of fresh muscle or fat was used. FAs were transmethylated to their FA methyl esters (FAME) using 0.66 N KOH in 14% methanol and methanolic boron trifluoride (BF3) according to the methods of AOAC (2007). The qualitative of the FAs was carried out by using GC/MS technique model (GC/MS-QP2010-Ultra), Simadzu Company, Japan, with capillary column

(Rtx-5ms-30 m × 0.25mm × 0. 25µm). The sample was injected by using split mode, heliumas the carrier gas passed with flow rate 1.61 ml/min. The temperature program was started from 60 ^{0}C with a rate of 10 ^{0}C /min to 300 ^{0}C as a final temperature degree. The injection port temperature was 300 ^{0}C the ion source temperature was 200 ^{0}C and the interface temperature was 250 ^{0}C. The sample was analyzed by using scan mode in the range of m/z 40- 550 charges to ratio and the total run time was 24 minutes. A reference standard (mix C4–C24 methylesters; Sigma–Aldrin, Inc., St. Louis, Mo, USA) was used for determining individual FA.

Statistical Analysis

Data were analyzed using SPSS program (version 13). One-way ANOVA was used to compare differences between fat content and fatty acid composition of goat tissues. Duncan's multiple range test was employed to detect significant between means. Differences between the least squared means were considered to be significant at P<0.05.

Result and discussion

The result of fat content is illustrated in Figure 1. The highest percentage of fat content (78.21%) was found in kidney fat, followed by subcutaneous fat (73.76%), whereas the lowest fat content (3.6%) was found in LD muscle. The fat content of goat muscle in this study was higher than that reported before by Babiker*et al*. (1990) in Sudanese goats. However, Mahgoub *et al.*, (2002) reported higher percentage of fat in Omani goat muscle (4.4% - 6%). The percentages of fat in goat adipose tissues were in the range reported previously (Mahgoub *et al.*, 2002). However, factors as genetic and nutrition can affect fat content in animal tissues.

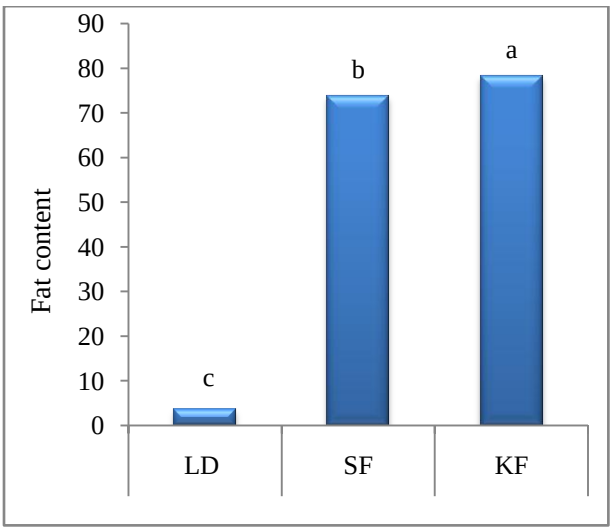


Figure 1: Fat content of muscle (LD), subcutaneous (SF) and kidney fat (KF) of goats

Bars with different alphabet notation differ significantly.

Results of FA composition of different goat tissues are presented in Table 1, different individual fatty acids have been found to have different effects on human health. Myristic (C14:0) and palmitic (C16:0) increase plasma low density lipoprotein (LDL) cholesterol, a main risk factor for cardiovascular diseases in human, although stearic (C18:0) has a neutral effect (Ohlsson, 2010). In this study, the most abundant FAs in the goat tissues were oleic acid (30.04-17.86%), palmitic acid (29.54-20.87%), and stearic acid (28.04-25.37%). This result was comparable to those reported in goat previously (Banskalieva *et al.*, 2000; Mahgoub *et al.*, 2002; Abuelfatah *et al.*, 2014). The proportion of palmitic acid was significantly differed among the goat tissues; however, the higher percentage found in KF and SF compared to LD. In contrast, the highest proportion of oleic acid (30.04%) was scored by LD, followed by SF (25.29%) and the least proportion (17.86%) recorded in KF. The stearic acid was significantly greater in KF (28.04%) compared to LD (25.37%) and SF (27.29%). These results are comparable to those

reported by Mahgoub *et al.*, (2002) and Abuelfatah *et al.*, (2014). Variation in FA composition between different goat tissues has been reported in many studies (Mahgoub *et al.*, 2002; Wood *et al.*, 2004; Horcada *et al.*, 2012; Abuelfatah *et al.*, 2014).

The proportions linoleic and α-linolenic acids, which constituted the total PUFA, were significantly higher in LD compared to KF and SF. Only these two PUFAs are known to be essential for humans as they cannot synthesis these two FAs or convert one to the other (Holman *et al.*, 1982). Generally, PUFA are higher in intramuscular fat rather than in other fat depots (Banskalieva *et al.*, 2000).

Table 1: Fatty acid composition of muscle, subcutaneous and kidney fats of goats

	Tissue[1]		
	LD	**SF**	**KF**
Fatty acid (%) of total fatty acids			
C10:0 carpic	0.30[b]	0.22[b]	1.83[a]
C12:0, lauric	0.27[c]	0.69[b]	1.31[a]
C14:0, myristic	6.14[c]	8.59[b]	10.43[a]
C15:0, pentadecanoic	0.60[c]	0.72[b]	1.88[a]
C15:1, pentadecanoic	1.88[a]	0.71[b]	0.46[c]
C16:0, palmitic	20.87[c]	25.32[b]	29.54[a]
C16:1, palmitoleic	1.95[b]	2.39[a]	1.02[c]
C17:0, heptadecanoic	0.77[b]	3.6[a]	4.31[a]
C17.1, heptadecenoic	4.56[a]	1.74[b]	0.39[c]
C18:0, stearic	25.37[b]	27.29[b]	28.04[b]
C18:1 n-9, oleic	30.04[a]	25.29[b]	17.86[c]
C18:2 n-6, linoleic	5.77[a]	2.96[b]	2.66[b]
C18:3 n-3, linolenic	1.48[a]	0.48[b]	0.27[c]
C20:0, arachidonic	0.48[b]	0.58[b]	2.29[c]
SFA[2]	54.32[c]	66.43[b]	77.34[c]
UFA[3]	45.68[a]	33.57[b]	22.66[c]
MUFA[4]	38.43[a]	30.13[b]	19.73[c]
PUFA[5]	7.25[a]	3.44[b]	2.93[c]
Desirable FA[6]	72.05[a]	60.86[b]	50.7[c]
UFA/SFA	0.84[a]	0.51[b]	0.29[c]
PUFA/SFA	0.13[a]	0.05[b]	0.04[b]

[1] LD= *longissimus dorsi* muscle, SF= subcutaneous fat, KF= kidney fat

[2] SFA (saturated fatty acids) = C10+C12:0 +C14:0+C15:0+C16:0+C17:0+ C18:0+C20.

[3] UFA (unsaturated fatty acids) C15:1+ C16:1 + C17:1 + C18:1n-9 + C18:2 n-6 + C18:3 n-3.

[4] MUFA (monounsaturated fatty acids) = C15:1+C16:1+C17:1+C18:1 n-9

[5] PUFA = C18:3 n-3 + C18:2 n-6.

[6] Desirable FA= C18:0+MUFA+PUFA.

The proportions of SFA in SF and KF were higher than in LD, with the SFA being much greater in the KF than in the SF. These results are similar to those reported by Mahgoub *et al.*, (2002) in Omani goats. Contrary, total UFAs were greater in LD (45.68%) than SF (33.57%) and KF (22.66%). Similarly, MUFA were

significantly higher in LD (38.43%), then in SF (30.13%) and the least percentage (19.73%) in KF.

The total percentage of desirable FAs, which comprise of stearic acid plus total MUFA (Huerta-Leidenz *et al.*, 1991), was significantly greater in LD (72.05%), followed by SF (60.86%), and the least proportion (50.7%) was exhibited by KF. The values of desirable FAs of LD in the current study were higher than that reported by Santos *et al.*,(2007). However, other study reported values ranging from 66.2 to 72.3% (Horcada *et al.*, 2012).

The UFA: SFA and PUFA:SFA ratios are usually used as an indicator to judge the nutritional value of fat food. The UFA: SFA ratio is typically used to express the saturation: unsaturation index of fat. In this study, the UFA: SFA ratio was significantly different among goat tissues. The highest ratio (0.84) was found in LD, and the least ratio (0.29) in KF, while in SF lit was in between (0.51). These values were less than those reported by Mahgoub *et al.* (2002), which were 1.0, 0.82 and 0.44 for muscle, SF fat and KF, respectively.

The PUFA: SFA ratio of goat tissues was 0.13, 0.05, and 0.04 for LD, SF and KF, respectively, and it was significantly higher in muscle compared to adipose tissues. The recommended ratio of PUFA: SFA in human diets according to the British Department of Health, (1994) is >0.45; however, the ratio in meat is found to be around 0.1 (Enser *et al.*, 1998).

Conclusion

From the present study, it can be concluded that goat meat in retail outlets in Khartoum state contained a high level of desirable fatty acids. Subcutaneous fat is less harmful than kidney fat because it contained higher levels of unsaturated and desirable fatty acids compared to kidney fat.

References

Abuelfatah, K., Zakaria, M. Z. A. B., Meng, G. Y., and Sazili, A. Q. (2014). Changes in Fatty Acid Composition and Distribution of N-3 Fatty Acids in Goat Tissues Fed Different Levels of Whole Linseed. *The* Sci. World J., 2014, Article ID 934154.

Adkins, Y. and Kelley, D. S. (2010). Mechanisms underlying the cardioprotective effects of omega-3 polyunsaturated fatty acids. J. Nutr. Biochem., 21: 781-792.

AOAC. (2007). Official Methods of Analysis, edited by K. Herlick, Association of Official Analytical Chemists, Arlington, Va, USA, 15th edition. In.

Babiker, S. A., El Khider, I. A. and Shafie, S. A. (1990). Chemical composition and quality attributes of goat meat and lamb. Meat Sci., 28: 273-277.

Banskalieva, V., Sahlu, T., and Goetsch, A. (2000). Fatty acid composition of goat muscles and fat depots: a review. Small Rumin. Res., 37: 255-268.

British Department of Health (1994). Nutritional aspects of cardiovascular disease. Report on Health and Social Subjects No. 46. London: HMSO

Enser, M., Hallett, K., Hewett, B., Fursey, G., Wood, J. and Harrington, G. (1998). Fatty acid content and composition of UK beef and lamb muscle in relation to production system and implications for human nutrition. Meat Sci., 49: 329-341.

Folch, J., Lees, M. and Sloane-Stanley, G. (1957). A simple method for the isolation and purification of total lipids from animal tissues. J. Biol.Chem., 226: 497-509.

Garg, M. L. and Wood, L. G. (2013). Nutrition and Physical Activity in Inflammatory Diseases: CABI.

Holman, R. T., Johnson, S. B. and Hatch, T.

F. (1982). A case of human linolenic acid deficiency involving neurological abnormalities. Am.J.Clin.Nutr., 35: 617-623.

Hooper, L., Thompson, R. L., Harrison, R. A., Summerbell, C. D., Ness, A. R., Moore, H. J.,Worthington, H. V., Durrington, P. N., Higgins, J. P. and Capps, N. E. (2006). Risks and benefits of omega 3 fats for mortality, cardiovascular disease, and cancer: systematic review. Brit. Medical J., 332: 752.

Horcada, A., Ripoll, G., Alcalde, M. J., Sañudo, C., Teixeira, A. and Panea, B. (2012). Fatty acid profile of three adipose depots in seven Spanish breeds of suckling kids. Meat Sci., 92: 89-96.

Huerta-Leidenz, N., Cross, H., Lunt, D., Pelton, L., Savell, J. and Smith, S. (1991). Growth, carcass traits, and fatty acid profiles of adipose tissues from steers fed whole cottonseed. J.Animal Sci., 69: 3665-3672.

Laviano, A., Rianda, S., Molfino, A. and Fanelli, F. R. (2013). Omega-3 fatty acids in cancer. Curr. Opin. Clin. Nutr. Metab. Care, 16: 156-161.

Madruga, M. S. and Bressan, M. C. (2011). Goat meats: Description, rational use, certification, processing and technological developments. Small Rumin. Res., 98: 39-45.

Mahgoub, O., Khan, A., Al-Maqbaly, R., Al-Sabahi, J., Annamalai, K. and Al-Sakry, N. (2002). Fatty acid composition of muscle and fat tissues of Omani Jebel Akhdar goats of different sexes and weights. Meat Sci., 61: 381-387.

MARF. (2015). Ministry of Animals Resources and Fishers, Information Center. In. Khartoum, Sudan.

McAfee, A. J., McSorley, E. M., Cuskelly, G. J., Moss, B. W., Wallace, J. M. ., Bonham, M. P. and Fearon, A. M. (2010). Red meat consumption: An overview of the risks and benefits. Meat Sci., 84: 1-13.

Ohlsson, L. (2010). Dairy products and plasma cholesterol levels. Food Nutr. Res., 54: 5124.

Raes, K., De Smet, S. and Demeyer, D. (2004). Effect of dietary fatty acids on incorporation of long chain polyunsaturated fatty acids and conjugated linoleic acid in lamb, beef and pork meat: a review. Anim. Feed Sci. Technol., 113: 199-221.

Santos, V., Silva, A., Cardoso, J., Silvestre, A., Silva, S., Martins, C. and Azevedo, J. M. T. d. (2007). Genotype and sex effects on carcass and meat quality of suckling kids protected by the PGI "Cabrito de Barroso". Meat Sci., 75: 725-736.

Werdi Pratiwi, N. M., Murray, P. J., Taylor, D. G. and Zhang, D. (2006). Comparison of breed, slaughter weight and castration on fatty acid profiles in the longissimus thoracic muscle from male Boer and Australian feral goats. Small Rumin. Res., 64: 94-100.

Wood, J. D., Enser, M. B., Richardson, R. I. and Whittington, F. M. (2007). Fatty acids in Meat and Meat Products. In C. K. In Chow (Ed.), Fatty acids in foods and their health implications. pp. 87-107: CRC Press.

Wood, J. D., Richardson, R. I.,Nute, G. R., Fisher, A. V., Campo, M. M., Kasapidou, E., Sheard, P. R. and Enser, M. (2004). Effects of fatty acids on meat quality: a review. Meat Sci., 66: 21-32.

Woods, V. B. and Fearon, A. M. (2009). Dietary sources of unsaturated fatty acids for animals and their transfer into meat, milk and eggs: A review. Livestock Sci., 126: 1-20.