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RUMINANT NUTRITION

Investigation of the feed resource for buffalo

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ABSTRACT. Buffaloes make better use of coarse and inferior feed by converting them to biologically valuable animal production. They make very good use of the additional production of crop production, such as straw, sunflower cakes, sprouts and other. The aim is to study the physicochemical and fatty acid composition of the rations of buffalo of the Bulgarian mura breed in a church farm in Gigentsi village, Pernik District. The application of standard methods for the nutrition of buffaloes in separate periods - pastured with succulent fodder, winter (indoor) with coarse fodder, through which the ruminants are provided with the necessary nutritional components, allows to obtain high quality milk as a basic raw material for the production of dairy products. The use of succulent fodder and the incorporation of root crops into the feed instead of the buffalo concentrate provides them with respect to linoleic and alphalinolenic fatty acids, which are substrates for the synthesis of CLA (anticancer action) in rumen of ruminants.

Keywords: farm; fodder; ruminants; nutrition.

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Introduction

In many areas of the world, including Asia and Europe, where buffalos are an integral part of the food chain and the rural economy, the irregular and inadequate supply of quality feed and their proper nutrition impedes the work of this unique animal. Many efforts have been made in the last few decades to improve the nutrition and productivity of the various buffalo categories (Sarwar, Khan, Nisa, Bhatti, & Shahzad, 2009; Wanapat & Kang, 2013).

Various buffalo feeding practices in Italy rely on rations depending on the physiological category of the animals-usually a total, mixed ration based on maize silage 60 and ryegrass 40%. The ration is supplemented and equalized with high quality concentrate. The buffalo feeding system is intense, similar to that of dairy cows (Sabia et al., 2015).

When compiling rations for milking daily milkiness, fat content of milk and live weight of the animal should be taken into account (Wanapat & Kang, 2013). The intake of dry matter (DM) in buffaloes is very often lower than that in dairy cattle, about 16 kg DM^{-1}. Buffaloes show higher digestibility of crude protein (CP) and fiber (Ranjhan, 1992; O'Brien & Hennessy, 2017). Adapting them to variable alimentary rations results in high resistance, especially with regard to excess protein, with the result that these animals do not suffer from protein nutrition (Napolitano, Pacceli, Grasso, Braghieri, & Rosa, 2013).

The energy status of the ration for lactating buffaloes can range from 0.85 to 0.90 feed units milk per kilogram dry matter (FUM kg^{-1} DM), and the percentage of crude protein (CP) should be 14-15%. The same author assumes that 2.47 g of crude protein (CP) per 1 g of milk protein is an acceptable component of balanced ration in lactating buffaloes (Ranjhan, 1992).

Milk from animal species other than cattle is fundamental to the nutritional status and well-being of people in certain regions. Buffalo milk, as a product with its 102.04 million tonnes, holds a significant share in this respect. The fatty acid content of these animals varies depending on a number of factors-lactation, season and other (Lock & Bauman, 2004; Mendoza et al., 2005). Lactating buffaloes entering the rumen via green fodder or concentrates, unsaturated fatty acids are subjected to hydrogenation (oxidation) by synthesizing conjugated linoleic acids (CLA). The percent lipid content of buffalo milk is higher than that of cow's milk (El-Fattah, Rabo, El-Dieb, & El-Kashef, 2012).

Buffaloes follow a systematic daily diet from the barn to the pasture grassland of the pasture, passing through a variety of vegetation (grasses, forbs, shrubs and trees) that influence their selection for feed (forage). Knowledge of the behavior of these animals is important both for maintaining vegetation and for improving nutrition and dietary practices (O'Donovan, Lewis, & O'Kiely, 2011; Evangelou, Yiakoulaki, & Papanastasis, 2014; Xu et al., 2017).

The rearing of ruminants on free pasture grass condition on a diet rich in plant extracts improves the quality of milk and meat and is perfectly responsible for the concept of functional food in the human diet (Renna et al., 2012a; Renna, Lussiana, Cornale, Fortina, & Mimosi, 2012b; Castillo, Pereira, Abuelo, & Hernández, 2013; Orr, Griffith, Rivero, & Lee, 2019; Wagner et al., 2018). The fatty acid profile of grassland used for animal feeding in free-range grazing changes with advancement of vegetation and major fatty acid groups undergo significant changes, namely saturated and monounsaturated fatty acids decrease, while polyunsaturated fatty acids increase and this in turn affects the fatty acid content in milk from ruminants (Dervishi et al., 2012; El-Fattah et al., 2012; Pajor et al., 2014; Steinshamn, Inglingstad, Ekeberg, Mølmann, & Jørgensen, 2014; Soják et al., 2015; Vlaeminck et al., 2015; Smid, Weary, Costa, & Von Keyserlingk, 2017; Arnott, Ferris & O'Connell, 2017; Freitas et al., 2019).

The aim is to study the physicochemical and fatty acid composition of the rations of buffalo of the Bulgarian mura breed in a church farm in Gigentsi village, Pernik District.

Material and methods

The physicochemical and fatty acid composition of the rations of buffalo of the Bulgarian mura breed in a church farm in the village Gigintsi, Pernik district, in 2019 was investigated.

During the spring and summer season, the animals are fed with succulent fodder, which includes corn silage - 25, green fodder - 10, and pasture grass -20 kg. During the autumn and winter the feeding is carried out on a coarse basis with coarse fodder, which includes hay - 5, straw - 5, and combined feed (concentrate) - 4 kg, and two more feeding schemes are applied. The first variant includes concentrate - 5, silage - 20, straw 5, and hay - 5 kg, while the second variant contains hay - 3, straw - 5, silage - 20, and root (fodder beets) - 10 kg. During the transition or periparturient period buffalo rations were included alfalfa hay - 2.5, meadow hay - 4, straw - 3.5, corn silage - 9, and concentrate - 1,4 kg. The diet during the first half of the lactation (lactating 1) silage-hay type of feeding Includes meadow hay - 5.1, wheat straw - 4, corn silage - 18, brewery - 2, and concentrate - 1.9 kg. During the second half of lactation (lactating 2), the animals were fed ration of the following composition: meadow hay - 5, wheat straw - 4.5, corn silage - 15, and concentrate - 1,3 kg (Table 1).

Methods of analysis

- Humidity- BSS1109:1989, ISO 9622;
- Dry mater-BSS 1109:1989, ISO 9622;
- Crude protein-ISO 9622, BSS EN ISO 8968-1:2002;
- Crude fat-BSS EN ISO 1211:2002, ISO 9622;
- Crude ash-BSS 6154:1974;
- Extraction of total lipids was performed using the Bligh and Dyer (1959) method. Fatty acid methyl esters (Fame) were analyzed using a Shimadzu-2010 gas chromatograph (Kyoto, Japan).

The results were processed by the method of variation statistics with the statistical package of Excel 2010 software. The validity of the differences between the studied groups was established by the Student's t-test.

Table 1. Composition of the ration during the all all sessions buffalo rearing.

Type of feed	Succulent fodder	Coarse fodder	Transition period	Lactating 1	Lactating 2	Indoor 1	Indoor 2
Corn silage, kg	25		9	18	15	20	20
Green fodder, kg	10						
Pasture grass, kg	20						
Meadow hay, kg		5	4	5.1	5	5	3
Straw, kg		5	3.5			5	5
Combined feed (concentrate), kg		4	1.4	1.9	1.3	5	
Alfalfa hay, kg			2.5				
Wheat straw, kg				4	4.5		
Brewery, kg				2			
Root, kg							10

Results and discussion

Buffaloes make better use of coarse and inferior feed by converting them to biologically valuable animal production. They make very good use of the additional production of crop production, such as straw, sunflower cakes, sprouts, etc. The waste from the food and brewing industry - beetroot slices in the fresh and dry state, molasses, brewing mash, bran, casseroles and groats are also readily accepted. The daily milk yield, fat content of milk and live weight of animals should be taken into account when drawing up for buffalo milk rations. In the winter, bulky fodder is straw, corn, chaff, low quality hay, silage, root, tuber and succulent fruits. Coarse feed is fed at 3kg and juicy feed at 5 per 100 kg live weight. The concentrated feed is given 200-400 g per Liter of milk. A buffalo milk ration with a daily milk yield of 7 may consist of only 2 of alfalfa hay and 5 kg of haylage per 100 kg of live weight. Higher productivity also requires concentrated feed. During the summer, milk buffaloes meet their nutritional needs with green fodder in the amount of 35-80 kg. They can accept it depending on the technology of cultivation in the form of grazing or cribs. Buffaloes eat as normal as cattle. In winter, buffaloes feed on roughage-straw, corn, corn cobs, hay and more (calculated per 100 kg live weight) 2.5-3 kg, succulent feeds 3-8 kg and in milk buffaloes 320-350 g concentrated feed per 1 Liter of milk. In the summer, the buffalo milk is given only green feed and 1.5-2.1 kg of concentrated feed (Ranjhan, 1992).

The humidity content of the studied plant resource varies from 9.63 to 13.11% depending on the type of nutrition. The highest crude protein content - 13.97% was found in succulent fodder, while the lowest content in the second indoor feed - 8.91%. Significant differences were found between the crude protein obtained for the succulent feed and the crude protein when fed to buffalo during the transition period. The crude fat in the studied nutrition variants of the Bulgarian mura breed ranged from 2.41 to 3.49% and a low confidence was found in the nutritional resource of coarse fodder and in the transition period (Table 2). Crude fiber has the highest concentration in the second feeding regime of lactating buffaloes - 39.10%, and the lowest content in coarse fodder - 23.85%. The crude ash in the samples analyzed forage ranges from 5.47 to 6.90%. The nitrogen-free extracts (NFE) range from 24.41 to 50.84%. High reliability of the results was found between coarse fodder and feeding during the transition period and the first half of the lactation period ($p \leqslant 0.001$), and a reliability of $p \leqslant 0.01$compared to the nutrition during the second half of the lactation and the nutrition regime during the rearing indoor 1. The provision of animals with respect to the calcium element is best with the use of succulent fodder - 1.27%, in the diet of buffaloes throughout lactation - 1.22-1.29% and in the first variant of indoor feed - 1.25%, while in element phosphorus was found to have the highest concentration at the succulent fodder - 0.22% and the first indoor feeding - 0.22%. The nutritional ration is best provided with respect to the nitrogen element in the succulent fodder - 1.29% (Table 2).

The fatty acid profile of succulent fodder has a saturated fatty acid (SFA) content of 59.47 g 100 g fat^{-1}, as opposed to coarse fodder in which they are 57.39 g 100 g fat^{-1}. Monounsaturated fatty acids (Mufa) in succulent fodder are 20.46 g 100 g fat^{-1}, while in coarse fodder they are 0.65% higher (33.58 g 100 g fat^{-1}). Polyunsaturated fatty acids (PUFA) were 2.5 times higher in succulent than coarse fodder. Omega-3 fatty acids in succulent fodder have 3.2 times the content of coarse fodder, which makes it better secured with respect to biologically active omega-3 fatty acids. The content of omega-6 fatty acids in the succulent fodder under study is 13.50 g 100 g fat^{-1} and is 2.3 times higher than the coarse feed-5.93 g 100 g fat^{-1}. Despite the higher content of omega-3 and omega-6 fatty acids in succulent feed, the ratio of omega-6 and omega-3 fatty acids is 3.41 in succulent fodder, while in coarse feed it is 4.83 but below 5, which defines both feeds as healthy for ruminants (Table 3).

Feeding during the transition buffalo period is extremely important as the development of the fetus is equally negatively affected by both nutritional deficiencies and animal nutrition. The feeding of buffaloes during the periparturient period should be planned taking into account the specificities of embryonic development and future milk productivity. The malnutrition of buffaloes during the dry season results in low milk productivity for future breastfeeding buffaloes. The provision of lactating buffaloes was divided into two periods to provide for their need for nutritional components during the lactation period and to provide quality milk. The SFA during the transition period were 72.54 g 100 g fat^{-1}, in the first half of lactation 70.10 g 100 g fat^{-1}, and in the second half 76.92 g 100 g fat^{-1}, at the expense of monounsaturated fatty acids respectively 12.69, 13.30 and 13.58 g 100 g fat^{-1}and polyunsaturated fatty acids - 13.81, 15.13 and 6.78 g 100 g fat^{-1}. The content of omega-3 fatty acids during the periparturient period was 1.43 g 100 g fat^{-1}, in the first half of lactation 2.27 g 100 g fat^{-1}, and in the second half 1.26, the omega-6 fatty acids were respectively 12.31, 10.51 and 5.14 g 100 g fat^{-1}. The ratio of omega-6 to omega-3 fatty acids was 8.64 during the transition period, 4.64 in the first half of lactation and 4.08 in the second half of lactation. The application of winter indoor nutrition to buffaloes was in two types of buffalo meal, depending on the available nutritional resource. In the first variant of indoor nutrition the saturated fatty acid content was 63.93 g 100 g fat^{-1}, monounsaturated-22.71 g 100 g fat^{-1}, polyunsaturated - 10.20 g 100 g fat^{-1}, omega-3 fatty acids - 0.82 g 100 g fat^{-1}, omega-6 fatty acids - 7.76 g 100 g fat^{-1} and a ratio of omega-6/omega-3 fatty acids - 9.52. The second variant of indoor feed has a lower content of saturated fatty acids than the first - 55.83 g 100 g fat^{-1} and monounsaturated fatty acids - 17.23 g 100 g fat^{-1}, while polyunsaturated fatty acids have a higher content - 22.91 g 100 g fat^{-1}, omega-3 - 3.20 g 100 g fat^{-1}, omega-6 - 18.76 g 100 g fat^{-1}, resulting in a ratio of omega-6 to omega-3 fatty acids, low - 5.87. Branched fatty acids (BFA) had the lowest nutrition concentration during the transition period - 0.89 g 100 g fat^{-1}and the highest in the indoor fodder 2 - 4.03 g 100 g fat^{-1} (Table 3). The amount of branched fatty acids is determined by the microbiological activity in the food resource.

The main representatives of saturated fatty acids in the feeds tested were lauric (C12:0), myristic (C14:0), palmitic (C16:0) and stearic (C18:0) acids. The highest stearic acid content was found during feeding in the second part of lactation 24.70 g 100 g fat^{-1} and the lowest in succulent fodder - 2.11 g 100 g fat^{-1}. Myristic (C14:0) acid was at its highest concentration in the first half of lactating buffaloes - 28.29 g 100 g fat^{-1}and lowest in coarse feed - 8.39 g 100 g fat^{-1} (Table 4). Palmitic (C16:0) acid in different types of nutrition ranges from 12.88 (lactating 1) to 33.40 g 100 g fat^{-1} in coarse fodder. Stearic (C18:0) acid ranges from 2.43 to 7.81 g 100 g fat^{-1}.

Changes in the content of monounsaturated fatty acids were determined by trans 9 hexadecanoic (C16:1tr9-palmitelaidic acid), palmitoleic (C16:1n7), vaccinic (C18:1t11) and oleic (C18:1cis9) acid. The content of C-16:1tr9 ranges from 0.13 to 0.59 g 100 g fat^{-1}, palmitoleic (C16:1n7) from 0.24 to 5.34 g 100 g fat^{-1}, of vaccine (C18:1t11) acid from 0.03 to 0.51 g 100 g fat^{-1}, and oleic (C18:1c9) acid from 4.45 to 21.19 g 100 g fat^{-1} (Table 5). Identical results for the oleic (C18:1c9) acid content from 16.31 to 18.97 g 100 g fat^{-1} in grazing of buffalos have been established by Tsvetkova and Angelow (2010).

Of particular interest is the dynamical changes in linoleic (C18:2c9,12) and α-linolenic acid, which are substrates for the synthesis of conjugated fatty acid (CLA-anticancer action) in rumen of ruminants. The concentration of C18:2c9,12 in the feeds tested ranged from 1.58 to 15.93 g 100 g fat^{-1}, alpha-linolenic acid ranged from 0.06 to 3.37 g 100 g fat^{-1}, g-linolenic from 0.17 up to 0.89 g 100 g fat^{-1} (Table 6).

Table 2. Physicochemical composition (%) of the feed resource by categories.

Type of feed	Succulent fodder	Coarse fodder	Transition period	Lactating 1	Lactating 2	Indoor 1	Indoor 2
Humidity	13.11	9.63	12.25	11.77	12.36	12.35	12.51
Crude protein	13.97c	11.31	9.04d	9.21	9.17	10.36	8.91
Crude fat	3.18	3.49a	2.41b	2.78	3.06	2.99	3.17
Crude fiber	32.39	23.85	32.27	36.80	39.10	36.79	33.00
Crude ash	6.90	6.01	5.50	6.12	6.47	6.31	5.47
NFE	32.84	50.84eh	24.41i	28.55gj	31.12f	33.53g	37.46
Ca	1.27	1.04	1.08	1.22	1.29	1.25	1.15
P	0.22	0.21	0.17	0.17	0.15	0.22	0.16
N	1.29	-	0.72	0.74	0.74	0.73	0.67

[ab]Means in the same row without common letter are different at $p < 0.05$. [cdefg]Means in the same row without common letter are different at $p < 0.01$. [hij]Means in the same row without common letter are different at $p < 0.001$.

Table 3. Fatty acid (g 100 g fat^{-1}) composition of the food resource by categories.

Groups FA	Succulent fodder	Coarse fodder	Transition period	Lactating 1	Lactating 2	Indoor 1	Indoor 2
ΣCLA	0.00	0.15	0.15	2.42	0.56	1.68	1.01
ΣC18:1TFA	0.12	1.09	1.26	2.23	2.36	0.69	0.62
ΣC18:1CFA	15.92	21.52	9.74	7.36	5.30	14.54	12.48
SFA	59.47	57.39	72.54	70.10	76.92	63.93	55.83
Mufa	20.46	33.58	12.69	13.30	13.58	22.71	17.23
Pufa	17.45	7.21	13.81	15.13	6.78	10.20	22.91
Σn-3	3.95	1.23	1.43	2.27	1.26	0.82	3.20
Σn-6	13.50	5.93	12.31	10.51	5.14	7.76	18.76
Σn-6/Σn-3	3.41	4.83	8.64	4.64	4.08	9.52	5.87
BFA	2.63	1.82	0.89	1.38	2.71	3.16	4.03

Table 4. Saturated fatty acids (g 100 g fat^{-1}) in the feed resource by categories.

SFA	Succulent fodder	Coarse fodder	Transition period	Lactating 1	Lactating 2	Indoor 1	Indoor 2
C11:0	0.00	3.15	0.01	0.18	0.09	0.47	0.45
C12:0	2.11	2.51	21.76	24.31	24.70	12.54	13.79
C13:0	0.80	1.00	0.64	0.14	5.26	5.95	3.86
C14:0	11.16	8.39	19.25	28.29	20.25	12.73	8.86
C15:0	0.65	0.12	0.11	0.05	0.22	0.33	0.03
C16:0	32.67	33.40	26.23	12.88	18.60	27.44	24.53
C17:0	0.51	0.01	0.17	0.07	0.49	1.06	0.02
C18:0	7.16	7.81	3.48	2.43	6.12	2.59	3.12
C20:0	0.14	0.07	0.05	0.13	0.04	0.13	0.00
C21:0	0.98	0.27	0.03	0.30	0.29	0.34	0.25
C22:0	2.37	0.09	0.09	0.49	0.15	0.03	0.34
C23:0	0.28	0.04	0.03	0.26	0.11	0.06	0.16
C24:0	0.28	0.18	0.00	0.09	0.27	0.07	0.13
C25:0	0.00	0.13	0.29	0.00	0.01	0.11	0.18
C26:0	0.35	0.23	0.41	0.49	0.31	0.10	0.11

Table 5. Monounsaturated fatty acids (g 100 g fat^{-1}) in the feed resource by categories.

Mufa	Succulent fodder	Coarse fodder	Transition period	Lactating 1	Lactating 2	Indoor 1	Indoor 2
C10:1	0.52	2.69	0.00	0.17	0.00	0.07	0.20
C12:1n1	0.00	0.72	0.02	0.26	0.53	2.32	1.22
C14:1n5	0.00	0.16	0.08	0.14	0.33	0.11	0.29
C15:1n5	0.33	0.00	0.01	0.18	0.05	0.40	0.02
C16:1tr9	0.17	0.27	0.12	0.22	0.13	0.21	0.59
C16:1n7	2.11	5.34	0.24	0.59	1.01	2.15	0.93
C16:2n4	0.00	0.00	0.01	0.11	0.06	0.62	0.03
C17:1n7	0.22	0.64	0.18	0.07	0.22	0.44	0.04
C16:3n4	0.00	0.00	0.03	0.08	0.63	0.39	0.05
C18:1t4	0.05	0.24	0.06	0.46	0.10	0.00	0.08
C18:1t5/6/7	0.01	0.27	0.23	0.11	0.41	0.32	0.05
C18:1t9	0.00	0.24	0.20	0.25	0.30	0.00	0.06
C18:1t10	0.01	0.15	0.16	0.06	0.21	0.07	0.02
C16:4n1	0.00	0.00	0.00	0.14	0.00	0.00	0.00
C18:1t11	0.03	0.06	0.51	0.35	0.18	0.09	0.04
C18:1c9	15.82	21.19	9.19	4.45	4.63	13.68	11.40
C18:1t15	0.65	0.64	0.77	0.12	0.52	0.07	0.12
C18:1c11	0.00	0.04	0.00	0.11	0.75	0.03	0.14
C18:1c12	0.00	0.10	0.08	0.07	0.17	0.06	0.06
C18:1c13	0.08	0.05	0.04	1.26	0.04	0.35	0.16
C18:1t16	0.02	0.11	0.10	0.88	0.40	0.18	0.22
C18:1c14	0.02	0.00	0.12	0.65	0.22	0.08	0.34
C18:1c15	0.00	0.17	0.31	0.92	0.23	0.38	0.52
C20:1n9	0.00	0.10	0.04	0.29	0.25	0.38	0.00
C22:1n11	0.00	0.10	0.16	0.58	0.21	0.15	0.34
C22:1n9	0.33	0.16	0.03	0.47	1.52	0.07	0.09

Table 6. Polyunsaturated fatty acids (g 100 g fat^{-1}) in the feed resource by categories.

Pufa	Succulent fodder	Coarse fodder	Transition period	Lactating 1	Lactating 2	Indoor 1	Indoor 2
C18:2t9,12	0.04	0.16	0.10	0.68	0.31	0.47	0.46
C18:2c9,12	11.83	5.05	6.74	3.42	1.58	6.20	15.93
C18:3n6	0.00	0.28	0.33	0.89	0.34	0.17	0.54
C18:3n3	3.37	0.66	0.67	0.25	0.59	0.06	1.36
CLA10t,12c	0.00	0.00	0.00	0.51	0.02	0.60	0.15
C18:4n3	0.00	0.00	0.00	0.13	0.33	0.32	0.04
CLA9c,11c	0.00	0.11	0.06	0.30	0.28	0.61	0.33
CLA9t,11t	0.00	0.04	0.09	1.61	0.25	0.47	0.23
C20:2n6	0.53	0.17	4.43	3.56	2.44	0.55	1.04
C20:3n6	0.58	0.17	0.29	0.61	0.12	0.17	0.12
C20:4n6	0.47	0.00	0.34	1.02	0.13	0.12	0.33
C20:3n3	0.00	0.11	0.02	0.49	0.06	0.10	0.45
C20:5n3	0.30	0.08	0.10	0.44	0.07	0.01	0.40
C22:2n6	0.05	0.00	0.01	0.26	0.04	0.02	0.28
C22:5n3	0.28	0.03	0.16	0.21	0.08	0.02	0.65
C22:6n3	0.00	0.35	0.47	0.75	0.13	0.30	0.30

The use of succulent fodder and the incorporation of root crops into the indoor feed instead of the buffalo concentrate provides them with respect to linoleic and alphalinolenic fatty acids, which are substrates for the synthesis of (anticancer action) in rumen of ruminants.

Conclusion

Application of standard methods for nutrition of buffaloes during the separate periods-spring and summer (pasture) with succulent fodder, winter (sowed) with coarse fodder, transition period according to the needs of the buffalo mother for feeding and wear of the fetus, lactation-divided into two periods, the first being biologically adequate for feeding the toddler and the second during which providing the ruminants with the necessary nutritional components allows them to obtain high quality milk as a basic raw material for dairy production.

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