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[Witold Chabuz](#) , [Paweł Żółkiewski](#) ^{*} , [Wioletta Sawicka-Zugaj](#) , Krzysztof Buczek , Marta Staniec , [Sylwester Kowalik](#) , Piotr Rydel , Andrzej Lisowski

Posted Date: 18 September 2023

doi: 10.20944/preprints202309.1156.v1

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Article

Adaptability of Polish Red Cows to Extensive Feeding Conditions

Witold Chabuz ¹, Paweł Żółkiewski ^{1,*}, Wioletta Sawicka-Zugaj ¹, Krzysztof Buczek ², Marta Staniec ², Sylwester Kowalik ³, Piotr Rydel ⁴ and Andrzej Lisowski ¹

¹ Department of Cattle Breeding and Genetic Resources Conservation, University of Life Sciences in Lublin, Akademicka Str. 13, 20-950 Lublin, Poland

² Department of Epizootiology and Clinic of Infectious Diseases, University of Life Sciences in Lublin, Głęboka Str. 30, 20-950 Lublin, Poland

³ Department of Animal Physiology, University of Life Sciences in Lublin, Akademicka Str. 12, 20-950 Lublin, Poland

⁴ Polish Red Cattle Breeders Association, Rumian 55, 13-220 Rybno, Poland

* Correspondence: pawel.zolkiewski@up.lublin.pl, +48814456574

Abstract: The aim of the study was to assess the adaptability of Polish Red cows to extensive housing and feeding conditions. The study was carried out using 22 cows together with their offspring, kept on a certified organic family farm, from 15 October 2017 – the start of the winter feeding season – to 30 October 2018 – the end of the pasture season. The animals were kept as beef suckler cows, which stayed in the pasture during the summer and were kept in buildings with permanent access to a large cattle run in winter. The following were determined in the study: changes in the cows' weight and body condition, daily gains in calves, 210-day standardized body weight, and estimated milk yield of suckler cows. To evaluate the cows' health, blood was collected from them twice and analysed for haematological and biochemical parameters. The results indicated that during the study period the Polish Red cows had adequate body condition, normal vital parameters, and a normal course and development of pregnancy despite the sparse winter diet. This definitively confirms the breed's high capacity to adapt to an extensive system.

Keywords: native breed; vital parameters; body condition; poorer-quality feedstuffs; suckler cows

1. Introduction

Adaptation in the animal world can be described as an evolutionary process in the conditions of a demanding environment, competition for food, migration in search of pastures, challenges associated with disease, and also the needs of civilization, which has allowed a relatively small group of animals to transform into a separate and distinct unit in a specific geographic and climatic niche [1].

From a scientific and practical perspective, adaptation is a problem to solve, because it usually has low heritability, e.g. 0.04–0.08 for respiration rate and rectal temperature. Furthermore, it can have antagonistic genetic correlations with milk production [2,3].

Adaptation in animals can currently be treated as the combined effect of multiple factors, and the adaptability of farm animals is largely dependent on farmers and their ways of exploiting these abilities and managing available resources (land, feed, water and capital) [4]. An additional problem is rapidly progressing climate change, to which organisms must adapt. Adaptation can take various forms and take place at various rates, depending on the type of response, the trait, the population, and environmental conditions. The current decline in biodiversity has made it clearly evident that many species and populations of both animals and plants are unable to adapt rapidly enough to the changes taking place in nature [5]. The subject of adaptation of farm animals has also been raised by the Food and Agriculture Organization of the United Nations (FAO) [6], which has indicated the need to protect genetic resources in order to preserve a valuable reservoir of genes that can be of great importance in the age of widespread climate change.

Examples of adaptation include morphological, anatomical, physiological, biochemical and behavioural mechanisms which help the animal to survive in a given environment [7]. Adaptation can be defined as a response to a specific factor (stressor). It can be short-term (phenotypic) and non-genetic or long-term (generational) and genetic. Short-term reactions are usually caused by severe stress factors such as a heat wave in a temperate climate zone. The same heat waves in a subtropical, tropical or equatorial zone will be treated as chronic stressors. Non-genetic responses to such factors include reduced feed intake or an increased respiration rate. At the same time, the same stressor in some animals may lead to permanent changes in gene expression, allowing the animals to cope better than those with a short-term response [4,8]. When a stress factor acts for a sufficiently long time, the physiological responses resulting from the expression of beneficial genes and their combinations can become established in the entire population through suitably conducted selection [1].

The most commonly mentioned environmental stressors determining the comfort of animals include temperature, humidity, wind speed, and solar radiation. Studies on these factors have resulted in several indices, such as the black globe-humidity index [9], equivalent temperature index [10], heat load index [11], adjusted temperature humidity index [12], comprehensive climate index [13], and index of thermal stress for cows [14], which are variants of the temperature-humidity index developed by Thom [15]. This type of stressor magnifies the role of sensible heat transfer (by conduction, convection, or radiation) and latent heat transfer (evaporation through sweating and panting) [16]. A short-term response when the neutral values of these factors have been exceeded may be the activation of mechanisms aimed at maintaining homeothermy, i.e. an increased respiration rate, increased rectal temperature, reduced pulse, panting, profuse sweating, and decreased feed intake [7,17,18]. Animals which are able to maintain their physiological responses within normal ranges in stressful environmental conditions are considered to be adapted to this environment [19].

A classic example of adaptation is that of zebu cattle (*Bos indicus*) to the specific conditions of a hot, humid climate, characterized by increased sweating compared to *B. taurus*, owing to highly dense sweat glands with a sac-like shape and greater volume [20–24]. In addition, each sweat gland duct is joined to one hair follicle [25], so that the sweat glands are much denser than in *B. taurus* cattle [26–28].

Another example of anatomical adaptations, reported by Brito et al. [29], is differences in the ratio of the length and volume of the testicular arteries to the volume of the testes, thickness of the testicular artery wall, and the distance between the arterial and venous blood in the testicular vascular cone. The authors compared the anatomical structure of the Nelore and Angus breeds and showed twofold differences in the ratio of the length and volume of testicular arteries to the volume of the testes, in favour of the Nelore breed representing *Bos indicus*. This resulted in a twofold difference in the decrease in blood temperature after passing through the testicular vascular cone.

A specific adaptive trait of local populations is resistance to disease. An example is trypanosomiasis, transmitted by ticks. The main vectors in cattle are *Trypanosoma congolense* and *Trypanosoma vivax*. Mattioli et al. [30] and Lemecha et al. [31] showed the highest trypanotolerance in African breeds of *B. taurus* – N'Dama, present in central and western Africa, and Sheko, raised in eastern Africa. The cattle most susceptible to the disease are breeds of both *B. taurus* and *B. indicus* referred to as exotic in this area.

Regarding local breeds, researchers often indicate many beneficial traits in this group of farm animals, including longevity, fertility, adaptation to difficult living conditions, and resistance to disease [32]. The oldest indigenous breed, not only in Poland but in all of Europe, is considered to be Polish Red cattle, derived from the short-horned taurine cattle *Bos taurus brachyceros* [33]. The current population of Polish Red cows, concentrated mainly in southern and northern Poland, is estimated at about 2800 head [34], of which about 2600 cows on 248 farms are covered by a genetic resources conservation programme [35]. Breeding of this breed is supported by two programmes: the Genetic Improvement of Breeds Programme and the Genetic Resources Conservation Programme. According to Adamczyk et al. [36], Polish Red cattle are distinguished by high resistance to difficult environmental conditions, good health and resistance to disease, very high fertility and calf viability,

longevity, the ability to reduce yield to survive temporary feed deficits, rapid regeneration of lost body condition, and very good milk quality.

The aim of the study was to assess the adaptability of cows of the Polish Red breed in an extensive housing and feeding system.

2. Materials and Methods

2.1. Experimental design and feeding

The study was carried out using 22 Polish Red cows with their offspring, kept at a certified organic family farm located in a lowland area of central-eastern Poland. The study was carried out from 15 October 2017 – the start of the winter feeding season – to 30 October 2018 – the end of the pasture season. The animals were kept as beef suckler cows. They stayed in the pasture during the summer and were kept in buildings with permanent access to a large cattle run in winter.

The experiment was begun on 15 October 2017, when the animals had left the pasture, and the herd was divided into two feeding groups. Group 1 was fed rye straw, straw from a cereal blend, wheat straw, and meadow hay from floodplains, with nutritional value similar to that of straw. Group 2 was fed haylage and meadow hay. The feed was supplied *ad libitum*, and the animals' basic nutritional needs were ensured in accordance with the INRA cattle feeding system (INRAration 4.07 software).

To determine changes in the cows' weight and body condition, the animals were weighed and their body condition was assessed on the 5-point BCS scale (Body Condition Score), at the start and end of winter feeding – 15 October 2017 and 1 March 2018. All cows included in the experiment gave birth to healthy calves, which were weighed twice – at birth and at weaning.

The weights of the calves were used to determine the following:

- daily gains:

$$DG = (WW - BW) / A_w$$

where:

BW = calf weight at birth

WW = calf weight at weaning

A_w = calf age at weaning

- 210-day standardized body weight:

$$W_{210} = (WW - BW) / A_w \times (210 - A_w) + WW$$

- the milk yield of suckler cows was estimated according to the use value assessment method for meat cattle [37]:

$$MYC = WW \times 1700 / A_w$$

2.2. Selection of animals for the research

Cows chosen for the experiment were matched for age, lactation number, physiological status, and body condition. The average age of the cows expressed as lactation number was 4.6 (4.9–4.3 lactations). Physiological status was expressed as gestation length. At the start of the study it ranged from 76 to 81 days, and at the end of the winter feeding season the cows were on average in their 216th day of gestation (213 days – group 1 and 218 days – group 2; Table 1).

Table 1. Age and physiological status of cows

		Feeding group		Total
		1	2	
Lactation number	N	11	11	22
	X	4.9	4.3	4.6
	SD	2.4	2.5	2.4
	X	76.1	81.5	78.8

Day of gestation (days) – start of winter feeding	SD	31.7	34.7	32.6
Day of gestation (days) – end of winter feeding	X	213.1	218.5	215.8
	SD	31.7	34.7	32.6

Note: Feeding group 1 – Diet based on straw and meadow hay; Feeding group 2 – Diet based on haylage from permanent grassland and meadow hay.

2.3. Blood collection and analyses

To determine the cows' health parameters, blood was drawn from them twice – at the start and end of the experiment.

Blood was collected from the external jugular vein using a sterile needle and Vacutainer blood collection tubes (Becton, Dickinson and Company, USA). About 2 ml of blood was collected once into a tube containing EDTS K2, and about 9 ml of blood was collected once into a tube containing a clotting activator. The samples were then cooled in a water bath to about +4°C. Haematological analysis of the whole blood collected into tubes with an anticoagulant was performed using an automatic haematological analyser with species-specific software (Horiba Scil Vet ABC Plus, Horiba Ltd., Japan), to determine the number of erythrocytes, leukocytes, and thrombocytes as well as the haematocrit and haemoglobin concentration. In addition, red blood cell parameters were determined: mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and mean corpuscular volume (MCV).

The study protocol was approved by the II Local Ethics Committee to Animal Experiments (Decision No. 104/2015 of December 8, 2015).

Blood samples with a clotting activator were centrifuged (2000 G x 10 min, +4°C), and the serum obtained was analysed for biochemical parameters: bilirubin, total cholesterol, creatinine, urea, total protein, and minerals – Ca, Mg and P. The activity of enzymes was determined as well: alanine aminotransferase (ALAT), aspartate aminotransferase (AspAT), and alkaline phosphatase (ALP). These parameters were determined by colorimetric methods using AlphaDiagnostics reagent kits (AlphaDiagnostics, Poland).

The results were read using an automatic biochemical analyser Mindray BS-120 (Mindray, China).

Statistical analysis of the data was performed using Statistica 13.0 software. Means and standard deviation were calculated. Significance of differences for means was tested by one-way analysis of variance (ANOVA) and Duncan's multiple range test at $p \leq 0.05$ and $p \leq 0.01$. For haematological and biochemical parameters of the blood, due to the varied physiological status of the cows (advancement of lactation), the significance of differences was analysed only within feeding groups in a given feeding period, without comparing the parameters obtained at the start and end of the winter feeding season.

3. Results

The feeds used during the winter feeding period can be classified as extensive due to their high content of crude fibre (29.9–43.0% in group 1 and 24.3–28.5% in group 2) and low content of crude protein (5.25–7.00% in group 1 and 12.62% in group 2). The feedstuffs used in group 2 had higher content of crude protein compared to group 1, with lower content of crude fibre (Table 2).

Table 2. Nutritional value according to the INRA system and the proximate chemical composition of the feedstuffs used in the diet of lactating cows

Feedstuff	Dry matter (%)	Content of nutrients in per kg d.m.							
		UFL	PDIN (k/kg)	PDIE (g/kg)	FUC	Crude protein (g/kg)	Crude fat (g/kg)	Crude fibre (g/kg)	Crude ash (g/kg)
Group 1 (hay, straw)									

Wheat straw	93.85	0.42	38	44	1.60	6.06	2.07	31.2	3.71
Rye straw	93.25	0.42	39	44	1.60	6.19	1.47	37.9	3.3
Straw from cereal blend	94.32	0.42	33	44	1.60	5.25	1.93	43	3.85
Meadow hay (2nd cut)	93.36	0.70	44	67	1.10	7.00	1.23	29.9	4.08
Group 2 (hay, haylage)									
Meadow hay (1st cut)	92.73	0.77	78	84	1.0	12.62	1.53	28.5	4.47
Haylage from permanent grassland (1st cut)	62.84	0.74	83	84	1.10	13.37	1.73	24.3	6.16
Haylage from permanent grassland (2nd cut)	66.08	0.83	78	87	1.00	12.62	2.37	25.4	5.72

Note: UFL - feed unit for milk production; PDIN – protein truly digestible in the intestine with nitrogen limiting factor for microbial synthesis in the rumen; PDIE – protein truly digestible in the intestine with energy limiting factor for microbial synthesis in the rumen; FUC - fill unit for cows.

The rearing parameters for the calves in the study population are presented in Table 3. Calves in both groups had similar birth weight, on average 32.7 kg. They were also weaned from their mothers at a similar age – 211.5 days in group 1 and 215.7 days in group 2. The body weight of the calves at weaning was 204.5 kg in group 1 (fed straw and hay) and 233.5 kg in group 2 (fed hay and haylage). The difference was confirmed statistically ($p \leq 0.01$). As a result, the daily gains in calves born to cows from group 2 were 110 g higher than in group 1 (930 g and 820 g, respectively), and their 210-day standardized body weight (228.9 kg) was higher than in group 1 (204.4 kg; $p \leq 0.01$). The milk yield of the mothers in group 2 was also significantly ($p \leq 0.01$) higher (1848.8 kg of milk) than in group 1 (1655.2 kg of milk).

Table 3. Rearing parameters of calves

Parameter	Feeding group		Total	
	1	2		
	N	11	11	22
Birth weight (kg)	X	32.0	33.4	32.7
	SD	2.5	3.6	3.1
Age at weaning (days)	X	211.5	215.7	213.6
	SD	21.4	20.9	20.8
Body weight at weaning (kg)	X	204.5 ^B	233.5 ^A	219.0
	SD	12.0	19.8	21.8
Daily gains until weaning (kg)	X	0.82 ^B	0.93 ^A	0.88
	SD	0.08	0.08	0.10
210-day standardized body weight (kg)	X	204.4 ^B	228.9 ^A	216.6
	SD	16.5	15.3	20.0
Mothers' milk yield (kg)	X	1655.2 ^B	1848.8 ^A	1752.0
	SD	157.4	139.9.5	175.9

Feeding group 1 – Diet based on straw and meadow hay; Feeding group 2 – Diet based on haylage from permanent grassland and meadow hay. A,B – means in rows with different letters are significantly different ($p \leq 0.01$).

The body weight of the cows at the start of the experiment – the start of the winter feeding period – ranged from 531 to 576 kg (for groups 1 and 2, respectively). The body condition score of cows

(BCS) averaged 3.5 in group 1 and 3.8 in group 2. In both groups the body condition score decreased (by BCS 0.6) during winter feeding. There were minor fluctuations in the body weight of cows during the experiment (the winter feeding period). It should be noted that at the end of the winter feeding period the cows were in advanced gestation (Table 4).

Table 4. Changes in the body weight and body condition (BCS) of cows during the winter feeding period

Parameter		Feeding group		Total
		1	2	
	N	11	11	22
Body weight of cows (start of winter feeding) (kg)	X	531.1	576.4	553.7
	SD	52.8	61.7	60.6
Body weight of cows (end of winter feeding) (kg)	X	532.4	566.4	549.4
	SD	57.7	65.1	62.5
Changes in body weight in winter feeding period (kg)	X	1.27	-10.0	-4.4
	SD	40.6	36.4	38.1
Body condition of cows (start of winter feeding) (BCS, pts.)	X	3.5	3.8	3.7
	SD	0.6	0.5	0.5
Body condition of cows (end of winter feeding) (BCS, pts.)	X	2.9	3.2	3.1
	SD	0.5	0.4	0.5
Changes in body condition in winter feeding period (BCS, pts.)	X	-0.6	-0.6	-0.6
	SD	0.3	0.3	0.3

Note: Feeding group 1 – Diet based on straw and meadow hay; Feeding group 2 – Diet based on haylage from permanent grassland and meadow hay.

Haematological analysis of the blood of the cows revealed no significant differences in parameters between feeding groups 1 and 2 (Table 5). It could be noted that at the start of the winter feeding period, group 1 had slightly lower values for all haematological parameters than group 2. It should be emphasized, however, that in all cows, in both group 1 and group 2, the average values for the haematological were generally within physiological ranges for the species. It is worth mentioning that total bilirubin exceeded the norm. In this case, as for cholesterol content and aspartate aminotransferase, there were statistically significant differences between feeding groups (Table 6).

Table 5. Results of haematological analyses of the blood of cows at the start and end of the winter feeding period in two feeding groups.

Parameter	Ref. range*	Feeding group				Total	
		1		2		X	SD
		X	SD	X	SD		
Start of winter feeding season							
WBC (white blood cells) (10^9)	4.0-12.0	6.71	1.43	7.01	1.38	6.86	1.38
RBC (red blood cells) (10^{12})	5.0-10.0	6.20	0.56	6.41	0.49	6.31	0.52
HCT (haematocrit) (%)	24.0-46.0	28.52	2.19	29.72	3.14	29.12	2.71
HGB (haemoglobin) (g/dl)	8.0-15.0	11.04	0.80	11.58	1.04	11.31	0.95
MCV (mean corpuscular volume) (fl)	40.0-60.0	46.08	2.60	46.42	4.55	46.25	3.62
MCH (mean corpuscular haemoglobin) (pg)	11.0-17.0	17.85	0.80	18.14	1.51	18.00	1.19

MCHC (mean corpuscular haemoglobin concentration) (g/dl)	30.0-36.0	38.77	0.79	39.14	0.70	38.95	0.75
PLT (platelets) (10 ⁹)	100-800	164.91	23.94	174.09	47.95	169.50	37.28
End of winter feeding season							
WBC (white blood cells) (10 ⁹)	4.0-12.0	6.68	1.28	7.75	1.26	7.22	1.35
RBC (red blood cells)(10 ¹²)	5.0-10.0	5.86	0.55	6.24	0.43	6.05	0.52
HCT (haematocrit) (%)	24.0-46.0	30.98	3.70	32.55	2.69	31.76	3.25
HGB (haemoglobin) (g/dl)	8.0-15.0	10.95	1.16	11.62	0.87	11.28	1.06
MCV (mean corpuscular volume) (fl)	40.0-60.0	52.81	2.77	52.32	4.90	52.56	3.89
MCH (mean corpuscular haemoglobin) (pg)	11.0-17.0	18.71	0.85	18.70	1.53	18.70	1.21
MCHC (mean corpuscular haemoglobin concentration) (g/dl)	30.0-36.0	35.48	0.77	35.82	0.57	35.65	0.69
PLT (platelets) (10 ⁹)	100-800	140.73	37.83	137.18	26.75	138.95	32.02

Note: Feeding group 1 – Diet based on straw and meadow hay; Feeding group 2 – Diet based on haylage from permanent grassland and meadow hay. *Reference ranges according to *Merck's Veterinary Manual* [38].

Table 6. Results of biochemical analyses of the blood of cows at the start and end of the winter feeding period in two feeding groups.

Parameter	Ref. range*	Feeding group				Total	
		1		2		X	SD
		X	SD	X	SD		
Start of winter feeding season							
ALAT (U/l)	11-40	27.92	5.69	28.52	2.70	28.22	4.36
ALP (U/l)	0-500	30.89	6.68	31.97	9.67	31.43	8.13
AST (U/l)	60-125	61.22 b	10.34	74.91 a	13.47	68.06	13.66
BIL (mg/dl)	0.0-1.6	0.43 B	0.08	0.66 A	0.26	0.54	0.22
Ca (mg/dl)	8.0-11.4	10.53	0.35	10.72	0.16	10.63	0.28
CHOL (mg/dl)	65-220	113.94	35.55	138.05	29.74	126.00	34.29
CREA (mg/dl)	0.5-2.2	1.27	0.29	1.10	0.22	1.18	0.26
Mg (mg/dl)	1.5-2.9	2.22	0.22	2.19	0.17	2.21	0.19
Phos (mg/dl)	5.6-8.0	5.20	1.12	5.75	0.85	5.47	1.01
Urea (mg/dl)	10-25	13.63	4.31	15.29	4.32	14.46	4.30
TP (g/dl)	6.7-7.5	7.82	0.63	7.69	0.54	7.75	0.58
End of winter feeding season							
ALAT (U/l)	11-40	21.97	2.66	21.15	3.27	21.56	2.94
ALP (U/l)	0-500	22.02	4.15	22.08	7.59	22.05	5.97
AST (U/l)	60-125	44.85	9.66	44.42	8.22	44.63	8.75
BIL (mg/dl)	0.0-1.6	1.48 b	0.44	1.98 a	0.47	1.73	0.51
Ca (mg/dl)	8.0-11.4	7.58	0.66	8.05	0.48	7.81	0.61
CHOL (mg/dl)	65-220	92.76	21.23	95.86	22.85	94.31	21.58
CREA (mg/dl)	0.5-2.2	0.71	0.17	0.74	0.21	0.73	0.19
Mg (mg/dl)	1.5-2.9	1.54	0.23	1.48	0.17	1.51	0.20
Phos (mg/dl)	5.6-8.0	2.34	0.83	2.10	0.65	2.22	0.74
Urea (mg/dl)	10-25	18.04	6.91	21.90	6.98	19.97	7.06
TP (g/dl)	6.7-7.5	2.41	1.00	2.82	1.00	2.62	1.00

Note: Feeding group 1 – Diet based on straw and meadow hay; Feeding group 2 – Diet based on haylage from permanent grassland and meadow hay. Significance of differences was analysed only within feeding groups in a given feeding period. a,b – means within rows with different letters are significantly different ($p \leq 0.05$). A,B –

means within rows with different letters are significantly different ($p \leq 0.01$). *Reference ranges according to *Merck's Veterinary Manual* [39] and [40].

4. Discussion

Domestic cattle, as a domesticated form of the aurochs *B. primigenius*, should be a species with good adaptability to environmental conditions and tolerance for poor nutrition. In modern times, these traits are found in *B. indicus*, whereas *B. taurus* is characterized by lower voluntary feed intake [41,42], higher feed efficiency on a high-roughage diet [41], and a lower metabolic rate [16]. In effect, maintenance energy requirements in *B. indicus* and its hybrids are lower than for *B. taurus* [43–45]. However, some adaptive traits have been preserved in various populations of *B. taurus*. One example is the typical lowland Jersey breed, which was imported and acclimatized to the high mountain conditions of Tibet, adapting to local conditions, associated with both diet and the reduced oxygen levels in the air [46,47]. Another example of adaptability is the Simmental breed, which adapted superbly to the difficult climate conditions of South Africa, where it has been raised for 100 years [48].

The minimal changes in body weight during the winter feeding period observed in the study population of Polish Red cows indirectly confirm their good utilization of feed with low nutritional value. According to Konopiński [49], from the 18th century to the interbellum period Polish Red cattle were already spread across nearly all Polish lands. The fact that this breed was bred mainly by peasants, while the nobility preferred mainly imported breeds (Dutch Black and White or Simmental), says a great deal about its conformation and functional traits. Long-term breeding in these conditions led to the perpetuation of traits such as resistance to severe climatic conditions, poorer-quality feedstuffs, and even periodic feed shortages during the winter feeding period [50].

After the winter feeding period, the cows had a lower BCS, but it was not reflected in their body weight. Changes in BCS are associated with the strategy of accumulation of lipid tissue by ruminants during periods with a large amount of nutrient-rich feed and its mobilization for energy production in times of shortage [51–53]. This situation is characteristic of indigenous breeds in subtropical environments, where wet seasons are interspersed with long dry periods with low quantity and quality of pastures, and the ability to store fat in seasons of abundance and later use it for maintenance, pregnancy and lactation during adverse seasons is a basic survival strategy. Negussie et al. [51] and Ermias et al. [52] presented an example of this kind of adaptation based on accumulation of fat in different parts of the body in Horro and Menz sheep raised in Ethiopia but in varying environmental conditions (e.g. elevation above sea level).

Nutrient-poor winter feeding did not affect the birth weight of calves, which did not deviate from the averages for the entire national population [results of assessment by [34], but did significantly affect the cows' milk yield and thus daily weight gains in the calves. This suggests that during the period when Polish Red cows are fed low-quality feed, they reduce their milk yield while maintaining energy reserves for the foetus. This is the reverse of the situation in high-yielding cattle breeds, which maintain high milk yield at the expense of their own bodies. Local breeds in particular have this type of adaptation, as described by Mirkena [53]. In his opinion, breeds adapted to moderate temperatures are highly productive, but require a balanced feed ration composed of high-quality ingredients. On the other hand, they lose weight, and deaths may even occur, when they are fed poor-quality grass or straw. In contrast, animals of indigenous breeds continue to grow, produce some milk, and reproduce in difficult conditions.

The average daily weight gains of calves obtained in the present study, amounting to 880 g, were higher than those reported by Litwińczuk et al. [54] (730 g). It should be noted that the calves in the present study were kept with their mothers in the pasture, while in the study by Litwińczuk et al. [54] the animals were kept indoors without their mothers. Similar daily gains (850 g for heifers) or somewhat higher values (1120 g in bullocks) than in the present study were reported by Choroszy and Choroszy [55] for feedlot calves up to 12 months of age. Among breeds of the Baltic Red type, Danish Red has the highest daily gains, at 1090 g [56], similar to Norwegian Red (1020–1040 g) [57]. Somewhat lower effects were obtained for Lithuanian Red (970 g) [58].

The blood haematological and biochemical parameters of the animals did not show major deviations from the normal range during the winter feeding period. This may indicate adequate physiological adaptation of the Polish Red breed to variable climatic conditions, and thus feeding conditions. On the other hand, when the cows were switched from pasture feeding to winter feeding, the average serum levels of total cholesterol (CHOL), total bilirubin (BIL), and aspartate aminotransferase (AST) differed significantly ($p \leq 0.05$; $p \leq 0.01$) between feeding groups 1 and 2. Nevertheless, the values were within the physiological ranges for this species and evened out following the winter feeding period. The only parameter that exceeded reference values was the total bilirubin concentration. The significantly higher ($p \leq 0.01$; $p \leq 0.05$) blood parameters in the cows tested in spring (March) in comparison to autumn may be linked to their advanced pregnancy, as cases of an increase in this parameter in cows during this period have been described. Kozitcyna et al. [59] noted a successive increase in the total bilirubin concentration in cows from 6 to 9 months of gestation. The highest bilirubin concentrations, exceeding reference values, were noted immediately after parturition by Zhou et al. [60] and persisted for about two weeks. This has also been confirmed by Rohn et al. [61].

González et al. [62] and Moreira et al. [63] indicate that analysis of GLDH, GGT and AST activity and the concentration of bilirubin are particularly useful in diagnosing subclinical liver damage and dysfunction in the course of fatty liver disease. However, the results of the analyses of parameters whose values change significantly in such cases (CHOL, AST, and ALAT) did not confirm this type of disease. The increase in the bilirubin concentration may also have been caused by a long-term energy deficiency in the feed ration, leading to anaemia [64]. However, this hypothesis is not confirmed by the haemoglobin and haematocrit values in the populations, which did not change significantly during the period when they were fed poor-quality feed. Nevertheless, the significantly higher bilirubin levels obtained in the groups of animals fed on haylage and permanent grassland (group 2) may indicate a dietary cause of these differences.

5. Conclusions

Based on the study, it can be concluded that cows of the Polish Red breed have great adaptability to extensive farming systems. This is indicated by very good utilization of feed with low nutritional value, as well as adequate body condition, normal vital parameters, and a normal course and development of pregnancy despite the sparse winter diet.

Author Contributions: Conceptualization, W.C., P.Ż. and P.R.; methodology, W.C., P.Ż., K.B., M.S. and P.R.; software, P.Ż.; validation, W.C., P.Ż. and W.S.-Z.; formal analysis, P.Ż., W.C. and S.K.; investigation, W.C. and P.Ż.; resources, K.B., M.S., S.K. and A.L.; data curation, P.Ż., K.B., M.S., P.R. and A.L.; writing—original draft preparation, P.Ż., W.S.-Z.; writing—review and editing, W.C. and W.S.-Z.; visualization, P.Ż.; supervision, W.C., W.S.-Z.; project administration, W.C.; funding acquisition, W.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the “Uses and conservation of farm animal genetic resources under sustainable development” project co-financed by the National Centre for Research and Development in Poland within the framework of the strategic R&D program “Environment, agriculture and forestry” BIOSTRATEG, contract number: BIOSTRATEG2/297267/14/NCBR/2016. Publication co-financed by a statutory activity subsidy from the Polish Ministry of Education and Science for Faculty of Animal Sciences and Bioeconomy University of Life Sciences in Lublin.

Institutional Review Board Statement: The animal study protocol was approved by the Ethics Committee of University of Life Sciences in Lublin (Decision No. 104/2015 of December 8, 2015).

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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