

Effects of Bread Waste Flour Utilization in Cattle Diets on Milk and Meat Productivity

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Abstract. Reducing feed costs and the cost of production is of great importance for increasing the economic efficiency of production in small, medium-sized, and large-scale farms. For this purpose, increasing attention is being paid to the use of by-products as alternative feed resources. Bread waste and bakery product residue flour is a promising feed component rich in carbohydrates, rapidly fermentable, and easily digestible. An experimental feeding trial was conducted through collaboration between the Scientific Research Institute of Animal Husbandry and Fisheries, ATS FOOD LLC, and the Agdash Feed Factory. The aim of the study was to evaluate the effect of incorporating bread waste flour (BWF) into feed mixtures on milk productivity and growth parameters of cattle. The study included 22 lactating cows in a 12-week feeding trial and 11 young cattle in a 50-day feeding trial. Feed mixtures containing 37.5% BWF for lactating cows and 34.0% BWF for young cattle were prepared. Daily milk yield and the main compositional characteristics of milk were evaluated in lactating cows, while changes in live body weight were assessed in young cattle. The results showed that the inclusion of bread waste flour in the feed ration improved milk yield and growth parameters. During the trial period, total milk production increased by 8–10 liters, while live body weight increased by 80–100 kg. The results indicate that the use of BWF as an alternative feed component in cattle feeding is appropriate.

Keywords: bread waste flour, milk productivity, milk fat percentage, live body weight, feed conversion efficiency

Introduction

In cattle production, feed costs account for 60–70% of the total costs incurred in production (NRC, 2001; FAO, 2016). In recent years, the increase in the prices of conventional cereal-based feeds in foreign countries including Azerbaijan, has intensified the search for alternative feed sources. The use of alternative feed sources contributes to a reduction in the feed conversion ratio (Krause et al., 2013; Lee et al., 2000; Patra, 2012; Steele et al., 2012). Processed BWF is obtained from surplus bread and other bakery products and is considered one of the most promising energy-rich feed sources for use in animal nutrition.

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It is characterized by a high content of rapidly fermentable starch, moderate moisture content after processing, and a high digestible energy value, which makes it a potential partial substitute for corn and barley in animal diets (Van Soest, 1994; Hristov et al., 2013; Janssen, 2010). Globally, overproduction, expiration of shelf life, and inefficient consumption result in the generation of large quantities of bread waste every day, and its utilization in animal nutrition contributes to both economic efficiency and environmental sustainability (Gustavsson et al., 2011; FAO, 2016).

It has been demonstrated through conducted research studies that flour obtained from bread and other by-product wastes can replace 10–30% of cereal feeds in the diets of lactating cows without negatively affecting productivity (Kaltenegger et al., 2020). The increase in daily milk yield in cows, improvement in energy balance, and reduction in feed conversion are explained by the improvement of fermentation processes in the rumen of the animals (Kolver & Muller, 1998). The rapid degradation of starch obtained from bread waste stimulates the formation of volatile fatty acids (VFA), particularly propionate. Propionate, in turn, acts as one of the main precursors for glucose synthesis in the liver and the formation of milk lactose (Russell & Rychlik, 2001).

The use of BWF is strongly dependent on the level of its inclusion in the diet and the balancing of the overall diet. Thus, the excessive inclusion of rapidly fermentable carbohydrates may disrupt the balance of microorganisms in the rumen, lead to a decrease in pH, and increase the risk of subacute ruminal acidosis (SARA). This, in turn, negatively affects overall productivity (Plaizier et al., 2008; Allen, 1997; Zebeli et al., 2008). Therefore, careful formulation of the diet is essential to maintain stable digestion in animals.

In beef cattle production, the inclusion of activated bread waste products used as a partial substitute for the animals' energy requirements. This improves the growth performance of animals and the efficient utilization of feed (Fox & Tylutki, 1998; Owens et al., 1997). Increasing the energy balance in the diet creates conditions for the normal development of the microflora in the rumen and leads to an increase in protein synthesis (Bampidis & Robinson, 2006; Fregulia et al., 2021).

BWF is mainly used in the diet in an activated form together with other feed components, such as protein feeds and mineral supplements. Such a combination helps meet the organism's requirements for nitrogenous compounds, stabilizes fermentation, and increases the efficiency of nutrient utilization (Tedeschi et al., 2004; Van Soest, 1994; FAO, 2016; Gustavsson et al., 2011). Despite all its advantages, when using BWF, variations in its composition, moisture content, and storage conditions should be taken into consideration (AOAC International, 2019).

Materials and Methods

Experimental Trial and Selected Animals

The experimental trial was conducted to evaluate the effect of BWF on milk and meat productivity indicators. The experimental trial was carried out at the semi-intensive livestock farm of the Auxiliary Experimental Farm of the Scientific Research Institute of Animal Husbandry and Fisheries. A total of 22 clinically healthy dairy animals and 11 young animals were selected for the experiment.

Dairy Production Group. Holstein Friesian, Simmental, Jersey, Swiss, and Aberdeen Angus breed animals were selected.

Beef Production Group. In this group, Holstein Friesian, Simmental, Jersey, and Swiss breed animals were selected.

The experimental trial was conducted over a period of 12 weeks by adding 37.5% bread waste flour to the daily diet of lactating cows and over a period of 50 days by adding 34% to the daily diet of young animals. The control animals were raised under farm conditions.

Processing Regime

Bread waste flour was prepared from white and black bread waste. In the first stage of the processing procedure, bread residues with a moisture content of 38–44% were dried to a moisture content of 10% by keeping them in baking ovens at 60 °C for 20 minutes and then ground into flour with a particle size of 0.4 µm. This flour was incorporated into concentrate feed mixtures as a partial substitute for traditional energy sources such as corn and barley. Throughout the experimental period, the animals were continuously provided with clean drinking water.

Measurement of Milk Production

The total daily milk yield was recorded, and milk samples were analyzed in the laboratory of the Scientific Research Institute of Animal Husbandry and Fisheries using a Lactoscan device to determine the quantities of the main compositional parameters.

Growth Performance Indicators

In the beef cattle group, live body weight measurements were recorded at the beginning of the experiment and subsequently every 25 days until the end of the 50-day feeding period. Feed conversion was calculated.

Chemical Analysis Methods

The chemical composition of the feed was determined using spectral analysis method with a Perten DA 7250 NIR instrument.

Table 1

Composition of the prepared BWF, %

Sample	Moisture, %	Protein, %	Fat, %	Sugar, %	Starch, %	Ash, %
White bread	8.4	8.7	0.9	5.5	65.4	2.1
Black bread	8.2	11.4	0.5	4.8	64.1	2.2

White and black bread flour were mixed at a 50/50 ratio, and “Milk 2 Feed” was prepared for lactating cows, while “Super Fattening Trial Feed” was prepared for young animals. The “Milk 2 Feed” was prepared using 25% high-protein feed additive (protein 40%, ME-2700 kcal/kg), 37.5% bread waste flour, 12.5% wheat bran, and 25% corn (Table 2).

Table 2

Chemical composition of “Milk 2 Feed”

Parameters of the prepared feed	DM, %	ME (Mcal/kg)	CPr (g)	DPr (g)	Bypass Pr (g)	Ccell (g)	ADF (g)	NDF (g)	Cfat (g)	Crude Ash (g)	TDN, %	NEL (Mcal/kg)	NEL (MJ/kg)
Milk 2 Feed	0.90	2.81	190	130	53	37	43.9	114	28.8	44.3	73.2	1.77	7.40

Note. DM – dry matter; ME – metabolizable energy; CPr – crude protein; DPr – digestible protein; Bypass Pr – bypass protein; Ccell – crude cellulose; ADF – acid detergent fiber; Cfat – crude fat; TDN – total digestible nutrients; NEL – net energy for lactation (Mcal/kg or MJ/kg).

An experimental study was conducted over a period of 12 weeks on 22 lactating cows of different breeds, raised at the Auxiliary Experimental Farm of the Scientific Research Institute of Animal

Husbandry and Fisheries, located in Firuzabad settlement, Goygol District, using the prepared 19% protein “Milk 2 Feed” (Table 3).

Table 3

Breed composition of the selected lactating cows

Days in milk	Breed composition				
	Holstein Friesian	Simmental	Jersey	Swiss	Aberdeen Angus
5–150	3	1	2	2	0
151–305	4	0	0	0	1
305+	7	1	0	1	0
Total number of cows	14	2	2	3	1

Note. The average number of days in milk was 298 days.

During the feeding trial, a 7-day adaptation period was applied to lactating cows to allow the animals to adapt to the experimental diet (Table 4).

Table 4

Daily diet for the animals

Feed	At 1–3 days, kg	At 4–6 days, kg	At 1–12 weeks, kg
Barley straw	3	3	3
Dried alfalfa hay	9	9	9
Milk 2 Feed	6	9	12
Total	18	21	24

Results and Discussion

Milk Production Indicators under the Inclusion of BWF in the Daily Diet of Lactating Cows

The inclusion of BWF in the diet of lactating cows affected daily milk yield.

Table 5

Comparative indicators of milk production

Groups	Productivity indicators				
	Number of animals	Total milk, L	Average milk yield per animal, L	Milk fat, %	Milk density
At 1–7 days					
Experimental	21	337.26	16.06	3.30	29.12
Control	21	273.21	13.01	3.65	28.89
At 1–5 weeks					
Experimental	20	386.20	19.31	3.39	29.31
Control	22	299.20	13.60	3.66	29.12
At 5–8 weeks					
Experimental	18	389	21.61	3.99	28.68
Control	21	267.12	12.72	3.99	28.69
At 8–10 weeks					
Experimental	19	450	23.68	3.48	28.67
Control	21	277.2	13.2	3.71	28.85
At 10–12 weeks					
Experimental	21	442	21.05	3.63	28.85
Control	21	276.99	13.19	3.89	28.78

As shown in the table, total milk production increased by 23.44–62.34%, while the average milk yield per animal increased by 23.44–79.39%. These results are consistent with the findings of previous studies. The inclusion of moderate levels of rapidly fermentable carbohydrate sources in the diet increases propionate production and milk lactose synthesis, which in turn increases milk yield (Broderick, 2003) (Fig. 1).

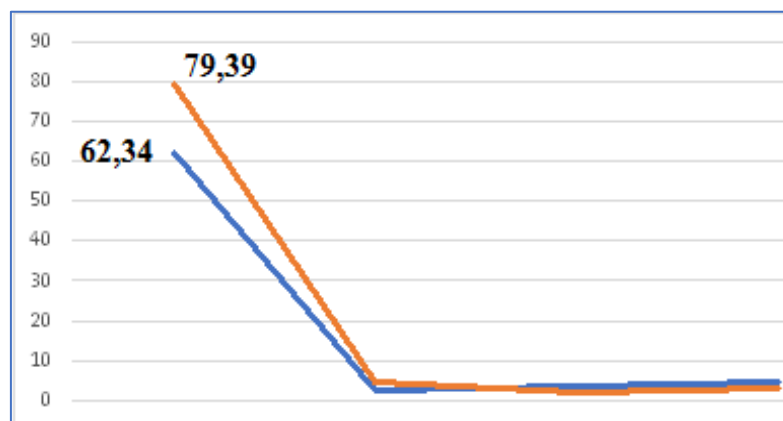


Figure 1

Diagram of the increase in total milk production and average milk yield per animal

Live Body Weight Gain Indicators under the Inclusion of BWF in the Daily Diet of Young Animals

To study the effect of the use of bread waste flour on live body weight gain in young animals, BWF was included in the daily diet at a level of 34%. For this purpose, Holstein Friesian, Simmental, Jersey, and Swiss breed animals were selected, and “Super Fattening Trial Feed” was prepared. The live body weight indicators of the young animals were recorded at the beginning of the experiment and subsequently every 25 days until the end of the 50-day feeding period (Table 6).

Table 6

Breed composition of selected young animals

Breed	Age, days	Sex	Live body weight at the beginning of the experiment, kg
Swiss	390	Female	212
Holstein Friesian	421	Female	260
Holstein Friesian	481	Male	291
Holstein Friesian	428	Female	283
Holstein Friesian	437	Female	241
Holstein Friesian	406	Male	317
Crossbred	507	Male	310
Aberdeen Angus	248	Female	196
Crossbred	468	Female	345
Crossbred	283	Male	246
Simmental	284	Female	207

When preparing the “Super Fattening Trial Feed”, 15% high-protein feed additive (protein 31.4%, ME-2119.5 kcal/kg), 34.0% bread waste flour, 35.0% wheat bran, and 16.0% wheat were used. The feed mixture was prepared at Agdash Feed Factory, located in Laki settlement, Agdash District (Table 7).

Table 7
Chemical parameters of “Super Fattening Feed”

Parameters of the prepared feed	DM, %	ME (Mcal/kg)	CP _r (g)	DP _r (g)	Bypass Pr (g)	Ccell (g)	ADF (g)	NDF (g)	Cfat (g)	Crude Ash (g)	TDN, %	NEL (Mcal/kg)	NEL (MJ/kg)
Super Fattening Feed	0.90	2.68	156.55	105.91	41.38	60.82	73.14	204.51	31.96	44.72	70.30	1.69	7.06

Note. The protein content of “Super Fattening Feed” is 15.6%.

During the feeding trial, a 3-day adaptation period was applied to young animals to allow them to adapt to the experimental diet (Table 8).

Table 8
Daily diet for the animals

Feed	At 1–3 days, kg	At 4–22 days, kg	At 23–50 days, kg
Alfalfa	0	2	3
Straw	2	2	2
Natural grass	2	0	0
Super Fattening Feed	3	5.4	7.2
Total	7	9.4	12.2

The inclusion of BWF in the daily diet of young animals resulted in an increase in live body weight (Table 9; Figure 2).

Table 9
Live body weight gain of young animals

Breed	Sex	Live body weight at the beginning of the experiment, kg	Live body weight at the end of the experiment, kg	Difference in live body weight, kg
Swiss	Female	212	300	88
Holstein Friesian	Female	260	321	61
Holstein Friesian	Male	291	380	89
Holstein Friesian	Female	283	345	62
Holstein Friesian	Female	241	325	84
Holstein Friesian	Male	317	397	80
Crossbred	Male	310	413	103
Aberdeen Angus	Female	196	272	76
Crossbred	Female	345	414	69
Crossbred	Male	246	316	70
Simmental	Female	207	254	47

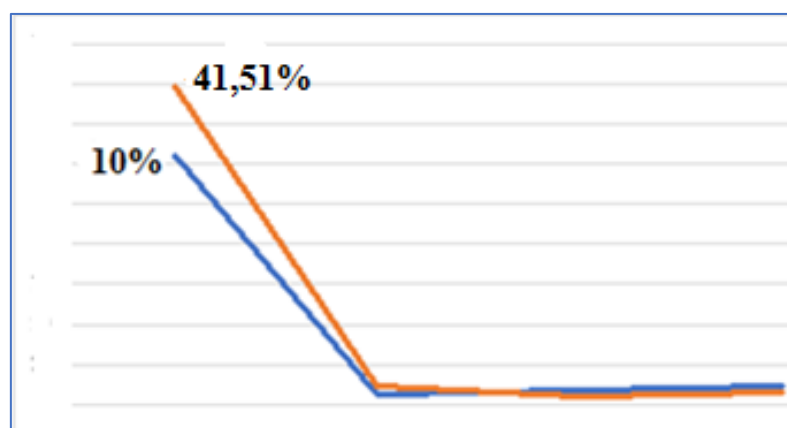


Figure 2
Live weight gain diagram

As shown in the table, the highest live weight gain was observed in the Swiss breed (41.51%), while the lowest increase was observed in crossbred animals (20.0%). The studies revealed that, under farm conditions, the live weight of young animals increased by 8–10% during the 50-day rearing period. In comparison, up to 31.5% greater live weight was obtained in the experimental group. The degree of consistency with international practices was demonstrated in the studies conducted (Fox & Tylutki, 1998; Owens et al., 1997).

Analysis of the Results

Reasons for the Increase in Milk Productivity of the Animals

1. Increase in the Energy Value of the Diet

BWF is rich in highly digestible starch and rapidly fermentable carbohydrates. This increases the energy density of the overall diet and provides animals with energy for higher milk synthesis.

2. Increase in Propionate Production

The rapid fermentation of BWF in the rumen leads to an increase in volatile fatty acids, particularly propionate. Propionate is a major source for glucose synthesis in the liver and enhances the formation of milk lactose. Lactose, in turn, directly regulates milk volume.

3. Enhancement of Milk Lactose Synthesis

Increased glucose availability enhances lactose synthesis in the mammary glands. Since lactose regulates the osmotic composition of milk, it leads to an increase in milk volume.

4. Improvement in Feed Utilization Efficiency

BWF acts as a partial substitute for cereal feeds in the diet, thereby improving feed conversion. As a result, greater milk production is achieved from the same amount of feed.

5. Optimization of Rumen Fermentation

The inclusion of BWF at an appropriate level stimulates microbial activity and makes the fermentation processes more efficient. This leads to improved absorption of nutrients.

6. Stabilization of Energy Balance

The presence of an additional rapidly available energy source in the diet reduces negative energy balance in animals, thereby contributing to a sustained increase in milk yield.

Reasons for the Increase in Live Weight of the Animals

1. Provision of High Energy Density

BWF is rich in starch and rapidly digestible carbohydrates. This increases the overall energy value of the diet and provides the calories required for daily weight gain in animals.

2. Increase in Propionate Production and Glucose Synthesis

BWF is rapidly fermented in the rumen, resulting in increased propionate production. Propionate is a major source for glucose synthesis in the liver, and this energy is directed toward growth and tissue formation.

3. Improvement in Protein and Energy Balance

When BWF is used together with other feed components (barley, corn, etc.), the energy-to-protein ratio is optimized. This accelerates muscle tissue formation and supports the increase of lean body mass.

4. Improvement in Feed Utilization Efficiency

When BWF is included in the diet, feed is utilized more efficiently, the feed conversion ratio improves, and greater live weight gain is achieved with the same amount of feed.

5. Activation of Rumen Microflora

Moderately fermentable carbohydrates stimulate microbial activity. This accelerates the breakdown of fiber and other nutrients and increases nutrient absorption.

6. Improvement in Nitrogen Utilization Efficiency

When BWF is used together with other protein sources, microbial protein synthesis is enhanced. This contributes to muscle tissue growth and promotes an increase in live weight.

7. Stabilization of Energy Balance and Reduction of Stress

Adequate energy supply reduces negative energy balance in animals, minimizes metabolic stress, and results in more stable growth dynamics.

Comparative Analysis of the Results

1. When 37.5% bread waste flour was added to the daily diet of lactating cows, total milk production increased by 23.44–62.34%, while the average milk yield per animal increased by 23.44–79.39%.

2. When 34% bread waste flour was added to the daily diet of young animals, the highest live weight gain was observed in the Swiss breed (41.51%), while the lowest increase was observed in crossbred animals (20.0%). The studies revealed that, under farm conditions, the live weight of young animals increased by 8–10% during the 50-day rearing period. In comparison, up to 31.5% greater live weight was obtained in the experimental group.

Conflict of Interest

The authors declare that they have no conflict of interest regarding this article.

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