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EFFECT OF FORAGE PRESERVATION METHOD ON THE FATTY ACIDS PROFILE AND HEALTH LIPID INDICES IN THE SHEEP'S MILK

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Abstract

The aim of this study was to evaluate the influence of the method of conservation of grasses (pasture) on fatty acids content and structure of milk fat and health lipid indices respectively. 24 sheep lactation in Turcana, were divided into 3 groups relatively homogeneous, after which they were randomly assigned to one of three experimental diets: P - maintained on pasture, F - fed a ration based hay and S - fed a ration based on grass silage. Feed intake was completed in all 3 groups with 300 g / day of concentrate mixture administered twice daily in equal parts during milking. The basic nature of the food forage (pasture, hay, grass silage) resulted in profound changes in fatty acid composition and health lipid indices value. The pasture fresh assured the highest concentrations of fatty acids functional milk (C18:1 trans-11, C18:2 c9, t11; C18:3n-3, C20:5n-3 and C22:6n-3) and the best values for health lipid indices (best ratio PUFA/SFA and lowest atherogenic index value and thrombogenic). Of the two methods of preservation of pasture grasses (hay or silage), hay provided a higher concentration of functional fatty acid and health lipid indices in milk compared to the silage. The results demonstrate that the pasture is an important source of active biocomponents which can add milk, naturally extra nutritional value to qualify him as a "functional food".

Key words: milk, Omega-3 FA, CLA, Atherogenicitiy index (AI), n-6/n-3 FA

INTRODUCTION

Lately interest in potential foods sanogenous respectively with high content of functional biocomponents greatly increased, stimulating the development of functional products for the food market. Milk and milk products have come to occupy an important place in this market functional foods because besides the important contribution of nutrients are a valuable source of bioactive compounds, particularly fatty acids and antioxidants lipophilic functional. Thus, to manipulate the composition of milk fat, raising the concentration of vaccenic acid (C18:1 trans-11, VA), conjugated linoleic acid (C18:2 *cis*-9, *trans*-11, RA) and omega-3 (ALA, C18:3n-3, EPA, C20:5n-3, DHA, C22:6n-3) and lower weight of saturated fatty acids (SFA), represents a huge challenge for research in this area.

Natural grassland is an important source of PUFA and especially C18:3n-3, feed. Hay drying in the sun lead to significant loss of unsaturated

fatty acids in grass (Boufaied et al., 2003). Shingfield et al., (2005) determined that milk from cows fed with rations based fan has a higher content of C18:2n-6, C18:2 c9,t11 and C18:3n-3 compared at a cow fed on silage rations, although PUFA intake was lower.

The aim of this study was to evaluate the influence of the method of conservation of grasses (pasture) on fatty acids content and structure of milk fat and that the indices that characterize lipid sanogenic milk quality in terms of impact on human health.

MATERIAL AND METHOD

The experiment was held in a private company in the submontane (1248 m altitude). A body of about 8.6 ha pasture was divided into 3 parts about equal in area, who were randomly assigned to one of 3 ways to use: grazing, harvesting in the early phase of blossoming grasses and transformation in hay (sun dried and bundled) and in storage (wilting prior-20 hours and silage storage in concrete cells). In terms of flora meadow was comprised of *Festuca rubra*, *Phleum pratense*, *Poa pratensis*, *Dactylis glomerata*, *Trifolim repens* and different weed species. 24 sheep lactation (breastfeeding 3-4) in Turcana, were divided into 3 groups relatively homogeneous, after which they were randomly assigned to one of three experimental diets: P - maintained on pasture, F - fed a ration hay base and S - fed a ration based on grass silage. Feed intake was completed in all 3 groups with 300 g/day of concentrate mixture. Basic feed ration was provided ad libitum and concentrates were administered twice daily in equal parts during milking.

Milk samples for determination of the chemical composition have been preserved with 2 tablets Bronopol® (BroadSpectrum Micro-tabs II, D & F Control Systems Inc., USA) and stored at 4 ° C until laboratory analysis. Milk samples for profiling fatty acids, were frozen at -20^0C, no preservatives and later freeze-dried and stored until analysis. Feed samples stored at -20^0C and were later freeze-dried and stored until laboratory analysis to establish the fatty acid profile of the fat in food.

Milk chemical composition was established by automatic infrared analysis using the apparatus MilkoScan FT-120 (Foss Electric). Extraction of fats and fatty acids profile analysis was done as described by Blackbird (2012). The health lipid indices (PUFA/SFA; HFA/UFA; n-6/n-3 FA, the index atherogenic, index thrombogenic), were calculated in accordance with Chilliard et al., (2007) and Pilarczyk et al., (2015).

Data were subjected to analysis of variance using the GLM procedure (General Linear Models), version 9.1.3. (SAS Institute, Cary, NC, USA).

Multiple comparisons between mean values was made by Duncan's test. The level of significance was set at $p < 0.05$.

RESULTS AND DISSCUSIONS

The basic nature of the food feed sheep influenced daily milk production but also its components (Table 1). The largest milk production was recorded in sheep maintained on pasture, while the fat and protein content was higher in sheep fed rations based on hay. Remarkable is that the milk of sheep maintained on pasture showed the highest concentration of urea, which means that forage intake was deficient in energy, which is obtained by deamination of protein (Pulin et al., 1994).

Table 1

Influence method of preserving forage on milk yield and composition.

Item		Treatments		
		Pasture	Hay	Grass silage
Milk yield (ml/d)		575.2 ± 39.1^{a}	466.5 ± 33.2^{c}	528.4 ± 43.7^{b}
Milk fat	- %	6.72 ± 0.19^{b}	7.54 ± 0.26^{a}	7.15 ± 0.33^{ab}
	- g/zi	38.6	35.1	37.7
Milk protein	- %	4.21 ± 0.14^{b}	4.92 ± 0.11^{a}	4.40 ± 0.21^{b}
	- g/zi	24.2	22.9	23.2
Ureea (mg/dl milk)		32.8 ± 1.9^{a}	24.6 ± 2.2^{b}	28.7 ± 3.4^{ab}

In Table 2 shows the fatty acid composition of fats in feed used for feeding lactating ewes. It may be noted that the transformation of pasture grasses in hay or silage had a negative effect on fatty acid profile and the content of lipophilic antioxidants. Thus, there was a significant increase in the proportion of saturated fatty acids (SFA) and a corresponding decrease in polyunsaturated fatty acids (PUFA). In most green plants are in the form of fatty acids esterified, while in the silo are in the form of free fatty acids, which are easily oxidized under the action of lipoxygenase (Garcia et al., 2007). The negative influence on FA profile was more pronounced when green fodder preservation was done by silage compared to its drying (hay).

A significant increase in the concentration of unsaturated fatty acids AFS detriment has been found in milk from sheep fat fed with conserved forage (hay or silage) compared to the figure of sheep maintained on pasture (Table 3). It can determine the existence of a good correlation between fatty acid profile of milk fat and feed the base of the food of the sheep. Thus, compared with group P, the share structure of PUFA in milk fat fell from 35.3 to 46.3% respectively in groups F and S. Among PUFA milk most affected by the feed base nature of food were acids omega-3 fatty acids,

whose share has gradually declined from 3.05% (% of FAME) maintained on pasture with the sheep (P) to 2.11% and 1.70% in those fed on hay (F) or grass silage (S).

Table 2

Fatty acid profile of forages used for feeding ewes.

Fatty acids (FA)	Treatments			
	Pasture	Hay	Grass silage	Concentr.
C12:0	0.46	0.61	0.11	0.04
C14:0	0.50	0.70	1.53	0.21
C16:0	16.71	18.18	22.43	17.43
C16:1	0.18	0.72	0.42	0.64
C18:0	1.90	5.24	3.17	3.29
C18:1	3.71	6.97	3.32	24.69
C18:2 n-6 (LA)	16.4	20.18	19.43	41.20
C18:3 n-3 (ALA)	51.8	38.2	41.35	3.52
18:3/18:2	3.15	1.99	2.13	0.08
SFA (saturated fatty acids)	19.57	24.73	27.24	20.97
MUFA (monounsaturated fatty acids)	3.89	7.69	3.74	25.33
PUFA (polyunsaturated fatty acids)	68.2	58.38	60.78	44.72

The meadow hay and silage compared to the fat composition of milk ensured a significantly higher ponderee α-linolenic acid both (1.63 to 1.15% vs. 2.17%) and for its metabolites or eicosapentaenoic acid (C20:5n-3, EPA) and docosahexaenoic acid (C22:6 n-3, DHA).

Related aspects were registered in terms of omega-6 fatty acids, but the differences between groups were lower. Of the n-6 FA, the most significant differences were observed in the case of linoleic acid (C18:2n-6, LA), which had a concentration close to 2 times higher in fat milk from pasture.

The concentration of CLA and VA milk was about 2-3 times higher in milk obtained from grazing sheep maintenance compared to those fed with rations based on conserved forage (hay or silage) (P > F > S). The concentration of CLA and VA milk was directly associated with the intake of C18:2n-6 and C18:3n-3 in food (Kalac and Samkova, 2010).

The high concentration of ALA, EPA, DHA, CLA and VA in fat sheep's milk P, shows the importance of grazing in getting milk and dairy products rich in biomolecules that have a beneficial effect on human health, prevent disease and cardiovascular tumor (Simplous , 2006). In addition, milk from the pasture ensures the best indices of lipid sanogenic respectively lowest ratio n-6/n-3 FA, PUFA/SFA and HFA/UFA, and the lowest values of the index of atherogenic (AI) thrombogenic (TI) (fig. 1).

Table 3

Influence of forage preservation methods on fatty acid profile of milk fat (% of FAME)

Fatty acids	Treatments		
	Pasture	Hay	Grass silage
C4:0 – C10:0	17.26[b]	21.52[a]	21.23[a]
C12:0	2.07[c]	2.81[b]	3.54[a]
C14:0	7.83[b]	9.37[ab]	10.99[a]
C16:0	18.12[b]	22.68[a]	21.44[a]
C18:0	9.76[b]	10.11[ab]	11.28[a]
C18:1 n9t	0.59	0.47	0.52
C18:1 *trans*-11 (VA)	5.69[a]	3.28[b]	3.05[b]
C18:1 n9c	24.51[a]	20.07[b]	19.46[c]
C18:1 cis-11	0.64[a]	0.41[b]	0.40[b]
C18:2 n6t	0.39	0.36	0.38
C18:2 n6c (LA)	2.87[a]	1.76[b]	1.52[b]
CLA *cis*-9, *trans*-11 (RA)	3.06[a]	1.81[b]	1.32[c]
CLA *cis*-12, *trans*-10	0.17[a]	0.11[b]	0.09[b]
CLA-total	3.23[a]	1.90[b]	1.43[c]
C18:3 n-3 (ALA)	2.17[a]	1.63[b]	1.15[c]
C20:4 n-6	0.28[a]	0.22[b]	0.24[ab]
C20:5 n-3 (EPA)	0.41[a]	0.20[b]	0.21[b]
C22:6 n-3 (DHA)	0.47[a]	0.28[b]	0.34[b]
Unidentified fatty acids	3.71	2.93	2.82
SFA (saturated fatty acids)	55.04[b]	66.49[a]	68.48[a]
UFA (unsaturated fatty acids)	41.25[a]	30.58[b]	28.70[c]
MUFA (monounsaturated fatty acids)	31.43[a]	24.23[b]	23.43[b]
PUFA (polyunsaturated fatty acids) total	9.82[a]	6.35[b]	5.27[c]
PUFA n-6	3.54[a]	2.34[b]	2.14[b]
PUFA n-3	3.05[a]	2.11[b]	1.70[c]
HFA[1]	28.02[b]	34.86[a]	35.97[a]
DI (18:2 c9,t11)[2]	34.97[a]	35.56[a]	30.21[b]

[1]HFA (hipercholesterolaemic fatty acids) = C12:0 + C14:0 + C16:0; DI = Δ^9-desaturase index; [2]DI (18:2 c9,t11) = 100 x (18:2 c9,t11)/(18:2 c9,t11 + C18:1 t11).

FAME - fatty acids methil esters

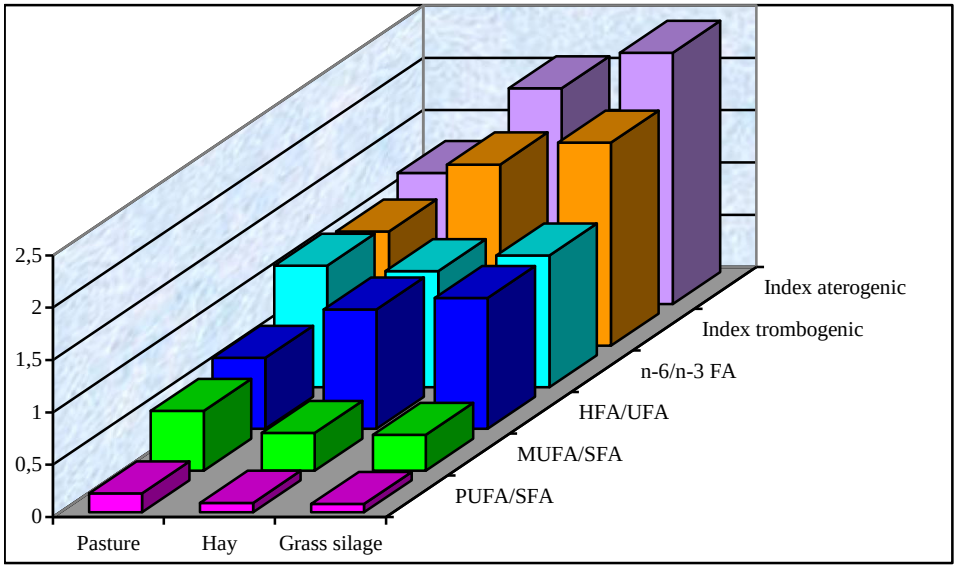

Fig. 1. Influence of forage preservation method on hellth lipid indices of milk fat.

CONCLUSIONS

Milk obtained from sheep maintained on pasture had a profile of fatty acids more favorable human health as a result of the content of higher fatty acids function (omega-3, CLA and VA) and lower in saturated fat, and top sanogenic lipid indices (lower values of the ratio n-6/n-3 FA, PUFA/SFA, atherogenic and thrombogenic index). Conservation fodder drying (hay) provided a higher concentration of functional fatty acid and health lipid indices best milk to preserving silage when the weight in milk composition saturated fatty acids (SFA).

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