

The relationships between the types of temperament on residual feed intake and the productivity of Kazakh White-Headed bulls



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Abstract The RFI of the most calm bulls (with temperament 1) was -0.83 ± 0.67 , and in bulls with a moderate temperament (temperament 2), this indicator was 36.5% less, that is, -0.53 ± 0.55 . The RFI of bulls with an excited temperament was 0.19 ± 0.85 , and in aggressive bulls, this indicator was 0.62 ± 0.86 . It is noted that the calmer the bulls are, the lower the RFI and vice versa. The highest average daily increase was in bulls with temperament 1 (equal to $1,507 \pm 0.06$ g), and in bulls with temperament 4, the average daily increase was $1,191 \pm 0.1$ g, which is 20.97% lower than that of their most calm peers. However, the difference in the average daily gain between bulls with temperaments 3 and 4 was 70 g or 5.56%, respectively, in favor of bulls with temperament 3. The average daily gain of bulls with temperament 3 was $1,261 \pm 0.09$ g, which was 5.97% lower than that of calmer bulls. At the end of the test, the body weight of the calmer bulls was greater than that of their peers with the most aggressive temperament. In particular, the body weight of bulls with temperament 1 was $312.78^a \pm 4.44$ kg, which is 12 kg or 3.9% greater than that of bulls with temperament 2, whose average body weight is $300.60^{ab} \pm 3.19$ kg. The lowest average body weight was observed in bulls with temperament 4 (aggressive) – $291.48^b \pm 7.17$ kg. $295.47^b \pm 6.70$ kg. Bulls with a temperament of 3 were weighed and lagged behind their peers with a temperament of 2 by 5.13 kg.

Keywords: meat steers, meat productivity, temperament, average daily gain, RFI

1. Introduction

The study of the ethics of farm animals, namely, the temperament of beef cattle, is relevant not only in Kazakhstan but also abroad. Temporary temperament affects many productive indicators of cattle (Uskenov et al., 2023).

Animal weight (BW) and average daily weight gain (ADG) are the main indicators of beef cattle productivity. The traditional method of weighing involves moving cattle to a weighing site, which is time-consuming, stressful and has a negative impact on their growth. An alternative approach is to use special weighing platforms attached to drinkers for weighing animals. This method allows daily monitoring of body weight and ADG without additional labor or stress. (Uskenov et al., 2023). Therefore, the Brazilian Intergado system was developed to solve these problems. Intergado's feed consumption and behavior monitoring technology is used by agricultural research centers and premium seed production centers around the world to conduct research in the field of animal husbandry and measure feeding efficiency.

In beef cattle breeding, product producers select cattle by temperament, primarily for safety reasons.

However, some studies show that the temperament of cattle can also have production and economic consequences for the production of meat (Café et al., 2011).

In beef cattle breeding, feeding efficiency is an important economic indicator not only because of the high cost of feed but also because of the growing need to reduce waste related to animal husbandry (for example, manure and intestinal methane) and the associated environmental impact. In addition, feed costs constitute approximately 70-80% of the entire production cycle (Llonch et al., 2016).

Due to the increased profitability of farms and the reduced environmental impact associated with increased efficiency, researchers have devoted much effort to studying strategies to improve feeding efficiency (Campo et al., 2010).

Feed conversion is one of the indicators used to measure the effectiveness of feeding beef cattle. Breeding based on residual feed intake (RFI) has recently been used as an indicator of feed efficiency because it is not related to animal body weight (BW). Residual feed intake was defined as the difference between observed and predicted dry matter intake (DMI) (Baldassini et al., 2017).

Temperament can also influence these abovementioned indicators. The selection of cattle classified

with a negative RFI (residual feed intake) and a calmer temperament will lead to an increase in feeding efficiency since it identifies animals consuming less feed than predicted based on the performance and growth of the animal (Café et al., 2011). The purpose of this study was to assess the influence of the temperament of bull calves on residual feed intake and on the growth of bull calves.

2. Materials and Methods

Purebred bulls of the Kazakh white-headed breed aged 7-8 months were selected for the experiment. By the end of the test, the bulls were 11-12 months old. The animals were selected considering the characteristics of the breed, sex, age, origin and body weight. During the trial period, the bulls were maintained under the same feeding and maintenance conditions.

The residual feed intake (RFI) was calculated using the Internado system (Brazilian System). The calculations of the RFI were carried out according to the following formulas:

$$\text{RFI} = \text{DMI}_{i1} - \text{DMI}_{i2} = \varepsilon_i$$

$$\text{DMI}_{i2} = a + b_1 \text{MBW}_i^{0.75} + b_2 \text{ADG}_i$$

where:

RFI – residual feed intake

DMI_{i1} – observed consumption of dry matter

DMI_{i2} – expected consumption of dry matter

a: intercept;

$b_1 \text{MBW}_i^{0.75}$: regression coefficient of the effect of metabolic body weight

$b_2 \text{ADG}_i$: regression coefficient of the effect of the average daily increase

The studies were conducted using the Internado system. On the VW1000 Internado Smart scales, bulls were weighed daily when they came to the drinker, and their individual weights were determined using an electronic ear

tag. The average daily increase was determined by the following formula: $A = \frac{W_1 - W_0}{t_1 - t_0}$, where t is the duration (in days) from the previous weighing session to the subsequent weighing session, W_0 is the live weight at the beginning of the period, and W_1 is the live weight at the end of the period.

The location of the research was the Akmola region, Republic of Kazakhstan. The study period is November–January 2022.

In our study, the diet of the experimental bulls consisted of feed produced on the farm. Feeding norms during the period of scientific research corresponded to the breed, live weight and physiological condition of the bulls. The diet contained 124.00 OE (metabolic energy), 11.934 g DM (dry matter), 1432 g CP (crude protein), 5200 g CF (crude fiber), 358 g CF (crude fat), 5131 g NDK (neutral detergent fiber), 324 g NDP (nondegradable protein), 321 g MP (microbial protein), -24.3 g BAR (nitrogen balance in the rumen), 55 g Ca, and 32 g P.

The temperament of the bulls was measured in two parts. The first is the flight score (exit velocity from the split). This is a subjective assessment assigned to an animal based on its behavior when exiting the split. Again, there is no widespread version of this test, but the score is often assigned based on a four-point scale (1-walking; 4-jumping) (Lanier et al., 2002). In combination with a subjective assessment, the exit or flight speed can also be recorded. This technology was first introduced by Burrow et al. (Burrow et al., 1988) to record the time taken by animals to reach a given distance after exiting a split or other confined space. A set distance of 1.77 meters was chosen because it is slightly shorter than the split. It is believed that the exit rate is a more objective indicator of temperament than the exit score or any other categorical variable. SPSS 25.0 (2017) software was used to obtain descriptive statistics.



Figure 1 VW-1000 Smart scale.



Figure 2 AF-1000 electronic feeders.

3. Results and Discussion

ANOVA was used to evaluate the influence of the temperament of the bulls on the average daily increase in temperature. The normality of the data was checked using the Kolmogorov–Smirnov test ($P=0.200$), and using the Levene test, it was found that the deviations were homogeneous ($P>0.05$). SPSS 25.0 software was used for the analysis. The results of the studies are shown in Table 1.

According to Table 1, the RFI of bulls with temperament 1 varied from -4.94 to 2.88, and that of bulls with temperament 2 varied from -4.70 to 3.97. The RFI of excited bulls with temperament 3 varied between -8.36 and 4.52 from the smallest to the largest, while that of aggressive bulls with temperament 4 ranged from -4.83 to 4.59. According to the analysis of variance, the relationship between RFI and temperament was not statistically significant. The significance level (P) is equal to - 0.525.

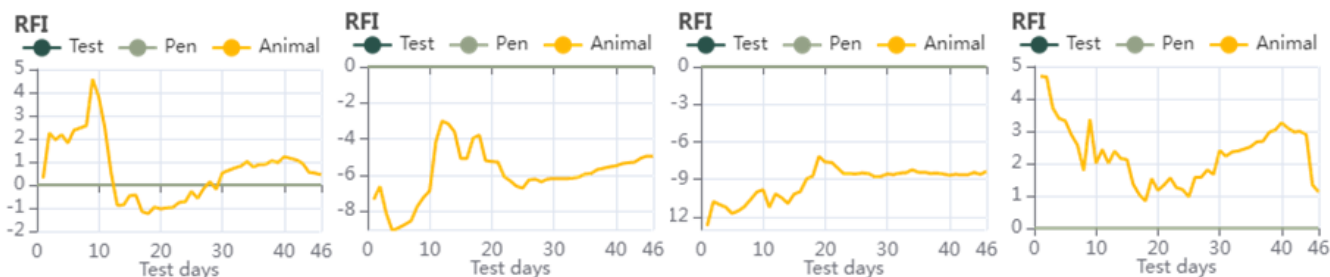


Figure 3 Examples of RFI bulls with the identification numbers KZC159731577, KZC159731592, KZC159731966, and KZC159731608.

Table 1 The influence of the temperament of bulls on residual feed intake (n=70).

Temperament	N	RFI, M±m	Lim	
			Min	Max
1	17	- 0.83±0.67	-4,94	2,88
2	25	- 0.53±0.55	-4,70	3,97
3	16	0.19±0.85	-8,36	4,52
4	12	0.62±0.86	-4,83	4,59
P value			0.525	

According to this Figure 4, it should be noted that the RFI of the most calm bulls (with temperament 1) was - 0.83±0.67, and in bulls with a moderate temperament (temperament 2), this indicator was 36.5% less, that is, - 0.53±0.55. The RFI of bulls with an excited temperament was 0.19±0.85, and in aggressive bulls, this indicator was equal to 0.62± 0.86. It was noted that the calmer the bulls were, the lower the RFI was.

A detailed analysis of the relationship between temperament and RFI have shown that calmer bulls had the lowest RFI compared to the most aggressive bulls. Each criterion (temperament and RFI) individually can be used to improve cattle performance and breeding selection, however, it is necessary to take into account the fact that the significance level between these criteria is very low.

Studies have shown that selection for low RFI, a characteristic of efficient livestock, affects the growth, yield

and quality of carcasses; reduces feed consumption with equal weight and average daily growth; improves the ratio

of feed and growth by 10-15%; and reduces the yield of methane and manure.

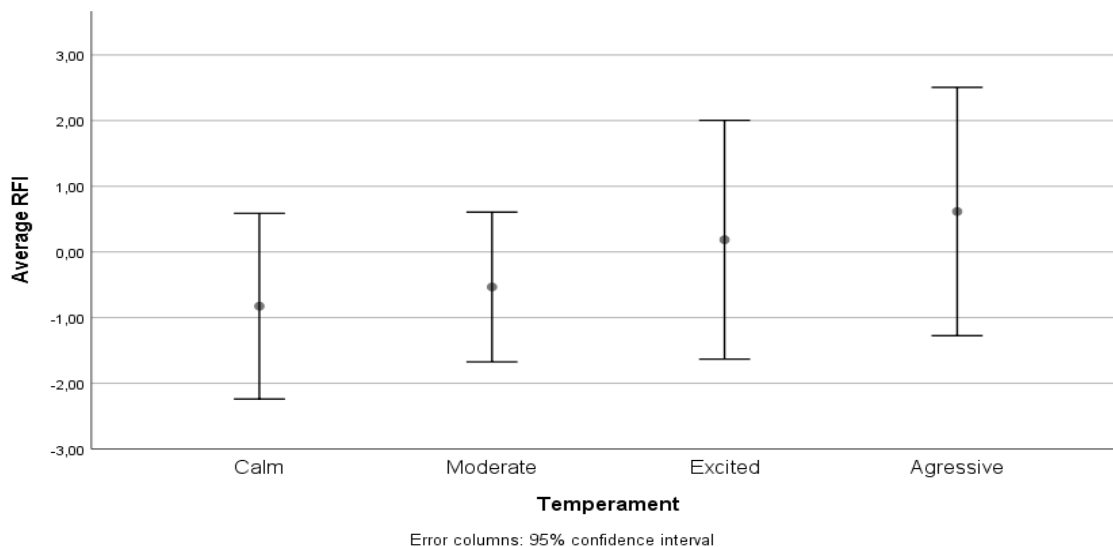


Figure 4 Dependence of temperament and RFI.

The residual feed intake (RFI) is an indicator of feeding efficiency that allows one to identify animals with similar indicators but differing in energy consumption for maintenance and production.

Scientists have found that some individuals have high growth rates at a low level of forage consumption, while others, under the same conditions of feeding and maintenance, reach small values at a high degree of consumption (Kadel et al., 2006).

Data obtained from beef cattle indicate that more efficient animals spend less time on the feeder than less efficient animals (Adam et al., 1984), possibly saving energy while doing this and spending more time in a sitting or lying

position. In addition, increased efficiency of animal feeding may be associated with decreased stress and decreased concentrations of circulating cortisol (Cundiff et al., 2010). However, negative zero phenotypic correlations (Maffei et al., 2006) were observed between RFI and flight speed (as an indicator of temperament).

To study the influence of the temperament of the bulls on the average daily increase, ANOVA was used. The normality of the data distribution was checked using a Q-Q graph, and the Levene test was used to determine that the deviations were homogeneous ($P > 0.05$). SPSS 25.0 software was used for the analysis. The results of the studies are shown in Table 2.

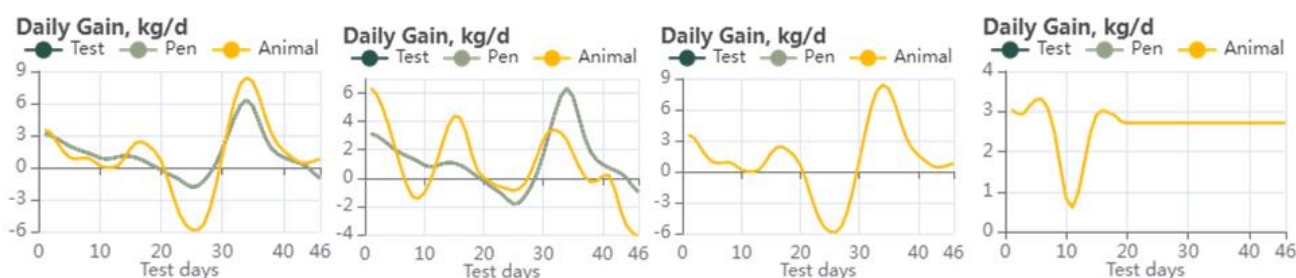


Figure 5 Examples of ADG bulls with the identification numbers KZC159732028, KZC159731601, KZC159732028, and KZC159731949.

Table 2 Average daily gain of bulls with different temperaments (n=70).

Temperament	ADG M±m, g	δ	Lim	
			Max	Min
1	1,507±0,06 ^a	0,26	1,170	1,950
2	1,341±0,05 ^{ab}	0,24	0,910	1,740
3	1,261±0,09 ^b	0,37	0,460	1,840
4	1,191±0,1 ^b	0,29	0,790	1,670
P value	0,031			

a,b: Different letters in the same column indicate a significant difference ($P < 0.05$).

According to the table, the highest average daily increase occurred in bulls with temperament 1 (equal to $1,507 \pm 0.06$ g), and in bulls with temperament 4, the average daily increase was $1,191 \pm 0.1$ g, which was 20.97% lower than that of the most calm peers. However, the difference in the average daily gain between bulls with temperaments 3 and 4 was 70 g or 5.56%, respectively, in favor of bulls with temperament 3. The average daily gain of bulls with temperament 3 was $1,261 \pm 0.09$ g, which was 5.97% lower than that of calmer bulls.

According to the analysis, it was found that temperament has a fruitful effect on ADG, and this is also

confirmed by the fact that the significance level is more than 95%.

As shown in the figure, the observed values of the ADG data coincided with the expected values; that is, the degree of deviation of the data from the theoretical distribution was minimal, which indicated normality of the distribution ($P > 0.05$).

Adaptation of beef cattle to interactions with humans at the early stages of their productive life can be an alternative to improving their temperament and, consequently, increasing their development and productivity (Maffei et al., 2006).

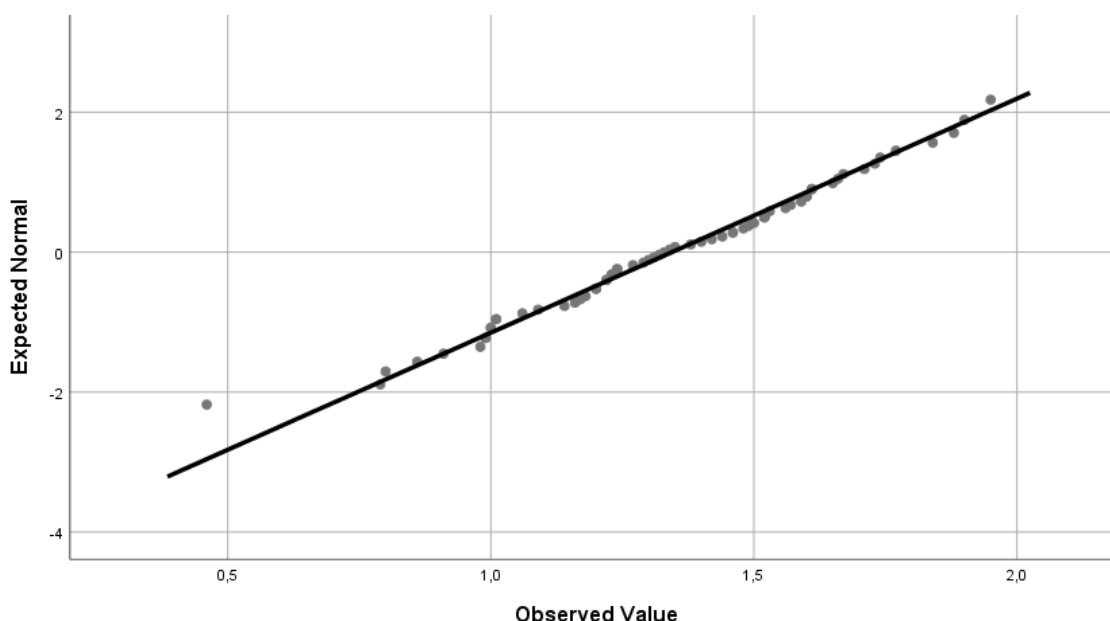


Figure 6 The distribution of ADG data according to the Q–Q graph.

Several studies have shown that temperament affects average daily gain. As the temperament of cattle becomes more excitable, the average daily gain (ADG) decreases. This detrimental effect of an excitable temperament on the ADG can be explained by three factors. First, temperamental cattle spend more time inspecting the environment and responding to “threats” instead of consuming feed and/or additives, which leads to a decrease in feed consumption compared to that of calm cattle (Cooke et al., 2012). Second, the nutrients used to increase live weight are redistributed to maintain the altered behavior of temperamental cattle (Voisinet et al., 1997). Third, the altered physiology of the body of temperamental cattle directly affects the increase in body weight. For example, an increased concentration of cortisol stimulates the destruction of body tissues, such as muscle and fat deposits, to release energy and protein to further support the behavioral response to stress (Fell et al., 1999).

Scientific research was conducted to study the influence of the temperament of bulls on live weight. ANOVA was used for this purpose, and the normality of the data was checked using the Kolmogorov–Smirnov test ($P > 0.05$); moreover, using the Levene test, it was found that the deviations were homogeneous ($P > 0.05$). SPSS 25.0 software was used for the analysis. The results of the studies are shown in Table 3.

According to the table, the average live weight of the bulls ranged from 206.72 ± 0.919 to 207.29 ± 0.830 kg. At the beginning of the test, all the bulls had approximately the same weight. The average live weight of all the bulls was 207.05 ± 0.496 kg. The minimum live weight of the bulls was 200 kg, and the maximum was 218 kg. The significance level (P) was – 0.969. The relationship between the live weight in the formulation and the temperament of the bulls was not significant.



In addition to reducing growth rates, an excitable temperament also has a detrimental effect on carcass quality. Excitable temperament, as a rule, is negatively related to the final weight of the carcass and the degree of carcass yield (Voisinet et al., 1997).

According to the analysis, at the end of the test, the live weight of the calmer bulls was greater than that of their peers with the most aggressive temperament. In particular, the live weight of bulls with temperament 1 was $312.78^a \pm 4.44$ kg, which is 12 kg or 3.9% greater than that of bulls with temperament 2, whose average live weight is $300.60^{ab} \pm 3.19$ kg. The lowest average live weight was observed in bulls with temperament 4 (aggressive) – $291.48^b \pm 7.17$ kg. A total of $295.47^b \pm 6.70$ kg weighed bulls with temperament 3 and lagged behind their peers with temperament 2 by 5.13 kg, and 5.6% weighed less than the most calm bulls.

It is important to note that the relationship between the live weight of the bulls at the end of the test and temperament was statistically significant; that is, the significance level (P) was less than 0.05.

Despite the fact that temperament does not affect the initial weight of the bulls, it productively affects the final weight of the bulls. Thus, breeding towards the most calm bulls is not only economically efficient, but also profitable for the farmers themselves.

According to the results of the data obtained, the most calm bulls gained weight faster; therefore, they had a large average daily increase. Notably, in calm animals, weight gain was 14-10% greater than that in more excitable bulls (Della Rosa et al., 2018).

Table 3 Relationship between body weight and temperament (n=70).

Temperament	N	Initial weight X ± m, kg	δ	Lim	
				Min	Max
1	17	207,29±0,830	3,42	200	214
2	25	206,72±0,919	4,59	200	216
3	16	207,18±1,215	4,86	200	218
4	12	207,25±1,023	3,54	200	212
P value	0,969				
Temperament	N	Final weight X ± m	δ	Lim	
				Min	Max
1	17	312,78 ^a ±4,44	18,31	288,00	343,50
2	25	300,60 ^{ab} ±3,19	15,93	270,70	329,10
3	16	295,47 ^b ±6,70	26,78	235,20	338,80
4	12	291,48 ^b ±7,17	21,52	260,30	325,90
P value	0,038				

Table 4 Correlation coefficients between RFI, initial weight, final weight and average daily gain (n=70).

Correlation		RFI	Initial weight	Final weight	ADG
RFI	Pearson Correlation	1	0,019	-0,054	-0,062
	P value		0,877	0,665	0,616
	N	70	70	70	70
Initial weight	Pearson Correlation	0,019	1	0,155	-0,039
	P value	0,877		0,211	0,753
	N	70	70	70	70
Final weight	Pearson Correlation	-0,054	0,155	1	0,981**
	P value	0,665	0,211		0,000
	N	70	70	70	70
ADG	Pearson Correlation	-0,062	-0,039	0,981**	1
	P value	0,616	0,753	0,000	
	N	70	70	70	70

** The correlation is significant at 0.01.

Correlation analysis of the relationships between different indicators revealed no statistically significant differences (P>0.05). However, there was a positive correlation between the average daily gain and live weight at the end of the test (R=0.981, P<0.01).

4. Conclusions

The RFI of the most calm bulls (with temperament 1) was -0.83 ± 0.67 , and in bulls with a moderate temperament (temperament 2), this indicator was 36.5% less, that is, -

0.53 ± 0.55 . The RFI of bulls with an excited temperament was 0.19 ± 0.85 , and for aggressive bulls, this value was 0.62 ± 0.86 . Note that the calmer the bulls are, the lower the RFI and vice versa.

Studies have shown that selection for low RFI, a characteristic of efficient livestock, affects the growth, yield and quality of carcasses; reduces feed consumption with equal weight and average daily growth; improves the ratio of feed and growth by 10-15%; and reduces the yield of methane and manure. However, according to the analysis of



variance, the relationship between RFI and temperament was not statistically significant. The significance level (P) is equal to -0.525 .

Under the same conditions of keeping and feeding, the temperament of the bulls affected the average daily gain ($P < 0.05$) and, accordingly, the live weight at the end of the test ($P < 0.05$).

The most calm bulls with temperaments 1 and 2 gained weight faster; therefore, they had a large average daily gain. Thus, the average daily increase in weight of the most calm bulls was 316 g greater than that of the aggressive bulls.

There was also a positive correlation between the average daily gain and the live weight at the end of the test ($R = 0.981$ and $P < 0.01$).

The temperament of bulls, along with the RFI, serves as an important criterion for breeding selection to breed calmer bulls. Those who consumed less feed and gained more weight.

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Ethical considerations

According to ethical standards, the animals were not subjected to any form of inhuman treatment.

Conflict of interest

The authors state that they have no conflicts of interest.

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