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The Effect of Different Weaning Ages on Fatty Acid Composition in Rack Joint of Male Kids

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Abstract: The present study aimed to determine the effect of different weaning ages on the fatty acid composition and nutritional value of rack joints (6th-12th ribs) of male Akkeci (white goat) kid carcasses. The study consisted of 15 heads of kids weaned at 45, 60 and 75 days of age. All kids were slaughtered when they reached approximately 27 kg commercial slaughter weight. There were no significant differences in nutritional value or collagen content among the groups. C 14:0 content was significantly higher in the group of kids weaned at 75 days ($p<0.05$) when compared to other groups whereas C 17:0 content was significantly higher in the group weaned at 45 days ($p<0.05$). There were no significant differences in total saturated and unsaturated fatty acids of rack joint fat tissue among groups. However, kids weaned at 45 and 60 days of age had significantly higher total mono-unsaturated fatty acids than those weaned at 75 days ($p<0.05$). C 18:1 content ($p<0.05$) greatly affected the differences in mono unsaturated fatty acids among groups. In conclusion, contents of some fatty acids in kid rack joints may be affected by differences in milk and concentrate consumption resulting from differences in weaning ages.

Key words: Fatty acid composition, goat meat, rack joint, weaning age, commercial slaughter weight

INTRODUCTION

Varying high protein and fat contents make meat one of the most important foods in human societies. Recently, quantity and quality of meat yields has begun to attract significant attention in both developed and developing countries. Changes in socio-economic structures have directed customers with the greatest purchasing power to healthier food products. One of the most important health issues in this regard has to do with levels of fat and saturated fatty acids in the meat of farm animals because of the known relationship between saturated fatty acid consumption and cardiovascular diseases. The meat of ruminant farm animals contains higher levels of saturated fatty acids and lower levels of unsaturated fatty acids than the meat of non-ruminants.

This is due mainly to the mechanism of biohydrogenation, whereby unsaturated fatty acids are saturated by rumen microorganisms. As a result, the body fat composition of ruminants is less dependent on diet composition when compared to non-ruminants (Church, 1993). During the weaning period, ruminants are at the pre-ruminant phase and must rely upon milk for nutrition. As a result, until their rumen functions become efficient, their body fat tissue composition and fat storage is affected by the fatty acid composition in milk (Bas and Morand-Fehr, 2000; Juarez *et al*., 2008). After the weaning period their rumens begin to function more efficiently and their feed composition changes.

As a result, the composition of their tissue fatty acids change and new fatty acid varieties are formed. Saturated fatty acid ratios in body fat vary among animal species and races and are influenced by a number of additional factors that include animal age and sex, type and anatomical location of fat storage, composition of rations and breeding system which includes decisions regarding weaning age. The aim of this study was to determine the effect of different weaning ages on the fatty acid composition of kid rack joints (6th-12th ribs).

MATERIALS AND METHODS

The present study comprised 30 male Akkeci (Saanen x Kilis (B_1)) crossbred kids divided into three groups of 10 kids weaned at 45, 60 and 75 days, respectively. The extended kidding period allowed kids born early, middle and late in the period to be weaned at 75, 60 days and 45 days, respectively so that the fattening period of all

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Table 1: Gas chromatography machine conditions and equipments

Gas chromatography machine	Thermo quest trace 2000
Detector	FID (Flame Ionization Detector)
Colon	Fused Silica capillar colon DB-23,30 m x 0.25 mm id and 0.25 mm film thickness
Transporter gas	N_2 (1.0 mL min^{-1})
Split ratio	1.80
Temprature	
Injection block	240°C
Colon	190°C
Detector	240°C

three groups could be initiated simultaneously. All kids were kept with their mothers and allowed unrestricted access to milk. Kids were introduced to feed concentrate (12.02 MJ kg^{-1} DM and 18% CP) at between 10-15 days of age. During fattening periods, groups were fed 200 g alfalfa hay/head/day and *ad libitum* concentrate (10.6 MJ kg^{-1} DM and 16.6% CP). The fattening periods for kids in the 45, 60 and 75 day groups were 80, 65 and 50 days, respectively. All kids were slaughtered when they reached approximately 27 kg commercial slaughter weight and an average age of 125 days. At the end of the fattening period, 5 kids from each group were chosen randomly. Carcasses were chilled to 4°C over a 24 h period. Rack joints (6th-12th ribs) were separated from subcutaneous fat and bones were dissected from carcasses. Samples were grinded to achieve homogeneity.

Rack joint samples were analyzed for dry matter, ash, crude protein, crude fat (AOAC, 1990) and collagen (Yang and Froning, 1992) concentrations. About 10 g of minced meat sample was extracted based on a modification of the procedure used by Folch *et al.* (1957). The methylation process was assigned based on Basturk *et al.* (2007). Gas chromatography was used to measure methyl ester ratios to determine the composition of fatty acids according to the AOAC (1990). Chromotagraph specifications are shown in Table 1. One-way ANOVA was conducted following the General Linear Models procedure using the statistical software package MINITAB 13.1. Tukey's test was used to determine differences among groups (Steel *et al.*, 1997). The following statistical model was used for the analyses of each measurement.

$$Y_{ij} = \mu + a_i + e_{ij}$$

Where:

- Y_{ij} = Individual observation
- μ = General mean
- a_i = Effect of ith weaning ages (i = 1, 2, 3)
- e_{ij} = Residual error normally distributed with mean 0 and variance σ_e^2

RESULTS AND DISCUSSION

The chemical composition of rack joints is shown in Table 2. Weaning age was found to have no significant effect on chemical composition. Findings regarding the chemical composition of rack joints in this study were generally in line with those of Kor (1997), Tomek and Serdaroglu (1998), Dhanda *et al.* (1999), Marinova *et al.* (2001), Tshabalala *et al.* (2003), Rao *et al.* (2003), Paleari *et al.* (2003), Abdullah and Musallam (2007) and Lee *et al.* (2008) with the exception of fat contents. Fat contents reported in the literature range widely from 1.3% (Lee *et al.*, 2008) to 13.93% (Kor, 1997). Although, collagen plays an important role in tissue formation and integrity, it is indigestible by humans and thus considered to contain no nutritional value.

Table 2: Chemical composition and collagen percentages of the rack joints

Items	45 days	60 days	75 days	p
Moisture	72.65±0.43	72.97±0.46	73.48±0.53	ns
Protein	18.55±0.26	18.46±0.47	18.08±0.37	ns
Fat	7.51±0.26	7.24±1.59	7.22±0.95	ns
Ash	1.00±0.01	1.03±0.01	1.04±0.04	ns
Collagen	6.85±0.57	6.14±0.42	6.62±0.86	ns

ns: not significant (p>0.05)

Table 3: Fatty acid compositions of the rack joints of groups

Fatty acids (%)	45 days	60 days	75 days	p
C 14:0	3.15±0.345[a]	3.25±0.348[a]	4.73±0.316[b]	**
C 14:1	0.24±0.046[a]	0.38±0.046[b]	0.36±0.042[ab]	*
C 15:0	0.63±0.050	0.61±0.051	0.72±0.046	ns
C 15:1	0.25±0.033	0.20±0.033	0.25±0.030	ns
C 16:0	23.07±0.535	22.86±0.540	24.35±0.490	ns
C 16:1	2.29±0.232[a]	3.09±0.234[b]	3.02±0.213[b]	*
C 17:0	1.74±0.096[a]	1.52±0.075[b]	1.54±0.088[ab]	*
C 17:1	1.47±0.088[ab]	1.70±0.088[a]	1.34±0.080[b]	ns
C 18:0	12.74±0.770	11.64±0.777	11.89±0.706	ns
C 18:1	46.10±0.800[a]	45.94±0.807[a]	42.65±0.733[b]	**
C 18:2	3.08±0.628	4.10±0.633	3.65±0.575	ns
C 18:3	0.57±0.114	0.81±0.115	0.83±0.104	ns
C 20:4	0.26±0.233	0.96±0.235	0.75±0.214	ns
Others	4.37±0.571	2.89±0.576	3.87±0.523	ns
SFA	41.33±1.193	39.89±1.120	43.24±1.093	ns
MUFA	50.37±0.855[a]	51.33±0.863[a]	47.64±0.783[b]	*
PUFA	3.92±0.871	5.88±0.879	5.24±0.798	ns
PUFA/SFA	0.10±0.023	0.14±0.023	0.12±0.021	ns

[a, b]Data shown in the same row with a different letter denotes a significant difference *p<0.05, **p<0.01, ns: not significant; SFA: Saturated Fatty Acids, UFA : Unsaturated Fatty Acids, MUFA: Monounsaturated Fatty Acids, PUFA: Polyunsaturated Fatty Acids

However, collagen content of meat and meat products is used as an indicator of protein quality (Oztan, 1999). The collagen tissue content was not found significantly different between groups in the study. The fatty acid composition of rack joints is shown in Table 3. The 75-day group had higher C 14:0 than other groups. Because kid rumens are non-functional (Banskalieva *et al.*, 2000) during the suckling period, the fatty acid composition of kid adipose tissue during this period is dependent upon the fatty acid composition of milk fat. Bas and Morand-Fehr (2000) and Valesco *et al.* (2004) and Juarez *et al.* (2008) reported that the fatty acid composition of adipose tissue in lambs reflected the fatty acid composition of milk which is richer in C 14:0 and C 16:0 in comparison to most post weaning diets. Bas and Morand-Fehr (2000) found higher C 14:0, C 16:0 and C 18:1 ratios and lower C 18:0, C 18:2 and C 18:3 ratios in the tissue of lambs slaughtered during suckling when compared to that of lambs slaughtered after weaning. Todaro *et al*. (2006) reported that total SFA of pelvic fat of kids that consumed only milk than kids have starter concentrate in suckling period. In this study, the significantly higher C 14:0 ratios found in the 75 days group which was weaned latest of the three experimental groups is an indication of the effect of the fatty acid composition of milk ingested during the suckling period on the composition of kid rack joints. However, there were no significant differences between 45 and 60 days groups for C 14:0. Branched chain fatty acids differed significantly among the groups ($p<0.05$) with significantly higher C 17:0 ratios in the 45 days group and significantly higher C 17:1 ratios in the 60 days group.

The presence of odd chain fatty acids such as C15, branched chain fatty acids such as C 17 and cis and trans-isomer fatty acids in the adipose tissue of ruminants is a result of microbial synthesis and modifications that take place in the rumen (Church, 1993). Cifuni *et al*. (2000) reported that saturated fatty acids ratios increased in line with rumen development and live weight. In the study, the 45 and 60 days group which were weaned earlier than the 75 days group and may therefore be presumed to have had higher rumen development, also had significantly higher C 17:0 and C 1:.1 fatty acid ratios than the 75 days group. C15:0 ratios did not differ significantly among groups. In Table 4, correlations of fatty acid composition obtain from all groups for evaluate the general tendencies according to changes in rumen development. Significant positive correlations ($p<0.05$) were found between odd chain fatty acids and C 14:0, C 15:0, C 16:0, C 16:1 significant negative correlations ($p<0.05$) were found between all the above fatty acids and C 18:1. Because the fattening period of the 45 day group was longer than the other groups, kids in this group consumed higher amounts of concentrate than those in the other groups. The contents of 18:1 in 45 and 60 days group had >75 days group ($p<0.05$). Karaca (1991, 2010) reported that quantities of C 18:0 and C 18:1 increased in various tissues of lamb and kids and quantities of C 14:0 decreased in relation to the length of the fattening period. Numerous researcher indicates that C 18:1 quantities in animal carcasses increase with concentrate feeding (Enser *et al*., 1996; Bas and Morand-Fehr, 2000; Rhee *et al*., 2000; Santos-Silva *et al*., 2002; Lee *et al*., 2008; Karaca, 2010).

In Table 3, C 18:0 and C 18:1 contents decreased with weaning age whereas C 14:0 and C 16:0 saturated fatty acids and C 18:2, C 18:3 and C 20:4 unsaturated fatty acids contents increased with weaning age of these, only the differences in C 14:0 and C 18:1 contents were significant ($p<0.05$). Differences in weaning age did not significantly affect total saturated and unsaturated fatty acid ratios of rack joints among the groups except MUFA.

However, mono-unsaturated fatty acid ratios differed significantly among the groups ($p<0.05$). Furthermore, the differences in mono-unsaturated fatty acid ratios were found to be considerably affected by amounts of C 18:1. There were no significant differences among groups in Polyunsaturated-to-saturated (P/S) ratios which were 0.10, 0.14 and 0.12, respectively for the 45, 60 and 75 days groups. The Polyunsaturated/Saturated (P/S) fatty acid ratio is a major criteria used to compare fatty acid composition among species, races and management practices (Enser *et al*., 1996; Dhanda *et al*., 1999; Banskalieva *et al*., 2000; Fisher *et al*., 2000; Calles *et al*., 2000; Lee *et al*., 2008). Banskalieva *et al*. (2000) reported an average P/S ratio of 0.24 in rack joints of Alpine kids slaughtered at five months. Dhanda *et al*. (1999) reported P/S ratios ranging from 0.03-0.08 in the *Longissimus dorsi* among different kid genotypes.

Pena *et al*. (2009) reported P/S ratios ranging from 0.50-0.60 in the *Longissimus thoracis* in their study. Moreover, P/S ratios of different anatomical locations of kids of various genotypes and ages varied from 0.16-0.49

Table 4: Correlations between fatty acids of the rack joints area

	14:0	14:1	15:0	15:1	16:0	16:1	17:0	17:1	18:0	18:1	18:2	18:3
14:1	0.502											
15:0	0.743**	0.406										
15:1	0.389	0.047	0.709**									
16:0	0.807***	0.213	0.323	0.060								
16:1	0.598*	0.785**	0.447	0.190	0.317							
17:0	-0.662**	-0.622*	-0.363	-0.372	-0.569*	-0.745**						
17:1	-0.548*	-0.074	-0.411	-0.427	-0.447	0.057	0.206					
18:0	-0.354	-0.770**	-0.309	-0.071	-0.100	-0.787***	0.514	-0.198				
18:1	-0.821***	-0.343	-0.392	-0.022	-0.859***	-0.381	0.452	0.561*	0.050			
18:2	-0.298	0.161	-0.552***	-0.682**	-0.203	0.195	0.181	0.407	-0.302	0.063		
18:3	0.128	0.622*	-0.059	-0.148	-0.118	0.446	-0.351	-0.198	-0.440	-0.119	0.423	
20:4	0.027	0.477	-0.408	-0.487	0.100	0.400	-0.292	0.035	-0.402	-0.218	0.664**	0.676**

*p<0.05, **p<0.01, ***p<0.001

(Banskalieva *et al*., 2000). A P/S ratio of <0.45 in the fatty acid composition of meat is recommended for healthy nourishment (Anonymous, 1994). The P/S ratios found in this study were under this limit (Table 3).

CONCLUSION

In this study, different weaning ages did not considerably affect the chemical composition of the rack joints. The 75 days group which was weaned the latest of the three experimental groups had higher C 14:0 ratios than the other groups. This may be due to increased milk consumption over a longer suckling period. Conversely, the 45 and 60 days groups had higher C 18:1, C 17:0 and C 17:1 ratios than the 75 day group, probably as a result of early weaning, greater consumption of concentrate feed and the production of odd-chain fatty acids that occurs as the rumen begins to function. Higher levels of C 18:1 may be related to the contents of concentrate feed as well as the saturation mechanism by which C 18:3 is systematically converted to C 18:2, C 18:1 and finally to C 18:0 in the rumen. C 15:0 ratios did not differ significantly among groups. Although, no differences in P/S ratios were found among the groups, mono unsaturated fatty acid ratios differed significantly. In conclusion, contents of some fatty acids in kid rack joints differed according to weaning age and may be explained by related differences in milk and concentrate consumption.

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