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Daily weight gain and slaughter value of young bulls fattened on fodders from permanent grassland and maize silage, taking into account the nutritional value of the fodder

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Chemical composition and nutritional value of roughage used in fattening 60 young bulls on 2 farms in the eastern Poland were analyzed. Daily weight gains of the fattened animals, as well as carcass weight and dressing percentage were determined. The roughage used on both farms was found to be of good quality, but a wider range of fodder was used on farm 1 because the bulls received haylage in addition to grass forage, hay and maize silage. The grass forage on farm 1 was of somewhat higher quality, as it contained 107.4 g PDIN and 97.6 g PDIE, compared to 94 and 91 g on farm 2. The nutritional value of the maize silage used on the two farms was comparable, while farm 2 had better quality hay. The mean daily weight gain for the animals during control fattening was 892 g. It was significantly higher on farm 1 – at 922 g compared to 875 g on farm 2 ($p \leq 0.05$). The dressing percentage for the bulls on farm 1 was also slightly higher (53.3%) than in case of the bulls on farm 2 (52.57%), but the difference was not statistically significant.

KEY WORDS: fattening of young bulls / daily weight gain / slaughter value / nutritional value of fodders

Nutrition to a considerable extent (65-70%) determines the efficiency of cattle fattening. The effect of nutrition may be defined by the growth rate, time required to obtain a specific body weight, feed conversion rate per 1 kg body weight gain as well as economic indexes, i.e. fattening profitability. Feeding intensity also affects post-slaughter indexes (dressing percentage, shares of individual primal cuts and tissue composition of

carcasses) as well as processability and dietary value of meat (marbling, tenderness, the fatty acid ratio) [1, 13].

In the case of beef we need to take into consideration high consumer expectations imposed on this meat, requiring a specific production technology for young slaughter cattle [21]. It was shown that by reducing feeding intensity and introducing forage produced on permanent grassland the dietary value of beef may be improved. According to Dannenberger et al. [8], green forage or silage from herbage contain greater amounts of polyunsaturated fatty acids, particularly *n-3*, while at the same time having a more advantageous *n-6*/*n-3* PUFA ratio in comparison to concentrates. Using fresh or ensiled herbage in the feeding of fattened cattle has a beneficial effect on the EFA concentration in muscle fat [2, 18].

The aim of this study was to analyse daily weight gains and slaughter value of young bulls fattened using feeds from permanent grassland and maize silage, taking into consideration the nutritional value of the fodder.

Material and methods

Analyses were conducted on 60 young bulls fattened on 2 farms located in eastern Poland, purchased at the age of approx. 2 months. They were animals of various breeds typical of that region, i.e. Polish Black-and-White, White-back, Polish Red, Polish Holstein-Friesian and Simmental. A total of 20 young bulls were fattened on farm 1, while 40 young bulls were kept on farm 2. On both farms the animals were kept in stanchion barns on deep litter. After the period of being fed milk and milk replacers the calves were fed grass silage and hay with an addition of concentrates. In the control fattening period (from the age of 6-7 months) on farm 1 animal nutrition in winter was based on haylage and maize silage, while in the summer season it was based on fresh forage, haylage and maize silage. On farm 2 in the winter season young bulls were fed maize silage and hay, while in the summer season it was mainly green forage, supplemented with maize silage. On both farms the feed rations were supplemented with a slight addition of ground grain. In the fattening period samples of all feeds used on the farms were collected twice in order to determine their nutritional value. The basic chemical composition of feeds was determined, i.e. dry matter content (by the over dry method according to the PN-88/R-04013 standard), crude protein (according to Kjeldahl as specified in the PN-75/A-04018 standard), fat (according to Soxhlet - the PN-76/R-64753 standard), crude fibre (the PN-76/R-64814 standard), ash (PN-76/R-64795) and nitrogen-free extractives. Analysis of the nutritional value consisted in the determination of PDIN (the total of ruminally undegradable protein contained in feed and microbial protein degradable in the small intestine calculated based on ruminally available nitrogen), PDIE (the total of ruminally undegradable feed protein and microbial protein digested in the small intestine calculated based on ruminally available energy), UFV (energy units for feed and forage) calculated using the INRAtion-PrevAlim 3.3 software. Upon the completion of fattening

the young bulls were slaughtered following the technology used in meat industry practice and supervised by a veterinarian.

The results were analysed statistically applying the one-way analysis of variance ANOVA in the STATISTICA ver. 9 software. The significance of differences between means was determined by the Duncan test.

Results and discussion

Data presented in Table 1 indicate that maize silage used on both farms during the winter feeding season had an adequate dry matter content, amounting to approx. 30% (i.e. characteristic of crops harvested at the dough stage). In their study Kowalik and Michalski [12] reported that at the milk-dough stage the dry matter content in the plant material prior to ensiling is 25.9%, when crops were harvested at the dough stage it is 29.5%, while at harvest performed at the beginning of full ripeness the dry matter content in the material is 34.7%, respectively. Dry matter content was also adequate in haylages produced from grass on farm 1 (54.3-61.2%) and in hay from farm 2 (91.3%), as well as ground grain used on both farms (87-88.4%, respectively). In turn, in their study Brzóska and Śliwiński [4] reported that dry matter content in green forage should be approx. 160-240 g/kg, in silages from wilted grasses 300-400 g/kg, while in maize silages it should be 280-340 g/kg. Dry matter content in samples of hay, straw and dried feed should be approx. 880-900 g/kg. In a study by Żurek et al. [23] the content of dry matter in silages from wetland meadows and pastures from the Biebrza river valley ranged from 43% to 66%, depending on the mowing date.

Minimum crude protein in feed, which is required to ensure proper digestion in the bovine alimentary tract, needs to be 150-170 g/kg DM [3, 15]. In the tested forages from the winter feeding period the crude protein content ranged from 7.5% DM in maize silage from farm 2 to 19.6% DM in haylage from farm 1. A slightly higher crude protein level was recorded in maize silage used in winter feeding on farm 1, as it amounted to 9.7% DM. In turn, all the tested feeds covered mean protein requirement, which according to the National Research Council [14] for adult fattening cattle is approx. 70 g/kg DM. In the opinion of various authors [5, 6], crude protein concentration in maize silage is below 100 g/kg DM. This is also confirmed by the results recorded by Sowiński et al. [20], giving 51-67 g protein in 1 kg DM, and by Dawo et al. [9], who reported 82-85 g. In a study by Podkówka and Podkówka [16], crude protein content ranged between 86 and 131 g in 1 kg DM.

The content of crude fat, which is determined as the ether extract, in bulky feeds generally falls within the range of 2-5% DM. Crude fat content in the tested forages used in the winter feeding period (Table 1) ranged from 2.4% DM in hay to 4.8-5.0% DM in grass haylage and maize silage. Particularly in the final stage of the fattening period thanks to the use of large amounts of bulky feeds, having a more advantageous fatty acid profile, we may obtain more desirable essential fatty acid (EFA) ratios in animal tissues [10]. In their studies Bilik and Kowalski [1] and Warren et al. [22] reported that when grass and

Table 1
Basic chemical composition and nutritional value of fodders used to fatten young bulls

Fodder	Basic analysis												Nutritional value					
	Dry matter (%)		Total protein (% DM)		Crude fat (% DM)		Crude fibre (% DM)		Crude ash (% DM)		Digestible nitrogen-free extractives (% DM)		PDIN (g)		PDIE (g)		UFV	
	Farm 1	Farm 2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Winter feeding																		
Maize silage	29.1	29.2	9.7	7.5	4.8	4.8	24.5	20.2	3.8	3.8	57.2	63.7	62.0	48.0	70.0	67.0	0.82	0.86
Haylage I	61.2	–	19.6	–	4.9	–	29.2	–	7.4	–	38.9	–	114.0	–	78.0	–	0.79	–
Haylage II	54.3	–	17.5	–	5.0	–	27.5	–	6.1	–	43.9	–	103.0	–	75.0	–	0.80	–
Hay	–	91.3	–	11.9	–	2.4	–	30.8	–	7.1	–	47.8	–	77.0	–	81.0	–	0.66
Grain meal	87.0	88.4	11.7	12.5	3.1	3.0	9.0	10.7	3.3	4.3	72.9	69.5	77.0	83.0	89.0	88.0	0.86	0.83
Summer feeding																		
Grass forage	14.4	17.2	17.1	15.2	3.1	3.2	25.0	25.9	12.2	13.0	42.6	42.7	107.4	94.0	97.6	91.0	0.91	0.74
Maize silage	38.5	25.0	8.7	9.2	2.6	3.1	21.2	21.2	4.6	3.7	62.9	62.8	55.0	59.0	71.0	71.0	0.83	0.86
Haylage I	49.7	–	10.4	–	2.5	–	21.6	–	12.1	–	53.4	–	67.0	–	69.0	–	0.85	–
Haylage II	65.3	–	12.1	–	2.9	–	33.8	–	6.4	–	44.8	–	67.0	–	59.0	–	0.65	–
Hay	91.1	91.5	10.1	12.4	2.8	2.5	33.4	27.0	5.4	8.1	48.3	50.0	63.0	77.0	74.0	81.0	0.63	0.66
Grain meal	88.1	89.3	13.2	11.1	2.4	5.9	6.0	11.6	1.8	2.4	76.6	69.0	87.0	73.0	98.0	82.0	0.98	0.78

meadow herbage are used in the fattening of cattle the content of linolenic acid (C 18:3 *n-3*) in the produced meat increases at the expense of the respective level of linoleic acid (C 18:2 *n-6*).

In terms of feed quality an important parameter when evaluating forage in feeding of ruminants is connected with fibre content. A too low fibre content in feed contributes to a reduced pH in the rumen and thus it promotes acidosis. On farm 1 haylages were the primary source of fibre in the feed ration, as they contained 27.5-29.2% fibre in DM, while on farm 2 the same function was served by hay with 30.8% fibre in DM. These results confirm the study presented by Nazaruk et al. [15], who reported crude fibre content in hay within the range of 218-362.9, and in haylage at 217-374 g/kg DM. In turn, in a study by Chabuz et al. [7] differences were found in crude fibre content depending on the ensiling method used for roughage, i.e. the application of ensiling agents or their lack. In the case of maize silage prepared with the addition of ensiling agents fibre content was lower (by 3 pp), while opposite trends were observed for haylage.

Haylage used in fattening of cattle on farm 1 proved to be a rich source of protein digested in the small intestine, i.e. metabolisable protein supply (ruminally non-degradable protein and microbial protein), providing 103-114 g PDIN and 75-78 g PDIE. Maize silage fed on that farm was also characterised by a higher PDIN level at 62 g/kg DM in relation to 48 g in silage used on farm 2. In turn, when analysing the energy value of feeds (UFV) a higher level was recorded for maize silage from farm 2, amounting to 0.86 in relation to 0.82 in silage from farm 1. For the other feeds a higher content of available energy was found in feeds from farm 1. This is confirmed by the results concerning contents of nitrogen-free extractives, which ranged from 38.9% DM for haylages to 72.9% in ground grain.

Analyses of crude protein contents in forages fed in the summer feeding period showed its higher levels in green forage from farm 1 (17.1% DM) in comparison to the green forage produced on farm 2 (15.2%). Opposite dependencies were recorded for maize silage and hay fed in the summer feeding period, as these feeds from farm 2 contained slightly higher protein levels. In turn, the content of crude fibre in green forage used on both farms was comparable, amounting to 25.0% DM in those forages from farm 1 and 25.9% DM in those from farm 2. In terms of the nutritional value of these feeds higher quality grass green forage was used on farm 1, as it contained 107.4 g PDIN and 97.6 PDIE in comparison to 94 and 91 g, respectively, in green forage from farm 2. It also had a greater energy value expressed as UFV (by approx. 22%). A comparable nutritional value was observed for maize silages used on both farms, whereas higher quality hay was fed on farm 2 (77 g PDIN and 81 g PDIE). The differences in the energy value (UFV) of the other feeds ranged from 3% for maize silage to 5% for hay. On farm 1 feeding was also based on haylage of high energy value, which amounted to 0.69-0.85 UFV (44.8-53.4 NFE). According to the INRA nutritional standards, the energy value of silage from permanent grassland ranges between 0.66 and 0.87, depending on the harvest date, dry matter content and ensiling method used.

Table 2
Fattening results and slaughter value of the young bulls

Specification		Farm 1 (n=20)	Farm 2 (n=40)	Average (n=60)
Initial body weight (kg)	x	203.1	197.6	199.6
	SD	21.4	29.0	26.3
Weight gain during control fattening (g)	x	922.0*	875.0*	892.0
	SD	54.0	93.0	84.0
Weight gain from birth to slaughter (g)	x	914.0**	842.0**	869.0
	SD	70.0	67.0	76.0
Hot carcass weight (kg)	x	308.0**	274.7**	287.0
	SD	31.1	34.4	36.7
Dressing percentage (%)	x	53.3	52.57	52.84
	SD	2.03	1.43	1.69

**The means between groups differ significantly at $p \leq 0.01$
*The means between groups differ significantly at $p \leq 0.05$

Generally it may be stated that on both farms bulky feeds were of good quality; nevertheless, a greater variety of forage was fed on farm 1, since next to green forage, hay and maize silage it also included haylage.

The age of experimental animals at the beginning of the control fattening period was around 6-7 months, while their body weight was approx. 200 kg (Table 2). The mean age of the animals at slaughter was also comparable, i.e. 19-20 months.

A richer composition of roughage was fed on farm 1, as haylage was also included in the feed rations, which may have influenced the uptake of nutrients and as a consequence it could also result in greater body weight gains, amounting to 922 g in comparison to 875 g on farm 2 ($p \leq 0.05$).

The mean hot carcass weight in the analysed group of young bulls was 287 kg, while hot carcass yield was 52.84%. A greater hot carcass weight was obtained from animals from farm 1, as it was 308 kg vs. 274.4 kg in animals from farm 2 ($p \leq 0.01$). Young bulls from farm 1 had a greater hot carcass yield (53.3%) in comparison to animals from farm 2 (52.57%). However, the recorded difference was statistically non-significant.

In a study conducted by Warren et al. [22] young bulls – Aberdeen Angus x Holstein-Friesian crosses when feeding included soybean concentrate had lower daily weight gains (by approx. 10%), lower body weight before slaughter (by approx. 4.5%), lower dressing percentage (approx. 5%) as well as less advantageous dressing percentage (approx. 40%) and carcass fatness (approx. 20%) in comparison to animals fed using bulky feeds, despite attempts to balance available nutrients in the feed ration. In meat of animals from that group an increased level of α-linolenic acid (18:3 *n-3*) was recorded in comparison to young bulls fed concentrates, along with an increased synthesis of long-chain *n-3* C20-22 PUFA in the phospholipid fraction, including docosahexaenoic acid (DHA, 22:6 *n-3*).

In their study Realini et al. [17] reported that in a typically extensive breed (Hereford), in the feeding system based on nutrient-dense feeds a superior carcass cutting yield was observed along with a larger rib-eye steak area in comparison to the respective results of animals grazing in the pasture. Their carcasses contained also more subcutaneous fat. A darker meat colour (i.e. a lower share of L colour) was recorded in young bulls grazing on the pasture, while their fat had a higher share of the yellow colour. In turn, intramuscular fat of young bulls grazing on the pasture was characterised by a higher total CLA concentration, primarily *cis*-9 and *trans*-11 CLA, in relation to animals fattened using concentrates (5.3-2.5 and 4.1-2.3 mg CLA/g fat). Similar results were reported by French et al. [11], who found 10.8 mg total CLA/g fat in the longissimus dorsi muscle in young bulls fed grass and 3.7 mg in animals fattened in the intensive feeding system. In turn, Shantha et al. [19] when analysing the semimembranosus muscle recorded 7.7 mg total CLA/g fat in young bulls fed grass and 5.2 mg in the case of animals fed maize with an addition of grass.

In summary it may be stated that in the studied farms forages of good quality were used in animal feeding; nevertheless, a richer composition (a greater variety) was found on farm 1, where next to green forage, hay and maize silage animals were also fed haylage. This may have influenced the availability and thus also the uptake of nutrients, which in turn may have affected weight gains of the analysed fattening bulls and their carcass weights.

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