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Assessment Of The Influence Of Herb Fattening On The Productivity And Quality Of Beef Cattle Meat.

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ABSTRACT

This article presents the results of studying the influence of various variants of herb fattening on the productive qualities of beef cattle, the fatty acid composition of meat, the oxidative stability of beef, and the formation of sensory characteristics of beef steaks. A conclusion was made about the effectiveness of using alfalfa extract in diets for feeding cattle to enrich meat with PUFA.
Keywords: marbled beef, herbal fattening, unsaturated fatty acids, steaks

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INTRODUCTION

The quality of nutrition is becoming increasingly important in the modern world and directly depends on the quality of food. Much attention is paid to increasing the content of n-3 PUFA in food, since the increased consumption of long-chain PUFA n-3 has a beneficial effect on human health and will reduce the incidence rate. Green fodder, rich in C18: 3n-3, is an important tool to increase the delivery of n-3 PUFAs through ruminants to meat (and milk).

Previous studies have allowed us to establish that seasonal and environmental factors play a significant role in the phenotypic variation in fatty acid content, which in turn will require adjusting the fatty acid composition of the feed in the growing process. Assessment of the degree of preservation of PUFA before entering the duodenum showed that this process is associated with a number of complex factors and interactions that occur between the components of forage grasses and the microflora of the animal rumen.

However, the instability of fatty acid composition of forage grasses requires studying the possibility of additional enrichment of the ration of cattle by sources of PUFA.

MATERIAL AND METHODS

Herbal fattening included either fresh grass or canned as a silage with / without feed for enriched n-3 PUFAs. Initially, linseed oil was to become the source of enrichment of n-3 PUFA, but after analysis of literature data, as well as recommendations of marbled meat producers, a vegetable extract obtained from the liquid fraction of fresh alfalfa (Medicago sativa L.) was used.

In the experiment, 40 calves of Kalmyk breed were used. The alfalfa extract (PX) contained about 10% oil containing 1.6% linoleic and 4% α-linolenic acid. PX was given as a crumb or injected into the compound feed. Feeding of cattle was carried out according to the system "in full" by ryegrass as a silage or on summer pasture, before assigning one of five diets (n = 8 / diet, the average age at the beginning of the experimental diet = 506 days); 1) the diet included only herbal silage (GS), 2) herbal silage plus 75 g PX / dry matter (DMI, GS-LPX), 3) herbal silage plus 150 g PX / DMI (GS-HPX), 4) straw and mixed feed (40:60, S-CC), 5) straw plus compound feed containing 25% PX and vitamin E (~ 300 mg / kg), (40: 60, S-PXC). The composition of these diets is shown in Table 1.

Table 1: Chemical composition and composition of fatty acids used diets

Chemical composition	Feed				
	Control Concs	PX Concs	PX Crumb	Straw	Silage
Dry matter (g / kg)	958,55	958,00	970,94	884,84	390,34
Total nitrogen (TN)	40,77	39,89	90,09	8,30	26,64
Water-soluble carbohydrates (WSC)	100,39	68,13	21,84	15,86	133,96
Neutral leaching fibers (NDF)	237,40	258,55	14,39	848,09	534,14
Acid-leaching fibers (ADF)	101,59	89,93	40,95	547,47	330,31
Ether extractables (EE)	70,09	69,87	143,85	9,87	41,52
Ammonium nitrogen (g / kg TN)	-	-	-	-	91,38
pH	-	-	-	-	4,19
Fatty acid composition					
12:0	0,67	0,32	0,46	0,07	0,12
14:0	0,67	0,86	1,84	0,34	0,23
16:0	24,42	9,94	14,26	1,37	5,27
18:0	2,33	0,86	1,93	0,11	0,35
18:1n-9	20,65	5,40	2,48	0,23	0,59
18:2n-6	25,53	19,44	13,62	0,68	3,98

18:3n-3	3,77	11,99	39,10	0,80	17,20
Total	78,04	48,81	73,69	3,6	27,74

The animals were kept on diets until the fat level reached 3L (the average number of days on the experimental diet = 118), after which slaughter was carried out. For the analysis of the quantitative content of fatty acids and sensory evaluation, the longest muscle of M. longissimus back was selected.

The fatty acid composition of beef was evaluated in neutral lipids and phospholipid fractions using gas chromatography. Identification of individual isomers of conjugated linoleic acid CLA was achieved using high pressure liquid chromatography with silver ions. The shelf life characteristics were analyzed by quantifying the vitamin E and substances reacting with thiobarbituric acid (TBARS) present in meat, after storing the steaks in a modified atmosphere (MHC, O2: CO2 75:25) at the Simulated retail display unit. The color of the meat, immediately after slaughter and during storage in MHC, was measured as Chroma, calculated from the coordinates L *, a * and b *. To assess the palatability, roasted steaks (74 ° C center temperatures) were used, which were previously held for 14 days in a vacuum package at 1 ° C. The assessment of taste qualities was based on linear scales 0-100 (0 - zero, 100 - extreme intensity) or 8-point scale of the category for anomalous intensity of beef taste, intensity of taste of beef (1 - extremely weak, 8 is extremely strong), juiciness (1-lopes tea-dry, 8-extremely juicy) and texture (1 - extremely hard, 8 - extremely tender).

RESULTS AND DISCUSSION

The data on total feed intake for cattle on the S-CC and S-PXC diets was higher than in animals receiving basic dietary diets (Table 2).

Table 2: Feed intake and animal performance

	Diet					SED	*P*
	S-CC	S-PXC	GS	GS-LPX	GS-HPX		
Consumed feed, kg DM / day							
Total	11,03	11,13	8,72	9,35	9,14	0,34	<0,001
Mixed feed or PX	7,34	7,34	-	0,65	1,19	NA	NA
Fodder	3,49	3,69	8,05	8,05	7,47	0,28	<0,001
Consumed fatty acids							
Total	512,78	341,99	214,12	264,12	290,78	8,43	<0,001
14:0	5,36	6,49	1,44	2,58	3,50	0,11	<0,001
16:0	159,14	69,32	38,01	47,17	52,12	1,79	<0,001
18:0	15,70	6,55	2,91	4,06	4,89	0,17	<0,001
18:1n-9	132,39	35,98	4,06	5,72	6,76	0,99	<0,001
18:2n-6	165,15	129,58	29,54	38,38	43,68	1,82	<0,001
18:3n-3	26,67	82,11	127,68	153,51	165,90	4,20	<0,001
Productive indicators							
Growth of live weight (kg / day)	1,27	1,11	1,07	1,17	1,13	0,98	0,354
Age of slaughter, day	639,54	638,52	634,44	636,48	636,48	9,46	0,969
Weight of the chilled side (kg)	181,56	166,77	174,32	176,36	173,40	6,02	0,209
Body structure	75,23	75,23	79,05	86,70	75,23	6,91	0,379
Fatness	54,74	46,13	60,27	62,73	54,12	8,15	0.264

Nevertheless, the increase in live weight, the age of slaughter, the mass of the carcass, the structure of the body and the nutritional indices were the same in all diets (Table 2). Successful alignment of growth rates and the structure of carcasses on diets prevented any confusing effects of changes in fatness and slaughtered age on the composition of fatty acids. Consumption of fatty acids varied depending on the diet, with the animals S-CC having the highest intake of C16: 0, C18: 0 and C18: 2n-6, and the lowest intake of C18: 3n-3 compared to all other diets. Basic feed diets led to a higher consumption of C18: 3n-3 compared to diets

based on mixed fodder, but while animals receiving the GS-HPX diet had the highest intake of C18: 3n-3, animals receiving only herbaceous silage (GS) had the lowest consumption of C16: 0, C18: 0 and C18: 2n-6. The inclusion of PX in feed (S-PXC) resulted in an increase in consumption of C18: 3n-3 and a decrease in consumption of C16: 0, C18: 0 and C18: 2n-6 compared to S-CC animals; whereas the opposite result was obtained in comparison with the GS diet. Thus, from the point of view of ensuring low intake of saturated fatty acids and high consumption of C18: 2n-6 and C18: 3n-3, the S-PXC diet provided an intermediate level of consumption compared to S-CC and fodder diets (± PX); where the GS diet provided the lowest intake of saturated fatty acids and increased consumption of 18: 3n-3 (compared to fodder). The addition of PX to dietary diets additionally increased the consumption of C18: 3n-3, but also of C18: 2n-6 and saturated fatty acids.

The fatty acid composition of the steaks by total amount of lipids, neutral lipids, phospholipids, saturated fatty acids and monounsaturated fatty acids did not differ between the fattening variants, but the amount of PUFA, n-6 and n-3 in total meat lipids was noted by the differential difference depending on the composition of the feeding Table 3).

Table 3: Fatty acid composition of M. longissimus, depending on the diet used

	Ration				
	S-CC	S-PXC	GS	GS-LPX	GS-HPX
Concentration (mg / 100 g of muscle)					
Neutral lipids	2210,52	1650,48	2107,93	1980,87	1834,36
Phospholipids	549,03	488,46	494,39	479,32	477,19
Saturated fatty acids[A]	1154,75	862,53	1076,00	992,64	940,60
MNFA[B]	1108,86	780,46	1082,53	1010,38	917,80
PUFA[C]	240,45	268,36	166,77	188,65	195,42
Sum n-6[D]	190,64	191,53	93,23	103,49	106,02
Sum n-3[E]	49,81	76,83	73,54	85,16	89,40
EPA+DHA	12,37	14,91	17,04	18,04	20,05
P:S[F]	0,14	0,25	0,08	0,11	0,12
n-6:n-3	4,21	2,68	1,29	1,20	1,13

[A]saturated fatty acids, (12:0 + 14:0 + 16:0 + 18:0).
[B]MNFA, (16:1 + t18:1 + 9c18:1 + 11c18:1 + 20:1).
[C]PUFA, (18:2n-6 + 18:3n-3 + 20:3n-6 + 20:4n-6 + 20:4n-3 + 20:5n-3 +22:4n-6 + 22:5n-3 + 22:6n-3).
[D] n-6, (18:2n-6 + 20:3n-6 + 20:4n-6 + 22:4n-6).
[E] n-3, (18:3n-3 + 20:4n-3 + 20:5n-3 + 22:5n-3 + 22:6n-3).
[F] P:S, (18:2n-6 + 18:3n-3)/(12:0 + 14:0 + 16:0 + 18:0).

In the meat of animals receiving forage diets, fewer n-6 fatty acids were contained, but higher concentrations of n-3 fatty acids compared to S-CC animals and vice versa (Table 4). Adding PX to feed or forage increased the number of n-3 fatty acids in the total lipid composition of muscle tissue, followed by an improvement in the n-6: n-3 ratio (Table 4).

The variation in n-6: n-3 ratios reflects the concentration of individual fatty acids in neutral lipid and phospholipid fractions. For example, S-CC diets were associated with high concentrations of C18: 2n-6 fatty acids and long-chain n-6 groups (Table 4).

Table 4: Concentration of fatty acids in lipid fractions of M. Longissimus (mg / 100 g of muscle)

	Diet				
	S-CC	S-PXC	GS	GS-LPX	GS-HPX
Neutral lipids					
14:0	58,81	40,35	60,82	59,36	55,44
16:0	571,63	411,47	577,15	586,60	556,92
18:0	290,96	221,94	270,05	300,09	306,98
18:1trans	71,08	58,01	50,44	62,01	68,79

18:1n-9	727,35	517,30	743,31	798,92	739,35
18:2n-6	29,11	31,91	15,42	19,72	21,20
18:3n-3	6,44	15,04	9,02	14,42	16,11
18:2 cis-9, trans-11 (CLA)	13,46	11,83	11,25	13,89	13,46
Phospholipids					
14:0	1,3	0,9	1,3	1,2	1,2
16:0	79,9	68,8	72,1	75,3	73,8
18:0	52,8	48,7	47,8	52,7	51,8
18:1trans	4,1	3,7	3,2	3,9	4,2
18:1n-9	94,6	51,0	116,7	103,9	100,2
18:2n-6	96,5	108,7	42,0	55,6	54,8
18:3n-3	7,7	21,6	18,2	26,7	27,1
18:2 cis-9, trans-11 (CLA)	1,2	1,2	1,4	1,5	1,5
20:3n-6	12,2	9,4	5,2	6,0	6,6
20:4n-6	39,2	34,5	27,8	29,4	30,9
20:4n-3	2,1	3,1	4,3	5,2	5,4
20:5n-3 (EPA)	10,2	13,1	14,5	17,2	18,8
22:4n-6	3,4	2,1	2,0	1,9	2,0
22:5n-3 (DPA)	17,5	18,5	22,1	24,7	24,6
22:6n-3 (DHA)	1,7	1,7	2,5	2,5	2,9

Forage diets led to a higher C18: 3n-3 deposition, a lipid fraction, and a long chain n-3 fatty acid group, including EPA, DPA and DHA, in phospholipids, the highest concentrations are associated with the GS-HPX diet (Table 5) . The inclusion of PX in the feed-feeding diet (S-PXC) increased the C18: 3n-3 deposition, but not EPA, DPA or DHA, compared to the S-CC diet, although the EPA deposition was similar between the GS and S-PXC diets (Table 4). It is important to note that the concentration of C18: 3n-3 in neutral muscle lipids in animals with the S-PXC diet was greater than in animals on the GS diet, despite the fact that GS animals have a higher intake of C18: 3n-3, than in animals on the diet of S-PXC. For a more complete assessment of the qualitative characteristics of the fatty acid composition of the total lipids of M. longissimus, a quantitative evaluation of the CLA isomers was performed. Of the thirteen individual CLA isomers in the total lipid fraction, only CLA trans-11, trans-13 and CLA trans-11 were identified, trans-13 were influenced by diets, the addition of PX to forage increased the deposition compared to the S-CC diet. In the phospholipid fraction, CLA cis-9, trans-11, there was also a moderate effect of the diet, but the bulk of this CLA isomer was found in neutral lipids, where no effect from diets was observed. Thus, this indicates an increased efficiency of the transformation of C18: 3n-3 from feed to muscle using PX extract compared to grass, possibly due to a decrease in the biohydrogenation of PX fatty acids in the rumen.

Shelf life and sensory characteristics. A study of the effect of different diets on the color characteristics of beef revealed that the steaks from animals on the GS-HPX diet had a lower color intensity than animal steaks on the S-CC diet (Table 5).

Table 5: Oxidation stability of the color of M. Longissimus steaks

	Diet				
	S-CC	S-PXC	GS	GS-LPX	GS-HPX
Bloomed colour					
L*	38,67	38,36	38,72	38,83	38,51
a*	20,00	18,45	18,97	19,57	17,24
b*	9,39	8,70	8,82	9,41	7,38
Hue	25,11	25,23	24,92	25,69	22,96
Chroma	23,39	21,60	22,15	22,99	19,88
Oxidizing ability					
TBARS, day 10[A]	1,24	0,28	0,57	0,79	1,30
Chroma, day 7	24,44	25,79	24,13	24,75	24,86
Vitamin E[B]	2,94	7,08	3,59	4,05	3,86

[A] Madonnanaldehyde / kg of meat.
[B] mg / kg of muscle.

However, by the 1st day on the Simulated retail display unit, the differences between diets were not detected. There was a significant interaction between time and diet on day 7, with a higher color saturation characterized by animal steaks on the S-PXC diet, compared to animal steaks on the S-CC and GS diets.

Preservation of the color saturation of steaks from animals on the diet of the S-PXC diet appears to reflect greater oxidative stability, with the lowest level of TBARS and the highest concentration of vitamin E (Table 5). The GS-based animal steaks were also associated with a lower TBARS, compared to the S-CC diet, although a similar amount of vitamin E was identified between the two groups (Table 5). The inclusion of PX in the fodder diet was associated with an increase in TBARS as compared to fattening only on grass, possibly due to higher concentrations of PUFAs associated with an increase in the proportion of PX. In contrast, the animal meat on the S-PXC diet had a lower TBARS value than the animals on the S-CC diet, probably because of additional vitamin E supplementation. However, for the oxidative effect of beef on taste, the TBARS value should be> 2 mg of malonaldehyde / kg of meat (Campoetal., 2006). In this study, TBARS is always <2 mg / kg of meat from all animals, regardless of diet.

The taste indicators of steaks slightly varied depending on the diet, although for the texture there were significant differences, from the terms "fatty" to "bloody" (Table 6).

Table 6: Flavored fried steaks (with a final temperature of 74 ° C in the center)

	Diet				
	S-CC	S-PXC	GS	GS-LPX	GS-HPX
8 point scale					
Texture	4,77	4,84	4,11	4,84	4,83
Juiciness	4,74	4,45	4,91	4,70	4,90
Intensity of beef flavor	4,90	5,03	4,77	5,21	5,21
Abnormal flavor intensity	3,14	2,97	3,17	2,89	2,70
Thickness 100 mm					
Greasiness	11,36	10,07	14,74	12,06	12,13
Bloodiness	5,83	4,09	9,63	6,66	7,03
Hepatic smack	13,32	13,61	15,93	14,26	13,38
Metallic taste	16,73	16,47	18,42	17,93	19,11
Astringency	7,71	7,39	10,88	7,03	7,67
Sweetness	10,61	9,95	12,05	10,88	10,04
Rancidity	1,99	2,71	4,56	2,42	0,75
Fish taste	6,15	4,19	6,23	5,01	4,67
Acidity	12,97	14,77	14,89	13,86	15,49
Cardboard	19,71	17,34	22,15	18,53	18,45
Vegetable / herbal flavor	13,19	10,86	14,21	14,99	13,68
Milk aftertaste	10,77	9,82	12,60	11,57	12,54
Hedonism					
General taste	47,29	48,56	47,59	51,73	53,49

Steaks from animals receiving the GS diet are associated with the lowest indicators of "texture" and the highest "greasiness" and "bloodiness" (table 6). Significantly better indicators of "texture" were noted in the other 4 diets, while the performance of the steaks from animals on the GS is much poorer in S-CC, S-PXC and GS-LPX diets for greasiness, and "bloody" for diets S- CC and S-PXC. While "greasiness" was associated with changes in general fatness, the fatness of animals was controlled in all diets. In addition, the difference in diets was not reflected in the "general taste".

Consequently, a moderate diet used for fattening cattle had a minimal effect on the taste of beef, but a significant effect on the composition of fatty acids.

CONCLUSION

1) Successful alignment of the rate of growth and structure of carcasses on diets prevented any confusing effects of changes in fatness and killer age on the composition of fatty acids. The increase in live weight, the age of slaughter, the mass of carcasses, the structure of the body and the nutritional indices were the same in all diets.

2) Evaluation of the fatty acid composition of meat showed that when using an extract of alfalfa (PX) compared to grass, there was an increased efficiency of the transformation of C18: 3n-3 from feed to muscle, probably due to a decrease in the biohydrogenation of fatty acids in alfalfa extract in the rumen.

3) Assessment of oxidative stability showed that despite the increase in thiobarbit number in beef with increased PUFA content, this did not lead to a decrease in its storage capacity.

4) Analysis of the formation of organoleptic characteristics of beef has shown that the least influence on the taste of beef is provided by the use of 5 diets (straw + compound feed containing 25% PX + vitamin E (~ 300 mg / kg) while significantly improving the fatty acid composition.

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