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Replacement of Yellow Corn Grains by Chocolate By-Products in Lactating Cows Rations: Effects on Nutrients' Digestibility, Milk Yield and Composition, Some Blood Parameters and Economic Efficiency

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Abstract

THE present experiment aimed to evaluate the partial replacement of yellow corn grains with chocolate by-products in the ration of lactating cows on feed utilization, blood profile, and lactation performance. For this goal, thirty multiparous Holstein cows (600±35 kg BW, 3±1 parity, 180±25 days in milk, and previous milk production of 20±2 kg/d), were randomly divided into 2 groups. Following a cross-over design for 60 days, the concentrated feed mixtures (CFM; 11 kg/head/d) were formulated from YCG, wheat bran, soybean meal, linseed meal, CBP (in Chocolate group) and some feed additives. Corn silage (17 kg/head/d) and alfalfa hay (3 kg/head/d) were used as roughages in the TMR formulation with a roughage: concentrate ration 43.7:56.3. During the first experimental period (Control), animals received the same pattern of the CFM in the adaptation period without any replacement, meanwhile, 20% of YCG was substituted by CBP in the CFM for the second period (Chocolate). Replacing 20% of YCG by CBP in the CFM of dairy cows ration increased milk production (actual 2.53% and fat corrected milk by 6.95%) and fat content (by +8%) in milk as well as feed efficiency in CBP group compared to control. Higher nutrient digestibility was observed in chocolate treatments compared to YCG group. The replacement increased the concentrations of plasma albumin, HDL, LDL and total cholesterol in comparison with the control. Replacement of YCG by CBP in dairy cow ration improve milk yield, composition, digestibility and economic efficiency and this trail can be recommended in dairy cow farms as a novel nutrition strategy. Therefore, additional experiments with treatments known to reduce blood triglyceride and cholesterol levels are recommended.

Keywords: Dairy Cow Nutrition, Chocolate By-Products, Blood Parameters, Digestibility, Feed Efficiency.

Introduction

Optimizing the nutritional management of high-yielding dairy cows is still a major challenge in animal nutrition science. The limited rumen capacity of these cows presents challenges to feed intake, this limits their ability to meet large energy needs through traditional nutrition strategies. Increasing the energy density of diets has been suggested as an effective way to meet the rising energy demands of these animals. [1]. Feeding lactating cows with energy-rich diets are essential because they deliver the necessary substrates to the mammary glands for milk synthesis and the production of its components. [2] Depending on corn grains as a primary ingredient in ruminant concentrates has contributed to higher feed costs, posing a significant economic challenge. Consequently, Animal nutritionists are exploring alternative feedstuffs, including agro-industrial by-products, which may offer cost-effective substitutes for corn while preserving or enhancing the nutritional quality of animal diets. [3].

Among the various strategies proposed to mitigate the high costs associated with traditional concentrates, adding energy-dense ingredients such as fats to the diets of lactating animals has gained considerable attention. Fat provides a concentrated source of non-fermentable energy, allowing for

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greater energy intake with reduced dry matter consumption. However, the inclusion of fats in ruminant diets is not without challenges, as unsaturated fatty acids strongly inhibit the activity of carbohydrate-splitting microorganisms which can disrupt rumen function. To counteract these harmful effects on ruminal fermentation, unsaturated fatty acids have been administered in the form of calcium salts [4]. Fats, oils, and carbohydrates are among the primary energy-rich feed ingredients used in ruminant diets, fat provides about 2.25 times more energy per unit compared to carbohydrates or proteins [2].

The food industry produces large quantities of by-products, which cause environmental problems. Reusing these by-products as raw materials for animal feed not only offers a sustainable solution to environmental pollution but also enhances the economic value of these otherwise discarded materials [5].

Ruminants have the unique ability to transform low-quality, unpalatable feeds into high-value animal products, such as milk and meat. The efficiency of milk production is often assessed by comparing the nutrient composition of milk with the nutrient intake of the animal [6]. In intensive ruminant production systems, the use of substantial amounts of energy-rich concentrates, particularly cereal grains, are often essential. To address the dual challenge of meeting the nutritional needs of high-producing animals. While minimizing competition for resources between livestock and humans, the dual challenge of meeting the nutritional needs of high-producing animals while minimizing competition for resources between livestock and human populations, the strategic inclusion of energy-rich by-products in ruminant diets has been advocated [7]. Many of these by-products can be added to animal rations in suitable amounts without adversely impacting growth performance, health, or carcass quality. One such by-product, chocolate waste, is generated during the production process due to spillage or irregular sizing. This waste material is rich in nutrients and has been recognized as a promising feed ingredient, especially for monogastric animals. [8]. Chocolate by products, with a high content of fats, gross energy content of 4036 kcal/kg and a metabolizable energy content of 3571.51 kcal/kg, represents a rich source of energy and other feed nutrients. Recent studies suggest that chocolate waste could serve as an effective alternative to conventional feed ingredients in dairy cow rations (9) and poultry diets [8]. The studies about using chocolate by products in ruminant’s ratio are very rare. So, this research aims to provide empirical data to determine the optimal inclusion levels of chocolate by-products (CBP) in dairy cow rations as a partial replacement from yellow corn grains (YCG), and investigate their effects on dairy cow performance. thereby refining nutritional strategies in high-yielding dairy systems.

Material and Methods

All fieldworks were carried out at a private dairy cow (El-Nemaky farm) that is in Monofia governorate, Egypt, while chemical analysis of feedstuffs, faecal samples, blood parameters and milk composition were performed at the labs of Animal Production Department, and Cairo University Research Park (CURP) - Faculty of Agriculture - Cairo University (Egypt). This study lasted for about 9 weeks (August to October 2021).

Ethical approval, animals experimental design and rations

For this study, thirty multiparous Holstein cows (600±35 kg BW, 3±1 parity, 180±25 days in milk, and previous milk production of 20±2 kg/d), were randomly divided into 2 groups. Following a cross-over design, cows were housed in open house system during 2 sequential periods of 21 days each in addition to 7 days of Washout and subjected to 2 consecutive experimental treatments (Control and Chocolate):

- Control: 0%- replacement of YCG by CBP.
- Chocolate: 20% of YCG was substituted by CBP.

Previously, throughout 2-weeks of adaptation, cows were fed a total mixed ration (TMR) to cover animal requirements for maintenance and milk production according to [10]. Drinking water was freely offered all the time during the day.

Table (1) shows that, , the concentrate feed mixtures (CFM; 11 kg/head/d) were formulated from YCG, wheat bran, soybean meal, linseed meal, CBP (in Chocolate group) and some feed additives. Corn silage (17 kg/head/d) and alfalfa hay (3 kg/head/d) were used as roughages in the TMR formulation with roughage: concentrate ration 43.7:56.3.

During the first experimental period (Control), animals received the same pattern of the CFM in the adaptation period without any replacement: meanwhile, 20% of YCG was substituted by CBP in the CFM for the second period (Chocolate).

The experimental TMR were offered 3 times per day at 3:00, 11:00 and 19:00 h (after milking times). It is worth noting that CBP were collected from Mondilez® factory (The10th of Ramadan City, Cairo, Egypt), grinded and then transported to the farm.

Digestion trials and chemical analysis of feed ingredients and feces

On days 19, 20 and 21 of each experimental period, digestion trials were performed to determine the digestion coefficient of nutrients and the nutritional value of rations (expressed as TDN and digestible CP). From 5 animals in each experimental group, fecal samples were taken in the morning and evening for 3 consecutive days from rectum before feeding. According to [11], acid-insoluble ash (AIA) was used as an internal marker to estimate nutrients’ digestibility.

Feedstuffs and fecal samples were analyzed for dry mater (DM), crude protein (CP), ether extract (EE), ash and crude fiber (CF), according to [12]. Furthermore, by the difference, nitrogen free extract (NFE) was calculated. Moreover, gross energy (GE; MJ/kg DM) was calculated following [13] equation: [17.2 × Carbohydrates (g)] + [23.6 × CP (g)] + [39.5 × EE (g)].

Nutrients' digestion coefficient and total digestible nutrients were estimated according to [11,14], respectively, as follows:

Dry matter digestibility (%) =100 – (100 x $\frac{Feed\ AIA\%}{Feces\ AIA\%}$),

Nutrient digestibility (%) = 100 – (100 x $\frac{\%\, nutrient\ in\ feces \times Feed\ AIA\%}{\%\, nutrient\ in\ feed \times Feces\ AIA\%}$),

TDN (%) = [Digestible CP (%) + Digestible CF (%) + Digestible NFE (%) + (Digestible EE (%) × 2.25)].

Table (2) shows the chemical composition of feed ingredients and CFM of control and treatment as dry matter basis.

Blood measurements

On the last day of each experimental period, blood samples of 10 ml per cow, from the jugular vein, were collected directly in heparinized tubes for 3 cows/group. Blood plasma was separated by centrifuging (4000 rpm; 15 minutes) and then conserved at -20°C until analyzed.

Blood haemoglobin (Hb, g/dl) was determined by colorimetric method (Spectrophotometer Jenway 6300 U.K) according to [15], haematocrit (Ht%), red blood cells (RBCs), white blood cells (WBCs) and platelets determined by Haemocytometer according to [16]. Blood plasma parameters were analyzed calorimetrically using Jenway 6300 Spectrophotometer U.K. The measured parameters include Plasma alanine transaminase (ALT) and aspartate transaminase (AST) [17], albumin (g/dl) [18], creatinine (mg/dl) according to [19], total protein (g/dl) [20], total lipids (mg/dl) [21] and urea (mg/dl) [22].

Milk production, sampling and composition

After 2 weeks of adaptation, milk production was daily recorded until the end of the trial. Cows were milked 3 times a day at 3:00, 11:00 and 19:00 h. On days 20 and 21 of each experimental period, representative and random milk samples were collected and stored at -20 C for analyses.

Milk composition; protein, fat, solid-not fat (SNF) and total solid (TS) was assayed through milko scan (type 10900 FOSS electric; 130 series; Denmark). Actual milk production was corrected to 4% FCM via [23] formulation: 4% FCM = 0.4 × (milk yield, kg) + 15 × (fat yield, kg).

Statistical analysis

All results were subjected to one-way ANOVA using the package "lme4" of R software (version R 4.2.3) according to the following statistical model:

$$Y_{ijk} = \mu + P_i + T_j + A(T)_{jk} + \xi_{ijk},$$

where, Y_{ijk}, is the dependent variable, μ, the overall mean, P_i, the fixed effect of period (i: 1 and 2); T_j, the fixed effect of treatment (j: Control and Chocolate), $A(T)_{jk}$, the random effect of animal (k) nested within treatment (j); ξ_{ijk}, the residual error.

To compare the differences of means between treatments, adjusting for multiple comparisons by Tukey correction, the package "emmeans" was used. Differences were considered significant at $P < 0.05$ and tend to be significant at $0.05 \le P < 0.10$.

Results and Discussion

Chemical composition and nutrient digestibility

As shown in Table (2), replacing YCG by CBP has slightly affected the TMR chemical composition, as CBP had about 25% EE, 66.92% NFE, and 3.55% CP (as DM basis), compared to 3.67% 84.4% and 8.21%, respectively, in YCG. The GE of CBP was 22.24 compared to 18.31 MJ/kg in YCG. The difference in the chemical composition of CBP and YCG was reflected slightly in the chemical composition of TMR of control and chocolate group.

The inclusion of CBP in the ration led to significant improvements in most of the nutrients' digestibility compared to control, Table (2). Dry Matter (DM) and organic matter (OM) digestibility was improved by 7.44% and 5.12%, respectively, in the second experimental period as animals were fed the CBP ($P < 0.05$). The highest effect digestibility was reported for on EE, with an 18.92% enhancement of was recorded for the chocolate rations ($P < 0.05$). This may indicate the higher efficiency of energy utilization that would be reflected in animal performance and productivity**.** Likewise, a significant increase in CP and NFE digestibility was observed in the chocolate diet versus the control one as follows: 70% vs 63.7% and 84.6% vs 79.4%, respectively ($P < 0.05$).

In the same context, [24] found that diets with higher energy content led to increased DM and OM digestibility. Also, [25] noted similar improvements in EE digestibility when energy-dense by-products were included in ruminant diets. In parallel, [26] revealed that high-energy diets may improve nitrogen retention and CP digestibility. Similarly, [27] found that including high-energy feed alternatives in ruminant diets can enhance carbohydrate digestion and overall energy utilization. On the other hand, there was no significant variation in CF digestion noted ($P > 0.10$), although high dietary fat levels can negatively impact fiber digestibility in ruminants, according to [28].

The previous enhancement in nutrient digestibility, being a result of CBP incorporation into diets, has led to a mark able improvement in the nutritive value either. Total Digestible Nutrients and Digestible CP increased from 71.3% to 76.4% and from 8.24% to 9.06%, respectively, with the CBP inclusion to the diet. The study of [29] supports our findings, as they found that high-energy diets could enhance the digestibility of both protein and energy components.

Effects on milk production and composition

The inclusion of CBP resulted in a slight increase in actual milk production (21.1 kg/cow/day) compared to the control diet (20.6 kg/cow/day) as shown in table (3). However, this difference was not statistically significant (P = 0.491). Some authors [8] found that including food industry by-products does not significantly impact milk production.

In contrast the FCM yield was higher in the chocolate by-product treatment (21.6 kg) compared to the control (20.2 kg), with a P-value approaching significance (P = 0.059). Also, [4] reported that energy-dense feedstuffs can improve FCM production. In the other hand the fat concentration increased from 3.86% in the control diet to 4.17% in the chocolate by-product diet (P = 0.006). Similarly, Other researchers [2] reported that the inclusion of fat-rich by-products in ruminant diets increases the fat content of milk. Furthermore, research by [7] supports this observation, showing that alternative energy-rich feed ingredients can enhance milk protein levels. In this study, milk protein increased from 3.25% to 3.49% (P = 0.038). However, there were no significant differences were observed in Solids Non-Fat (SNF) and Total Solids (TS) concentrations (SNF: P = 0.679; TS: P = 0.376). Some investigators [5] found that dietary changes involving by-products did not significantly impact SNF content.

Blood measurements

The chocolate by-product diet significantly affected several blood parameters. The authors [30] reported that feeding high-energy diets to ruminants improved haematocrit and haemoglobin levels. Similarly, [31] found that diets rich in energy and protein increased red blood cell counts and haemoglobin concentration in cattle. In this study, the diet increased haemoglobin levels (10.10 g/dL vs. 8.86 g/dL, P = 0.019), red blood cell count ($5.76 \times 10^6/\mu L$ vs. $4.64 \times 10^6/\mu L$, P = 0.002), and haematocrit (32.0% vs. 28.4%, P = 0.017). These findings suggest an enhancement in red blood cell health and improved oxygen transport capacity. However, other haematological parameters, such as white blood cell count (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and platelet counts, did not show significant differences between the chocolate by-product and control diets. In the lipid profile, changes in total cholesterol and LDL were not statistically significant (160 mg/dL vs. 155 mg/dL, P = 0.567), HDL (50.7 mg/dL vs. 47.3 mg/dL, P = 0.063), and LDL (92.8 mg/dL vs. 89.8 mg/dL, P = 0.740). However, the chocolate by-product diet resulted in a higher concentration of HDL, with a trend toward significance (50.7 mg/dL vs. 47.3 mg/dL, P = 0.063). Otherwise, [(32] found that diets enriched with fats could favourably influence HDL cholesterol levels, contributing to better cardiovascular health in dairy cattle. In addition to significant increases were observed in urea concentration (40.2 mg/dL vs. 30.8 mg/dL, P = 0.003) and changes in the albumin (A/G) ratio (0.947 vs. 0.803, P = 0.045). In addition, [26] noted that energy-dense diets promote efficient protein metabolism, often evidenced by increased urea concentrations in the blood.

Feed and economic efficiency of daily milk production

The substitution of YCG with CBP did not significantly alter the dry matter intake (DMI), which was almost similar between the Control (17.92 kg) and Chocolate (18.00 kg) groups. However, the Chocolate ration led to improved efficiency, with FCM increasing by about 6.95%, i.e., from 20.2 to 21.6 kg/cow/d in the control and chocolate by-product ration, respectively. The same trend was noted for the actual milk production. Moreover, the actual feed efficiency was 1.17 for the chocolate by-product group and 1.15 for the control group (a +1.74% increase). When considering FCM, feed efficiency increased to 1.20 by CBP inclusion compared to 1.13 in the control group (a +6.2% increase). Moreover, [33] found similar improvements in feed efficiency when using high-energy by-products. This was also consistent with findings from other previous studies indicating that energy-dense feedstuffs can enhance feed conversion efficiency by providing readily available nutrients for lactating cows [34].

As shown in Table (6), the total daily feed cost was lower for the chocolate by-product group (93.32 EP per cow) compared to the control group (95.19 EP per cow). The feed cost per producing kilogram of milk was also lowered in the chocolate by-product group (4.42 EP) compared to the control group (4.62 EP). Likewise, the daily milk income was higher for the chocolate by-product group (158.19 EP per cow) than for the control (151.82 EP per cow), so that the chocolate by-product group earned 64.87 EP per cow each day, which was more than 56.63 EP in the control (+14.54% higher). Similarly, economic benefits have been reported by [35], revealing that using food industry by-products can reduce feed costs and improve profitability in dairy production. [36] found similar results with other feed by-products, showing that by-products can be a cost-effective choice in dairy farming.

Conclusion

Replacing 20% of YCG by CBP in the CFM of dairy cows ration increased milk production (actual 2.53% and fat corrected milk by 6.95%) and fat content (by +8%) in milk as well as feed efficiency in CBP group compared to control. Higher nutrient digestibility was observed in chocolate treatments compared to YCG group. The replacement increased the concentrations of plasma albumin, HDL, LDL and Total cholesterol in comparison with the control. Replacement of YCG by CBP in dairy cow ration improve milk yield, composition, digestibility and economic efficiency and this trail can be recommended in dairy cow farms as a novel nutrition strategy. Therefore, additional experiments with treatments known to reduce blood triglyceride and cholesterol levels are recommended.

Acknowledgment

Not applicable.

Conflict of interest

According to the authors, there isn't a conflict of interest.

Funding statement

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TABLE 1. Formula (kg/ton) and prices (LE/ton) of the concentrate feed mixtures used in the experiment.

Ingredients, kg/ton	Treatment	
	Control	Chocolate
Yellow corn grains (YCG)	500	400
Chocolate by-products (CBP)	0	100
Wheat bran	150	150
Soybean meal	274	274
Linseed meal	30	30
Limestone	15	15
Salt	9.5	9.5
Sodium bicarbonate	12	12
Vitamins and minerals premix[1]	3	3
Dicalcium Phosphate	3	3
Anti-mycotoxins	1.5	1.5
Yeast	0.5	0.5
Price (EP/ton)	6584	6414

[1] Produced in June 2021 by Dakahlia Group, Sadat City, Egypt: Each 3 kg vitamins and minerals premix contain: 7000000 IU Vit A; 1500000 IU Vit D3; 30000 mg Vit E; 60000 mg Zinc; 60000 mg Manganese; 50000 mg Iron; 20000 mg Copper; 1000 mg Iodine; 250 mg Cobalt; 300 mg Selenium; Calcium bicarbonate up to 3 kg.

TABLE 3. Chemical composition (% DM, except for GE) of the feed ingredients and rations used in the experiment.

	Dry matter (g/100 g)	Chemical composition (%DM, except for GE)[1]					
		CP	CF	EE	Ash	NFE	GE
Feed ingredients							
yellow corn grains	89.13	8.21	2.35	3.67	1.37	84.40	18.31
Chocolate by-products	97.68	3.55	0.00	25.05	4.48	66.92	22.24
Soybean meal 44%	90.80	43.54	6.30	3.00	4.63	42.53	19.86
Wheat bran	89.88	13.25	10.57	2.93	0.97	72.28	18.53
Linseed meal	88.93	30.00	9.11	7.63	4.12	49.14	20.11
Alfalfa hay	89.65	16.52	43.26	1.35	9.80	29.07	16.87
Corn silage	31.51	7.00	31.27	4.91	11.25	45.57	16.81
Total mixed ration [2]							
Control	56.33	15.45	30.21	5.36	3.54	55.68	13.57
Chocolate	56.63	15.12	29.91	6.66	3.72	54.75	13.83

[1] CP: Crude protein; CF: Crude fiber; EE: Ether extract; NFE: Nitrogen free extract; GE: Gross energy (MJ/kg DM; calculated). [2] Calculated.

TABLE 3. Nutrients' digestibility and nutritive value (TDN and digestible CP) for the experimental rations (Control and Chocolate) [1].

Variable	Treatment		SED	*P*-value
	Control	Chocolate		
***Nutrients' digestibility* (%)**				
DM	67.2	72.2	0.868	0.008
OM	73.4	77.2	1.07	0.031
EE	70.3	83.6	1.01	<0.001
CF	64.8	65.2	1.11	0.766
CP	63.7	70	1.26	0.0129
NFE	79.4	84.6	0.295	0.0029
***Nutritive value* (%)**				
TDN	71.3	76.4	1.03	0.013
Digestible CP	8.24	9.06	0.163	0.012

[1] DM: Dry matter; OM: Organic matter; EE: Ether extract; CF: Crude fiber; CP: Crude protein; NFE: Nitrogen free extract; TDN: total digestible nutrients; SED: Standard error of the difference.

TABLE 4. Milk production and composition of the experimental cows fed rations containing chocolate by-products (0 and 20% of YCG).[1]

Variable	Treatment		SED	*P*-value
	Control	Chocolate		
Milk production (kg/cow/d)				
Actual	20.6	21.1	0.725	0.491
FCM	20.2	21.6	0.685	0.059
Milk composition (g/100g)				
Fat	3.86	4.17	0.089	0.006
Protein	3.25	3.49	0.099	0.038
SNF	8.13	8.35	0.518	0.679
TS	12.0	12.5	0.567	0.376

[1] FCM: Fat corrected milk; TS: Total solids; SNF: Solids non-fat; SED: Standard error of the difference.

TABLE 5. Blood measurements for the experimental cows fed rations containing CBP (0 and 20% of YCG)[1].

	Treatment		SED	*P*-value
	Control	Chocolate		
HG	8.86	10.10	0.326	0.019
RBCs	4.64	5.76	.0.259	0.002
HT	28.4	32.0	0.927	0.017
MCH	19.0	17.6	0.985	0.239
MCHC	31.1	31.5	0.216	0.1707
MCV	61	56	2.85	0.151
Platelet	324	383	30.9	0.129
Total leucocytic count	6.08	6.44	0.219	0.171
Lymphocytes	36.6	36.4	2.42	0.938
Monocytes	5.2	4.2	0.529	0.095
Eosinophils	4.8	4.2	0.424	0.195
AST (u/l)	29	21.7	1.86	0.016
ALT (u/l)	21.3	23.3	1.73	0.367
Urea (mg/dl)	30.8	40.2	0.551	0.003
Creatinine (mg/dl)	1.05	1.17	0.07	0.245
Total Protein (g/dl)	6.42	6.33	0.105	0.483

	Treatment			
	Control	Chocolate	SED	*P*-value
Albumin (g/dl)	2.85	3.08	0.054	0.054
Globulin (g/dl)	3.57	3.26	0.098	0.086
A/G Ratio	0.803	0.947	0.031	0.045
Total Cholesterol (mg/dl)	155	160	7.86	0.567
Triglycerides (mg/dl)	87	81.3	3.28	0.226
HDL (mg/dl)	47.3	50.7	0.882	0.063
LDL (mg/dl)	89.8	92.8	8.41	0.74
VLDL (mg/dl)	17.5	16.5	0.717	0.31

[1]ALT, alanine aminotransferase; AST, aspartate transaminase; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; MCV, mean corpuscular volume; RBC, red blood cells.

TABLE 6. Feed and economic efficiency of daily milk production for the experimental cows fed rations containing CBP (0 and 20% of YCG).[1]

Item	Treatment	
	Control	Chocolate
***Average milk production* (kg /cow)**		
Actual	20.6	21.12
FCM	20.2	21.6
***Daily feed intake* (kg DM /cow)**		
Concentrate	9.87	9.95
Corn silage	5.36	5.36
Alfalfa hay	2.69	2.69
Total DMI (kg/cow/d)	17.92	18.00
Feed efficiency		
FE-Actual	1.15	1.17
FE-FCM	1.13	1.20
Economic efficiency		
Concentrate (EP/kg)	6.584	6.414
Corn silage (EP/kg)	0.545	0.545
Alfalfa hay (EP/kg)	4.50	4.50
Total feed cost (EP/cow/d)	95.19	93.32
Feed cost per 1kg milk (EP)	4.62	4.42
Relative feed cost per 1 kg milk	100%	95.62%
Daily milk income (EP/cow)	151.822	158.19
Net feed revenue (EP/cow/d)	56.63	64.87
Economic feed efficiency	59.50%	69.52%
Relative Economic feed efficiency	100%	114.54%

[1] FCM: fat corrected milk; DMI: Dry matter intake; Feed efficiency = milk production (kg) / DMI; Total feed cost is calculated in association with the ration (11 kg of CFM + 3 kg of alfalfa hay + 17 kg of corn silage); Feed cost per 1 kg milk = total feed cost / actual milk production; Relative feed cost per 1 kg milk and Relative Economic feed efficiency are calculated relative to Control; Daily of milk income (EP/cow) = Average milk production (kg/cow)* market price of 1 kg cow milk (7.25 + 0.04 EP for each 0.1% Fat higher than 3.5%, September 2021); Net feed revenue = daily of milk yield income (EP/cow/d) - Total feed cost (EP/cow/d); Economic feed efficiency = Net feed revenue (EP/cow/d) / Total feed cost (EP/cow/d).

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استبدال حبوب الذرة الصفراء بمخلفات الشيكولاته في علائق الابقار الحلابه ودراسة تأثير الاستبدال على هضم العناصر الغذائية وإنتاج اللبن وتركيبه وبعض مقاييس الدم والكفاءة الاقتصادية

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الملخص

تم تصميم الدراسة الحالية لمعرفة تأثير الاستبدال الجزئى لحبوب الذره الصفراء بمخلفات الشيكولاته فى علائق الابقار الحلابه على الاداء الانتاجى ، تركيب مكونات اللبن ، الكفائه الغذائيه و مكونات الدم. تم اجراء الدراسه على 32 بقره هولوشتين فريزيان فى متوسط موسم الحليب تم قسمهم على مجموعتين و اجراء التجربه لمدة 60 يوم. 11 كجم علف مركز لكل راس فى اليوم يتكون العلف المركز من ذره صفراء و كسب فول صويا و كسب كتان و رده خشنه و مخلفات الشيكولاته (فى مجموعه الشيكولاته) و بعض الاضافات العلفيه. 17 كجم سيلاج ذره لكل راس فى اليوم و 3 كجم دريس حجازى لكل راس فى اليوم.المجموعه الاولى (الكنترول) كانت تتلقى الغذاء بدون شيكولاته و المجموعه الثانيه (الشيكولاته) كانت تتلقى الغذاء بعد استبدال 20% من حبوب الذره الصفراء بمخلفات الشيكولاته فى العلف المركز. استبدال 20% من حبوب الذره الصفراء بالشيكولاته ادى الى زيادة انتاج اللبن بنسبة 2.53% كما هو و لبن مصحح الدهن 6.95% من الانتاج و زيادة نسبة الدهن 8% فى اللبن مقارنة بمجموعة الكنترول. ولوحظ ارتفاع معدل هضم العناصر الغذائية في مجموعة الشيكولاته. الاستبدال ادى الى زيادة تركيز بعض مكونات الدم مثل الالبيومين و غيره. الاستبدال ادى الى ذياده انتاج اللبن، مكونات اللبن، هضم العناصر الغذائيه و الكفائه الاقتصاديه.

الكلمات الدالة: تغذية الابقار الحلابه ، مخلفات الشيكولاته ، مؤشرات الدم ، الهضم ، الكفاءة الاقتصاديه.