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FATTY ACID COMPOSITION OF MEAT FROM THE HIND LEG CUT OF RABBITS (O*RYCTOLAGUS CUNNICULUS*) FED DIETS CONTAINING GRADED LEVELS OF PROCESSED TALLOW (*DETARIUM MICROCARPUM*) SEED MEAL

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Abstract: Eighty one (81) weaned rabbits of mixed breeds and sexes (male and female) were randomly allotted to nine treatment groups with nine rabbits per treatment. Each treatment had three replicates with three rabbits per replicate. Processed tallow was included in the diets as a source of protein which was set at 16 % CP. The control diet had 100 % palm kernel cake (PKC) and 0 % tallow seed meal (TSM). Diets 1 – 4 contained cooked tallow seed meal (CTSM) included at 75 % PKC: 25 % CTSM, 50 % PKC: 50% CTSM, 25% PKC:75 % CTSM and 0 % PKC: 100 % CTSM, while groups 5 – 8 had fermented tallow seed meal diets (FTSM) and included at the same levels as in the cooked diets. Fifty four rabbits were randomly selected for slaughtering from the nine groups with six rabbits (male and females) per group. Fatty acid content of the hind leg of rabbits were determined. All the fatty acids measured were significantly ($P<0.05$) influenced by the processing methods except decosenoic acid methyl ester and pentadecanoic acid methyl esters. The levels of inclusion of tallow also significantly ($P<0.05$) affected all the fatty acids composition measured. It was therefore concluded that irrespective of the processing methods the use of tallow in the diets of rabbits has no negative effect on the fatty acid composition of rabbit meat.

Key words: fatty acid, hind leg, rabbits, tallow seed meal

Introduction

The information available on chemical composition of rabbit meat is extremely variable, especially regarding fat content *(Pla et al., 2004)*. These compositions depend on the part of the carcass studied *(Pla et al., 2004)* and also on the different productive factors *(Dalle-Zotte, 2002)*. The author also corroborated that feeding factors have a strong influence on the chemical composition of rabbit meat, in particular, on its lipid composition. Rabbit meat is characterized by its lower energy value compared with red meats *(Combes, 2004)*. This might be due to its low fat content. Fat content varies widely depending on the carcass portion from 0.6 to 14.4 % (fat from edible meat with intramuscular and intermuscular fat content) with an average value of 6.8 % *(Hernández and Gondret, 2006)* with the loin being the leanest part of the carcass (1.2 % of lipids). There is an increasing interest in the lipid composition of edible meat and fat of domestic animals because of its relationship with human health, particularly with cardiovascular illnesses *(Hu and Willett, 2002)*. The quantity and composition of fatty acids found in monogastrics is directly influenced by the composition of the diet *(Bernardini et al., 1999)* The aim of this study was to determine the fatty acid composition of meat from the hind leg cut of rabbits (O*ryctolagus cunniculus*) fed diets containing graded levels of processed tallow (*Detarium microcarpum*) seed meal.

Materials and Methods

Eighty one (81) weaned rabbits of mixed breed and sexes were randomly allotted to nine treatment groups with nine rabbits per treatment. Each treatment had three replicates with three rabbits per replicate. The crude protein level was set at 16 %. The control diet (0 % TSM) had 100 % Palm kernel cake (PKC) as the main source of protein. Groups 1-4 contained cooked tallow (*Detarium microcarpum*) seed meal (CTSM) diets and included as 75 % PKC: 25 % CTSM, 50 % PKC: 50 % CTSM), 25 % PKC: 75 % CTSM and 0 % PKC: 100 % CTSM, respectively. While groups 5-8 had fermented tallow (*Detarium microcarpum*) seed meal diets (FTSM) and included as 75 % PKC: 25 % FTSM, 50 % PKC: 50 % FTSM, 25 % PKC: 75 % FTSM and 0 % PKC: 100 % FTSM. Table 1 shows the composition of experimental diets. All diets were supplemented with equal amounts of bone meals, oyster shell, salt, vitamin-mineral premix, methionine and lysine. The rabbits were treated against endo parasites. In addition, medications were administered where was necessary. The diets were supplemented with some quantities of *Tridax procumbens* as source of forage in the evenings. The cages were equipped with feeders and drinkers. Prior to the start of the experiment, the animals were fed common diets and allowed an adjustment period of 5 days to enable the animals get accustomed to their cages and diets. The diets and fresh water were provided *ad-libitum* throughout the duration of the experimental period. The experiment lasted for 12 weeks. The design of the experiment was 2/4 factorial experiment and arranged as a completely randomized design (CRD). At the end of the growth studies, a total of 54 rabbits were randomly selected from the nine (9) dietary groups, with six (6) rabbits per group. The fatty acid content of the meat from the hind leg of rabbits was analyzed using the method described by *Schafer (1998)*. This includes the extraction of total lipids using chloroforms methanol (2:1, v/v). The lipids were methylated with Trimethylsolfonium hydroxide (TMSH). Fatty acids (FA) methlesters were thereafter separated by a gas chromatograph (HP 5890, Hewlett Packard GmbH, Germany) equipped with a polar capillary column (30cm FFAP, 8.53 mm I.D.Macherey and Nagel, Duren, Germany), a flame ionization detector and an automatic en-column injector. Helium was used as the carrier gas with a flow of 5.4ml min^{-1}. The data collected from this study were subjected to analysis of variance (ANOVA) using statistical package *(SAS, 1998)*. The variations in means were separated using the Duncan Multiple Range Test *(Duncan, 1955)*.

Table 1. Composition of experimental diets (%)

Ingredients	Control	CTSM				FTSM			
	0	25	50	75	100	25	50	75	100
Maize	17.69	23.48	27.13	32.20	35.18	24.76	30.31	33.95	37.75
PKC	58.06	39.20	24.31	10.89	0.00	38.24	22.72	10.45	0.00
TSM	0.00	13.07	24.31	32.66	40.57	12.75	22.72	31.35	38.00
Maize offal	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vita premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100
Determined analysis									
Dry matter	88.47	87.50	89.05	87.95	87.88	88.89	88.69	89.13	87.85
Crude protein	16.85	16.48	16.20	16.65	16.00	16.55	16.20	16.85	16.00
Crude fibre	15.62	16.12	16.50	15.50	15.50	15.50	16.60	16.03	16.03
Ash	4.50	4.50	4.50	4.00	4.00	4.00	4.50	5.00	5.50
Ether extract	9.00	11.00	11.00	10.50	9.50	10.50	9.00	9.00	9.50
NFE	42.50	39.40	40.85	41.30	42.88	42.34	42.39	42.25	40.82
Energy (Kcal/kg/ME)	2756	2840	2864	2941	2891	2842	2846	2615	2749

TSM = Tallow seed meal, CTSM= Cooked tallow seed meal, FTSM = Fermented tallow seed meal
Premix supplied per 2.5kg/tonne contains: Retinol acetate (10000000 iu), Vit. D_3 (2000000 iu), Vit E (15000 iu), Vit B (3000mg), Niacin (15000mg),
Calcium pantothenate (800mg), Vit . B_6 (3000mg), Vit. B_{12} (10mg) Vit. K_3 (2000mg), Biotin (20gm),
Folic acid (500mg), Choline chloride (250,000mg), Manganese (75000mg), Iron (25000mg), Copper (5000mg), Zinc (70000mg), Selenium(150mg), Iodine(1300mg), Magnesium (100mg), 500g ethoxyquin and BHT (700g)
NFE=Nitrogen free extrac

Results and Discussion

The results of fatty acid content of hind legs of rabbits fed diets containing graded levels of processed tallow seed meal are shown in Table 2a. Content of all the fatty acids measured was significantly (P<0.05) influence of the processing methods except decosenoic acid methyl ester and pentadecanoic acid methyl esters. Tallow share also significantly (P<0.05) affected all the fatty acids composition measured.Meat from rabbits fed cooked diets had higher fatty acid content except for stearic acid methyl ester, arachidic acid, arachidonic acid methyl ester and pentadecanoic acid methyl ester. With regard to the effect of the tallow share in the diets of the rabbits, no particular trend was observed except in myristic acid methyl ester, palmitic acid methyl ester, linoleic acid methyl ester, arachidic acid methyl acid ester and saturated fatty acids (SFA) where a slightly decrease observed in the content of the fatty acids with increase processed tallow share in the diets of the rabbits.

Table 2a. Fatty acid content of the hind leg of rabbits fed diets containing graded levels of processed tallow seed meal TSM) (%)

Methods	Lauric ME	Myris ME	Pal ME	Pal acid	Marg ME	Oleic ME	Stearic ME	Oleic Acid	Lino ME	Arach Acid	Arac ME	Deco ME	Pent ME	SFA	MUFA	PUFA	PUFA/SFA
Cooked	5.74^{a}	3.94^{a}	28.39^{a}	3.31^{a}	1.82^{a}	31.85^{a}	10.78^{b}	11.50^{a}	1.23^{a}	0.42^{b}	1.39^{b}	1.46	0.81	54.97^{a}	45.51^{a}	3.90^{a}	0.06^{b}
Fermented	5.44^{b}	3.62^{b}	26.45^{b}	2.90^{b}	1.32^{b}	28.98^{b}	11.04^{a}	11.09^{b}	0.87^{b}	0.54^{a}	2.45^{a}	1.46	0.85	51.51^{b}	42.93^{b}	3.03^{b}	0.08^{b}
SE±	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L O S	*	*	*	*	*	*	*	*	*	*	*	NS	NS	*	*	*	*
Levels																	
0	1.68^{d}	8.11^{a}	32.17^{a}	6.10^{a}	1.78^{c}	31.70^{c}	11.86^{a}	6.70^{e}	0.00^{e}	0.00^{e}	1.00^{e}	0.00^{d}	0.00^{e}	55.98^{a}	43.02^{d}	1.00^{e}	0.02^{c}
25	6.57^{b}	3.50^{b}	27.35^{b}	1.10^{e}	1.86^{b}	28.50^{d}	10.39^{d}	14.17^{a}	0.53^{d}	0.53^{d}	1.56^{d}	1.81^{bc}	1.30^{b}	51.70^{c}	44.50^{c}	3.86^{c}	0.10^{a}
50	7.06^{a}	3.25^{c}	27.31^{c}	3.87^{b}	0.61^{d}	28.24^{e}	10.23^{e}	12.44^{b}	0.54^{c}	0.54^{c}	1.58^{c}	1.82^{b}	0.73^{c}	52.60^{b}	43.00^{e}	4.43^{a}	0.09^{ab}
75	6.60^{b}	2.79^{d}	26.51^{d}	2.57^{b}	1.06^{d}	31.74^{b}	10.77^{c}	11.18^{d}	0.59^{b}	0.59^{b}	2.36^{b}	1.86^{a}	1.57^{a}	51.40^{d}	44.80^{b}	3.78^{d}	0.08^{b}
100	6.15^{c}	2.23^{e}	23.73^{e}	1.88^{d}	2.53^{a}	31.89^{a}	11.32^{b}	12.00^{c}	0.74^{a}	0.74^{a}	3.10^{a}	1.80^{e}	0.57^{d}	49.90^{e}	45.80^{a}	4.26^{b}	0.09^{ab}
SE±	0.05	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L O S	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
M x L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

^{abc} Means with different superscripts in the same column are significantly (P<0.05) different.

The interaction effect of processing methods and levels of inclusion of TSM on the fatty acid content of the hind leg of rabbits fed processed tallow seed meal diets (Table 2b) revealed that SFA were significantly (P<0.05) higher in meat obtained from rabbits fed control (0 % TSM) diets. MUFA was higher in the meat of rabbits fed 25 % FTSM diets and the least in the meat of those fed 50 % CTSM diets. PUFA was higher in the meat of rabbits fed 75 % FTSM diets and least in the meat of rabbits fed 0 % TSM diets. SFA / PUFA ratio was least in meat obtained from rabbits fed control (0 % TSM) diets and highest in meat from rabbits fed 75 % FTSM diets.

Table 2b. The interaction effect of processing methods and levels of inclusion of TSM on the fatty acid content of the hind leg of rabbits fed processed tallow seed meal diets

Levels (%)	Laur ME	Myris ME	Pal ME	Pal acid	Magar ME	Oleic ME	Stearic ME	Oleic acid	Lino ME	Arach	Arac ME	Deco ME	Pent ME	SFA	MUFA	PUFA	PUFA /SFA
Cooked																	
0	1.58^{e}	7.11^{a}	32,17^{a}	6.10^{a}	1.78^{e}	31.70^{d}	11.86^{a}	6.70^{j}	0.00^{j}	0.00i	1.00^{g}	0.00^{g}	0.00^{g}	55.98^{a}	43.02^{g}	1.00^{j}	0.02^{f}
25	6.14^{d}	7.00^{b}	28.83^{c}	2.20^{f}	1.53^{f}	24.43^{i}	9.61^{g}	14.10^{b}	1.80^{b}	0.45^{h}	1.10^{f}	1.80^{e}	1.05^{f}	56.32^{b}	40.33^{h}	3.35^{g}	0.10^{ab}
50	7.62^{a}	2.24^{g}	29.49^{b}	3.78^{c}	1.21^{g}	25.31^{h}	9.41^{h}	12.87^{c}	3.15^{a}	0.50^{g}	1.15^{e}	1.81^{d}	1.46^{d}	55.21^{c}	39.99^{i}	4.80^{c}	0.09^{bc}
75	7.10^{b}	0.00^{h}	28.08^{d}	2.41^{e}	2.11^{d}	31.93^{c}	11.44^{c}	11.20^{g}	0.68^{f}	0.52^{f}	1.11^{f}	1.89^{a}	1.53^{c}	52.67^{d}	45.02^{e}	2.31^{h}	0.04^{e}
100	7.00^{b}	3.35^{d}	23.39^{i}	2.06^{g}	2.45^{b}	31.53^{f}	11.59^{b}	12.65^{d}	0.50^{g}	0.61^{c}	2.58^{c}	1.79^{f}	0.00^{g}	50.04^{f}	46.27^{b}	3.69^{f}	0.07^{d}
Fermented																	
25	6.25^{d}	0.00^{h}	25-87^{e}	0.00^{i}	2.19^{c}	32.58^{a}	11.16^{d}	14.23^{a}	1.75^{c}	0.60^{d}	2.01^{d}	1.82^{c}	1.54^{b}	47.01^{i}	48.63^{a}	4.36^{d}	0.09^{bc}
50	6.50^{c}	3.33^{e}	25.12^{f}	3.95^{b}	0.00^{h}	31.16^{g}	11.05^{e}	12.00^{e}	1.25^{d}	0.58^{e}	2.01^{d}	1.83^{b}	0.00^{g}	49.95^{g}	45.99^{c}	4.06^{e}	0.08^{cd}
75	6.10^{d}	4.46^{c}	25.01^{g}	2.73^{d}	0.00^{h}	31.55^{e}	10.10^{f}	11.15^{h}	1.00^{e}	0.65^{b}	3.60^{b}	1.83^{b}	1.60^{a}	50.22^{e}	44.53^{f}	5.25^{a}	0.11^{a}
100	6.04^{e}	3.18^{f}	24.06^{h}	1.70^{h}	2.61^{a}	32.24^{b}	11.05^{e}	11.35^{f}	0.35^{h}	0.86^{a}	3.62^{a}	1.81^{d}	1.13^{e}	49.77^{h}	45.40^{d}	4.83^{b}	0.10^{ab}
SEM	0.03*	1.35x10^{-3*}	1.29x10^{-3*}	1.62x10^{-3*}	1.02x10^{-3*}	1.40x10^{-3*}	8.46x10^{-3*}	2.12x10^{-3*}	1.12x10^{-3*}	8.77x10^{-4*}	1.29x10^{-3*}	8.77x10^{-4*}	9.62x10^{-4*}	8.48x10^{-4*}	1.69x10^{-3*}	1.28x10^{-3*}	1.52x10^{-3*}

abc Means with different superscripts in the same column are significantly ($P<0.05$) different.0 TSM; 25 % TSM; 50 % TSM ; 75 %TSM and 100 % TSM

Abbreviation forTable 2a and 2b SEM= Standard error of mean ME= methyl ester, Myris= Myristic Pal= Palmitic Marg= Margaric Lino= Linoleic Arach= Arachidic Arac= Arachidonic , Deco= Decosenoic Pent= Pentadecanoic SFA= Saturated fatty acid MUFA= Mono unsaturated fatty acid, PUFA= Poly unsaturated fatty acid

Hernández and Gondret (2006) stated that rabbit meat fat comprises mostly saturated fatty acids (SFA) and polyunsaturated fatty acids (PUFAs), with percentages of 36.9 %, and 34.60 %, respectively, total fatty acids in the hind leg. Mono unsaturated fatty acids (MUFAs) are less representing about 28.50 %. The most ubiquitous fatty acids are oleic (C18:1), palmitic (C16:0), and linoleic (C18:2) acids, showing percentages higher than 20 % of total fatty acids. Altogether, rabbit meat has a high ratio of PUFA to SAFs (0.85) for the meat of hind leg *(Alasnier et al., 1996* and *Ramírez et al., 2005)*. From the results of this study when the fatty acids are grouped as SFAs, MUFAs and PUFAs were better in rabbits fed CTSM based diets except the ratio of SFA/PUFA that was better in rabbits fed FTSM based diets though quite the results were lower than those reported by *Alasnier et al. (1996)* and *Ramirez et al. (2005)*. The levels of inclusion and interaction effects were significant (P<0.05) in all the fatty acids determined. The high significant (P<0.05) difference observed in the results of SFA's might be due to the fatty acid content of the test ingredient which was directly deposited in the meat of rabbits. The high amount of palmitic acid methyl ester, palmitic acid and margaric acids in the meat of rabbits fed the control diets might be due to the high inclusion levels of PKC in the diet. This is in accordance with the report of *Hermandez (2008)*, who observed that rabbits and other non-ruminants are able to incorporate dietary fatty acids into adipose and muscle tissue lipids. The mono unsaturated fatty acids values were also higher in the meat of the rabbits in all the treatments compared to about 28.50 % given by *Hernández and Gondret (2006)* making the meat a good source of nutrition for diabetic and hypertensive patients *(Aduku and Olukosi, 2000)*. PUFA was generally low in all the treatments even though appreciable values were recorded in the FTSM based diets. *Xiccato, (1999)* and *Zsedely et al. (2008)* reported that high PUFA concentration in meat can have a negative effect on its storage stability due to higher susceptibility to peroxidation. It showed that the meat of rabbits from this study could store well for a longer period.

Conclusion

The present study showed that irrespective of the processing methods used in tallow meal diets preparation, they have no negative effect on the fatty acid composition of rabbit's meat.

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Sastav masnih kiselina mesa dela trupa (zadnje noge) kunića (O*ryctolagus cunniculus*) hranjenih sačmom prerađenog semena *Detarium microcarpum*

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Rezime

Osamdeset jedan (81) odbijeni kunić mešovitih rasa i polova (muškog i ženskog) su nasumično podeljeni u devet tretiranih grupa sa devet zečeva po tretmanu. Svaki tretman je imao tri ponovljanja sa tri kunića po ponavljanju. Prerađeno seme je uključeno u ishranu kao izvor proteina koji je postavljen na 16% CP. Kontrolni obrok je sadržavao 100% pogače palminog zrna (PKC) i 0% sačme *Detarium microcarpum* (TSM). Obroci 1 - 4 sadržavali su sačmu kuvanog semena *Detarium microcarpum* (CTSM) koja je bila uključena u sledećim nivoima: 75% PKC: 25% CTSM, 50% PKC: 50% CTSM, 25% PKC: 75% CTSM i 0% PKC: 100% CTSM, dok su grupe 5 - 8 hranjene obrocima koji su sadržavali sačmu fermentisanog semena (FTSM) i uključena na istom nivou kao i kod kuvanih obroka. Pedeset četiri kunića su nasumice odabrani za klanje iz devet grupa sa šest kunića (mužjaka i ženki) po grupi. Određivan je sadržaj masnih kiselina mesa zadnjih nogu kunića. Sve izmerene masne kiseline su značajno (P <0.05) bile pod uticajem načina obrade semena osim metil estra dokozenoinske i metil estra pentadekanske kiseline. Nivoi uključivanja semena je takođe značajno (P <0.05) uticalo na sve masne kiseline. Stoga je zaključeno da, bez obzira na metode obrade, upotreba *Detarium microcarpum* u ishrani zečeva nema negativan efekat na sastav masnih kiselina zečeva mesa.

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