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Economic performance of dairy cows fed diets with different levels of oregano

Julinessa Silva Oliveira de Oliveira[1*], Fabiano Ferreira da Silva[2], Lucas Teixeira Costa[1], Gonçalo Mesquita da Silva[1], Murilo de Almeida Meneses[1] and Eli Santana de Oliveira Rodrigues[1]

*[1]Programa de Pós-graduação em Zootecnia, Universidade Estadual do Sudoeste da Bahia, Praça Primavera, 40, 45700-000, Itapetinga, Bahia, Brazil. [2]Programa de Pós-graduação em Zootecnia, Departamento de Tecnologia Rural e Animal, Universidade Estadual do Sudoeste da Bahia, Itapetinga, Bahia, Brazil. *Author for correspondence. E-mail: julinessa1@hotmail.com*

ABSTRACT. This study aimed to evaluate the economic viability of using different levels of oregano in diets for lactating cows fed sugar cane. We used 12 crossbred Holstein x Zebu cows assigned to three 4 x 4 Latin squares. The four treatments consisted of different levels of oregano: oregano free-control diet (0%) and diets added with 0.8, 1.6, and 2.4% oregano. Diets were formulated to meet the requirements for maintenance and milk production of 15 kg day^{-1}. For economic analysis, we employed two economic indicators, net present value and internal rate of return. The total cost per animal and per liter of milk produced has increased with the inclusion of oregano. The inclusion of oregano was not effective for both productivity and profitability, with prices equal to R$ 0.87, 0.97, 1.09, 1.22, and R$ 0.78, 1.03, 1.28, and 1.52 of milk and concentrate, respectively for each level of inclusion. The internal rate of return was more advantageous when not adding oregano in the diet, indicating the viability of using oregano up to 0.8% inclusion to the diet of dairy cows under the conditions of this experiment. The net present value demonstrated that this investment is interesting for all discount rates used in the diet without the addition of oregano, pointing out that, in this treatment, the activity was feasible for any opportunity cost.

Keywords: concentrate, milk, production.

Avaliação econômica de vacas leiteiras submetidas à dieta com diferentes níveis de orégano

RESUMO. Objetivou-se, com este estudo avaliar a viabilidade econômica de diferentes níveis de orégano nas dietas de vacas lactantes alimentadas com cana-de-açúcar. Utilizaram-se 12 vacas mestiças Holandês x Zebu, distribuídas em três quadrados latinos 4 x 4. Os quatro tratamentos foram constituídos de diferentes níveis de orégano, como se segue: dieta controle sem orégano (0%); dieta com 0,8; 1,6 e 2,4% de orégano. As dietas foram calculadas para suprir as exigências de mantença e produção de 15 kg de leite/dia. Utilizaram-se, para efeito de estudo da análise econômica, dois indicadores econômicos, valor presente líquido e taxa interna de retorno. O custo total por animal e por litro de leite produzido aumentou com a inclusão de orégano na dieta. A inclusão de orégano não foi eficiente tanto na produtividade quanto na lucratividade, com os preços iguais a R$ 0,87; 0,97; 1,09; 1,22 e R$ 0,78; 1,03; 1,28 e 1,52 de leite e concentrado, respectivamente para cada nível de inclusão. A taxa interna de retorno foi mais vantajosa quando não se utilizou orégano na dieta, sendo viável o uso de orégano até 0,8% de inclusão na dieta de vacas lactantes nas condições do presente experimento. O cálculo do valor presente líquido demonstrou que este investimento é interessante para todas as taxas de desconto utilizadas na dieta sem inclusão de orégano, demonstrando que, neste tratamento, a atividade foi viável a todo custo de oportunidade.

Palavras-chave: concentrado, leite, produção.

Introduction

The increasing search for food with nutraceutical properties, i.e., with specific health benefits, besides traditional nutrients, demands the search for economic alternatives that benefit animal health and increase the quality of products, thus favoring the farmer. In dairy sector, diet manipulation aiming at increasing milk production seeks to produce a high quality food and at the same time, increasing the number of its components, thereby increasing the economic return to the producer.

On the composition of feeding costs, concentrate feeds and forages have an important participation since they represent 40-80% of dry matter (DM) of the diet of many categories that make up the dairy herd. Besides that, forage quality determines the variations in the quality and quantity of concentrate feed. Diets for dairy production system consist basically of forages associated with a concentrate and, according to Costa

et al. (2011), the economic evaluation of the use of concentrates is directly related to the quality of the forage and the genetic potential of animals. Production costs, revenues and return on invested capital are important factors contributing to the success of any production system. This analysis allows the detection of the item that at any time can hinder the activity, such as market price fluctuations Peres et al. (2004). Therewith, the economic analysis of the activity becomes essential to measure the profitability and identify possible setbacks in the productive system, enabling a more accurate analysis of the actual conditions of efficiency of farms, which facilitates the allocation of production factors (land, labor and capital), conditioning the producer to a greater rationality in decision making and business planning.

The study of Matsunaga et al. (1976) has been considered a reference by the National Confederation of Agriculture (CNA), in the Programa Campo Futuro, to help the farmer to calculate the costs, including for producing milk. Peres et al. (2004) stated that some economic indicators can be adopted for the financial evaluation of production systems, such as the net present value (NPV) and internal rate of return (IRR). The NPV is taken as a stricter evaluation criterion of projects and free of technical flaws (NORONHA, 1987; CONTADOR, 1988). It corresponds to the algebraic sum of the values of the cash flow of a project, updated to discount rate(s) of the period in question. In accordance with this indicator, a viable project has a positive NPV. In the implementation of the best project, it is chosen the one with the highest positive NPV. The internal rate of return (IRR) is defined by Contador (1988) as the interest rate that equates to zero the NPV of a project, i.e., it is the discount rate that equates the present value of the benefits of a project to the present value of its costs. A project is viable and should be adopted when its IRR is equal to or greater than the opportunity cost of resources for its implementation.

The use of oregano for cattle feeding has attracted the attention of researchers, once according to Hristov et al. (2012) supplementation of oregano to cattle feed help reducing by 40% the methane emissions, one aggravation of global warming. It represents a natural alternative without any negative effect on the animal, but it is not a low cost product. Therefore, researchers are trying to find an economically viable combination for livestock, which also reduce methane emissions. This study aimed to evaluate the performance and economic viability of using different levels of oregano in diets for confined dairy cows fed cane sugar as forage.

Material and methods

The experiment was conducted at the Paulistinha Farm, municipality of Macarani, Bahia State, from October 2010 to January 2011. Chemical analyses were performed at the Laboratory of Forage and Pasture, State University of Southwest Bahia (UESB), Itapetinga Campus. We used 12 crossbred Holstein x Zebu cows (blood level from ½ to ¾ of blood), at third or fourth lactation, with prior production between 2500 and 3000 kg, set at 300 days, and with 110 days, on average, of lactation at the beginning of the experiment, with 476 ± 3.68 kg body weight. Animals were assigned to three 4x4 Latin squares. The four treatments consisted of four levels of oregano in the diet, with sugar cane (*Saccharum officinarum*) variety RB 72454 as forage, added with 1% of a mixture of urea and ammonium sulfate (9:1), in the experimental phase, after an adaptation period of all animals to sugar cane and 0.5% of this mixture. The level of concentrate supplementation was defined by balancing diets to contain nutrients for maintenance and production of 15 kg milk day^{-1}, according to the NRC (2001), on the basis of data from chemical analysis of cane sugar, previously performed at the beginning of the adaptation period. All the diets were prepared to be isonitrogenous and isocaloric. The experimental diets were: Control (without oregano); 0.8, 1.6 and 2.4% of oregano in the total diet dry matter. Food was supplied as a complete mixture, twice a day at 6:00 a.m and 3:00 p.m. In this period, consumption was adjusted by weighing the food provided and leftovers, allowing intake ad libitum, with 5-10% leftovers, forage: concentrate ratio 65:35. Table 1 Composition of ingredients DM basis.

Table 1. Chemical composition of ingredients of the diets.

Oregano levels				
Ingredients	0%	0.8%	1.6%	2.4%
Sugar cane	64.93	64.93	64.93	64.93
Corn	20.96	20.09	19.22	18.35
Soybean	12.06	12.08	12.10	12.12
Oregano	0.00	0.84	1.69	2.54
Mineral salt[1]	0.90	0.90	0.90	0.90
Dicalcium phosphate	0.75	0.75	0.75	0.75
Limestone	0.41	0.41	0.41	0.41
Chemical				
DM (%)	46.20	46.20	46.19	46.22
OM (%)	93.08	93.43	93.56	93.74
ADF (%)	27.50	28.01	28.41	27.43
NDFcp (%)	44.09	44.27	44.27	44.13
CP (%)	16.84	16.88	16.80	16.82
EE (%)	2.03	2.12	2.12	2.16
NFC (%)	33.72	34.10	33.42	33.37

[1]Composition: Calcium, 20.5%; Phosphorus, 10%; Magnesium, 15 g; Sulfur, 12 g; Sodium, 68 g; Selenium, 32 mg; Copper, 1,650 mg; Zinc, 6,285 mg; Manganese, 1,960 mg; Iodine, 195 mg; Iron, 560 mg; Cobalt, 200 mg. DM – Dry Matter, OM – Organic Matter, ADF – Acid Detergent Fiber, NDFcp - Neutral Detergent Fiber corrected for Ash and Protein, CP – Crude Protein, EE – Ether Extract, NFC – Non Fiber Carbohydrate.

The experiment consisted of 4 experimental periods, lasting 21 days each, with the first 18 days for adaptation, and three days for milk collection. Animals were housed in individual pens equipped with feeders and drinkers, with automated feed supply. The food was offered ad libitum as a complete mixture, twice daily, at 7:00 a.m and 3:00 p.m, allowing for 5% leftovers.

During the experimental periods, we weighed the amount of diet supplied and the leftovers, in order to calculate the voluntary intake of each animal. From the day 19 to the day 21 of each period, we collected the leftovers and the diet supplied which formed a composite sample per period and per animal. Animals were weighed at the beginning of the experiment and at the end of each period to check variations in body weight in each treatment. For manure production, it was used the fecal output calculated by the indigestible fraction of dry matter in the diet, for each treatment. The chemical composition of diet ingredients is listed in Table 2.

Table 2. Chemical composition of ingredients of the diet.

Item	Ingredient			
	Sugar cane	Corn	Soybean meal	Oregano
DM %	24.81	85.81	86.08	80.45
OM %	96.35	98.70	91.20	91.90
CP %	13.63	7.11	44.50	10.48
EE %	1.36	3.00	3.40	3.27
NDF %	56.20	23.40	14.30	38.65
ADF %	37.90	6.63	9.65	19.85
HEM%	18.29	16.72	4.65	18.78
LIG%	7.91	1.12	4.00	6.24

DM – Dry Matter, OM – Organic Matter, CP – Crude Protein, EE – Ether Extract, NDF - Neutral Detergent Fiber, ADF – Acid Detergent Fiber, HEM- Hemicellulose, LIG- Lignin

Milk production was assessed from the 19th to 21st day of each experimental period. The milk production (PLC) corrected to 3.5% fat was estimated according to Sklan et al. (1992), with the following equation: PLC = (0.432 + 0.1625 x% milk fat) x milk production in kg day^{-1}.

The information required for the preparation of this study, composition of the costs, and data used (prices, useful life, etc.) were collected from the farmers, agricultural extension agents and commercial establishments in the region. The land use was calculated as the mean consumption and production of cane sugar of the property used. Within the price of sugar cane DM are spending on implementation, maintenance and recovery of sugarcane plantation. To assess the production cost, we considered the operational cost methodologies employed by IPEA Matsunaga et al. (1976), cited by Rodrigues Filho et al. (2002). Depreciation of leasehold improvements, machinery, equipment and service animals were estimated by the linear method of fixed quotas, with a final value of zero, except for animals. For the return on capital, we used the real interest rate of 6% per year. For economic analysis, we applied two economic indicators: NPV (net present value) and IRR (internal rate of return). The expression for calculating the NPV is:

$$NPC = \sum_{t=0}^{n=1} VF / (1 + r)^t$$

where:

NPV = net present value;

VF = net flow (difference between inputs and outputs);

n = number of flows;

r = discount rate;

t = period of analysis (i = 1, 2, 3...).

In calculating the NPV, three discount rates were applied on the monthly net flow of each production system. The rates adopted were 6, 10 and 12% per year. For IRR, according to the acceptance criteria, the greater the results obtained in the project, the greater the attractiveness for implementation. Thus, the IRR is the r value of that equates to zero the following expression:

$$NPV = \frac{VF0}{(1+r)^1} + \frac{VF1}{(1+r)^2} + \frac{VF2}{(1+r)^3} + \frac{VF3}{} + \frac{VFn}{(1+r)^n}$$

in which:

VF = net cash flows (0, 1, 2, 3,...,n);

r = discount rate.

To calculate the IRR and NPV, we ran simulation for one year for the study of economic characteristics, and thus computed the depreciation of leasehold improvements and machinery during this period. Table 3 shows the sale prices of milk and manure applied on the time of the experiment.

Table 3. Average selling price of products during the experimental period.

Product	Unit	Unit value
Milk	Liters (L)	0.90
Manure	Tons (t)	40.00

In Tables 4 and 5 are listed, in detail, prices of inputs and services, and the useful life and value of leasehold improvements, machinery, equipment, service animals and land, used in the experiment.

Table 4. Prices of inputs and services used in the experiment.

Items	Unit	Unit price (R$)
	kg DM	0.20
Sugar cane	mL	0.06
Vermifuge	mL	0.09
Acaricide	Dose	1.00
Mouth disease vaccine	D H^{-1}	30.00
Hand labor	mL	0.15
Other drugs*	kg	0.53
Corn		1.14
Soybean		1.40
Mineral salt		0.22
Limestone		2.10
Dicalcium phosphate		10.00
Oregano		

*Average prices of some drugs that were eventually used.

Table 5. Useful life and value of leasehold improvements, machinery, equipment, service animals and land used in the experiment and total value.

Item	Useful life (years)	Unit value (R$)	Quantity used (un)	Total value (R$)
Cattle scale – 1500 kg	15	2640.00	1	2640.00
Milk weighing scale	10	120.00	1	120.00
Stationary ration machine	15	3500.00	1	3500.00
Backpack sprayer	10	110.00	1	200.00
Machete for sugar cane	2	20.00	1	20.00
Round point shovel	2	22.00	1	22.00
Wheelbarrow	2	75.00	1	75.00
Four teeth fork	2	22.00	1	22.00
Low value units	2	40.00	1	40.00
Feedlot shed	20	8000.00	1	8000.00
Cows	8	1500.00	12	1500.00
Bare soil		4000.00	4	16000.00
Fixed amount invested				32139.00

Statistical analysis on data of DM intake of concentrate and sugar cane, milk production and body weight variation was run with the aid of the software SAEG - System for Genetic Analysis and Statistics (RIBEIRO JR., 2001), using the analysis of variance and regression, with a significance level of 5%.

Results and discussion

It was detected a positive linear effect ($p < 0.05$) for DM intake (Table 6), which increased 0.471 kg for each percent unit of oregano added to the diet, for the levels of 0, 0.8, 1.6, and 2.4% respectively. Hristov et al. (2012) found no effects of oregano inclusion on nutrient intake and total apparent digestibility of cows. Likewise, an oregano-based commercial product (Ropapharm Int, Ropadairy) included in sheep diets at 250 mg day^{-1} caused no effect on total nutrient digestibility Wang et al. (2009).

Intake of concentrate and sugar cane showed no variation ($p > 0.05$) with the inclusion of oregano in the diet, even with variation in DMI, which may have occurred due to the use of the same forage: concentrate ratio in the diets. The addition of oregano caused an increased DMI, thus it was expected an increased production of milk, which did not occur; the milk production and the milk production corrected to 3.5% fat were not influenced by the inclusion of oregano.

Feed efficiency, kg milk kg^{-1} DM, was not affected by the treatments, and showed similar levels between the oregano levels in the diet. Hristov et al. (2012) added oregano to the diets of cows and observed an upward trend ($p = 0.11$) in the feed efficiency and milk production of cows supplemented with oregano. The variation in body weight presented no influences by the inclusion of oregano, but showed an upward trend in relation to the control diet, when examined the experimental period and on a daily basis, respectively. This indicates that diets have met the genetic potential of animals and supplied nutrients for the recovery of body weight, achieving a greater gain in the treatment with 0.8% addition. This gain needs to be monitored to meet the recovery of body weight lost at the beginning of lactation.

Values of gross revenue per animal tended to increase, when raised the level of dietary oregano (Table 7).

Although oregano inclusion has not increased milk production, the results can be explained by the good market price of milk in the study period, as well as the amount of feces produced, since the manure is a byproduct of great importance in the gross revenue.

Table 6. Intake of sugar cane and concentrate, and herd productivity obtained with the addition of oregano to the diet.

	Oregano inclusion level (%)						
	0	0.8	1.6	2.4	CV(%)	Equations	R^2
DMI (kg day^{-1})[3]	14.89	14.87	15.41	15.97	5.93	y = 0.471x + 14.72	0.87
Cconc (kg day^{-1})[4]	5.21	5.20	5.39	5.58	5.93	Ÿ= 5.34	---
Ccane (kg day^{-1})[5]	9.67	9.65	10.00	10.38	5.93	Ÿ= 9.92	---
Milk (kg day^{-1})[6]	12.83	12.89	13.09	13.10	4.40	Ÿ=12.97	---
PLC (kg day^{-1})[7]	12.84	12.90	13.10	13.10	4.40	Ÿ=12.98	---
kg milk kg^{-1} DM[8]	0.85	0.83	0.89	0.85	12.56	Ÿ= 0.85	---
≠BW[9]	3.06	4.14	3.94	3.97	---	Ÿ=3.77	---
≠BW Day^{-10}	0.15	0.19	0.19	0.19	---	Ÿ=0.18	---

[1]Coefficient of Variation; [2]ns: non-significant ($p > 0.05$); L, Q and C: effects of linear, quadratic and cubic order for oregano inclusion in the diet. [3]DMI= dry matter intake; [4]Cconc= concentrate intake; [7]Ccana= sugar cane intake; PLC= corrected milk production; [9]≠ BW= body weight variation; [10]≠ PC= body weight variation.

Table 7. Gross revenue, effective operational cost, total cost, production profit per cow and per treatment, and return on invested capital.

Item	Unit price (R$)		Oregano level							
			0%		0.80%		1.60%		2.40%	
1-Gross revenue	kg	0.9	12.81	11.53	12.8	11.53	12.8	11.53	12.8	11.53
Sale of milk	kg MS^{-1}	0.035	41.8	1.46	42.3	1.48	40.0	1.4	43.0	1.51
Sale of manure				12.99		13.01		12.93		13.04
Total										
2-Cost										
2.1-EOC	d h^{-1}	30	0.12	3.6	0.12	3.6	0.12	3.6	0.12	3.6
Hand labor	kg MS^{-1}	0.78	5.21	4.06	5.2	5.35	5.39	6.84	5.58	8.48
Concentrate	kg MS^{-1}	0.2	9.67	1.93	9.65	1.93	10	2	10.38	2.07
Sugar cane	kW h^{-1}	0.27	0.86	0.23	0.86	0.23	0.86	0.23	0.86	0.23
Power				0.05		0.05		0.05		0.05
Drugs	R$			0.6		0.6		0.6		0.6
Repair of improvements	R$			0.05		0.05		0.05		0.05
RME				10.52		11.81		13.37		15.08
Subtotal										
2.2-COT	R$			10.52		11.81		13.37		15.08
2.2.1-EOC	R$			0.09		0.09		0.09		0.09
2.2.2-Dep. improvement	R$			0.1		0.1		0.1		0.1
2.2.3-Dep.machinery and equipment	R$			0.27		0.27		0.27		0.27
2.2.4-Dep.cows				10.99		12.28		13.83		15.55
Subtotal										
2.3-Total cost	R$			10.99		12.28		13.83		15.55
2.3.1-Cot	R$			0.12		0.12		0.12		0.12
2.3.2- Interest on capital of improvement				0.06		0.06		0.06		0.06
2.3.3-Interest on capital of machinery				11.18		12.47		14.03		15.74
Total cost/animal	R$			0.87		0.97		1.09		1.22
Cost/liter of milk	R$/L			1.8		0.53		-1.09		-2.7
Total profit/animal	R$			0.14		0.04		-0.08		-0.21
Unit/liter of milk	R$/L			1.99		0.72		-0.9		-2.51
Gross margin/Animal	R$			1.8		0.53		-1.09		-2.7
Net margin/animal	R$			94.13		94.73		95.32		95.83
COE/CT	%			72.46		72.81		73.72		73.48
COE/RB	%			56.98		61.67		66.14		69.99
Spent on food / COE	%			36		42		48		53
Cost of concentrate/CT	%			31		41		52		65
Cost of concentrate/RB	%									

*Prices specified in the previous table, **COE= effective operational cost and CT= Total cost, ***Gross income.

The effective operational cost (Table 7), which indicates the amount of resources directed to meet the expenditures with the activity, also raised with increasing level of oregano in the diet, confirming the importance of the participation of the cost of food in the total cost, reaching 56.98% of the total cost at the lowest level of oregano inclusion. Besides that, this same fraction of the cost became increasingly important, reaching 94.13% of the cost, also for this diet. According to Smith (2003) cited by Costa et al. (2011), the operational cost should not exceed 65% gross revenue. In the present study, the diets with 1.6 and 2.4% oregano have surpassed this threshold, which is explained by the high price of oregano. In intensive production systems, food often represent up to 70% effective costs (not total), but in less technical properties, these inputs account for less than 50% of costs. Our results are in agreement with this proposal, being equal to 56.98, 61.67, 66.14, and 69.99% for diets containing 0, 0.8, 1.6, and 2.4% oregano. The total cost, including depreciation, showed the same behavior of the effective operational cost, considering the use of the same infrastructure and animals in all treatments.

The total cost per animal and per liter of milk, which include the return on capital (opportunity cost), increased with increasing level of dietary oregano. Several economists who are dedicated to studies on dairy farming, including Gomes (2000), have considered that the spent on concentrated feed should not exceed 30% production value, as a reference for milk production systems with semi-confined crossbred cattle. In the present work, the values found were not within the range proposed by Gomes (2000) for all treatments, with 31% in the control (0%) increasing to 65% in the treatment with the highest level of inclusion of oregano (2.4%). The profit per animal was positive in the control and 0.8% oregano inclusion, clearly evidencing that the addition of oregano had not increased production, but increased the cost, and thus its use is impractical in the financial aspect. The IRR and profitability was positive in the treatment 0% and 0.8% inclusion of oregano, being negative in the other treatments, shown in Table 8.

Table 8. Monthly internal rate of return (IRR) and net present value (NPV) for return rates of 6, 10, and 12%, respectively for a year.

	Oregano levels (%)			
	0	0.8	1.6	2.4
IRR	1.65	0.46	-1.05	-2.52
NPV 6%	6815.88	-235.67	-9318.00	-18237.45
NPV 10%	4738.47	-2143.6	-11007.64	-19712.73
NPV 12%	3708.37	-3088.54	-11842.89	-20440.25

This rate reached 1.65% per month for the treatment with 0% oregano in the diet, which is considered high for dairy activities, and 0.46% for the treatment with 0.8% oregano. With increasing levels of oregano, the economic results were not attractive, compared to savings account. Therefore, there is a need for greater efficiency on the part of the animals, in order to achieve an increase in daily production, as a way to reduce fixed costs per liter of milk. The NPV pointed out that this investment is interesting for all discount rates used in the diet without oregano inclusion, evidencing that in this treatment the activity was viable for any opportunity cost.

Conclusion

The addition of oregano at levels of up to 0.8% dry matter to diets for crossbred dairy cows with average milk production of 12.9 kg day^{-1} proved to be economically efficient, being the most indicated.

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