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Impact of feed management on diet selectivity, performance, and economic return of feedlot lambs

Impacto do manejo alimentar na seletividade da dieta, desempenho e no rendimento econômico de cordeiros confinados

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Abstract: The development of feeding strategies can improve production indices and financial returns in livestock systems. This study evaluated the effects of bunk management and feeding adjustment intervals on selectivity, performance, feed refusals, and economic return of feedlot lambs. Sixty crossbred White Dorper x Ile de France lambs (27.89 kg ± 3.71 kg) at approximately 90 days of age (± X days) were assigned to treatments based on body weight, allocated to one of twenty pens (five pens, four blocks, and three animals per pen). The experiment consisted of a randomized block design with a 2 x 2 factorial arrangement and treatments consisting of bunk management for feed refusals of 5–10% and 10–15% and two feeding adjustment intervals every two or three days. Bunk management for feed refusals of 5–10% led to a higher intake of particles smaller than 4 mm (50.73% and 49.37%, P = 0.0022), lower feed waste (0.220 and 0.246 kg DM/day, P < 0.0001), and higher dry matter intake (DMI) (3.775 kg/day, P = 0.0440). Feeding adjustment performed every three days showed higher feed supply (3.966 kg and 3.863 kg DM/day, P = 0.0005) and higher DMI both in kg/day (3.775 kg/day, P = 0.0004) and body weight (3.334% and 3.233% of LW, P = 0.0150). Management with feed refusals of 5–10% and a feeding adjustment interval every three days presented the highest revenue (R$ 688.15) and the lowest cost per kilogram (R$ 2.57). Therefore, bunk management for feed refusals of 5–10% and feeding adjustment intervals every three days was the most viable strategy.

Keywords: feeding behavior; feedlot; feeding management; *Ovis aries.*

Resumo: O desenvolvimento de estratégias alimentares pode melhorar os índices produtivos e retorno financeiro dos sistemas de criação. O objetivo do trabalho foi avaliar os efeitos do manejo de cocho e de intervalos de tempo para ajustes no fornecimento da dieta sobre a seletividade, desempenho, a quantidade de sobra e o rendimento econômico de cordeiros confinados. Foram utilizados 60 cordeiros meio-sangue White Dorper x Ile de France (27,89kg± 3,71kg) com aproximadamente 90 dias de idade (± X dias). Os animas foram distribuídos nos tratamentos em função do peso corporal, alocados em uma das vinte baias (5 baias/4 blocos/; 3 animais/baia). O delineamento experimental foi de blocos casualizados em arranjo fatorial 2 x 2, sendo os tratamentos compostos por manejos de cocho para sobra entre 5-10% e sobra entre 10-15e dois intervalos de tempo para realização dos ajustes no fornecimento da dieta, a cada 2 ou a cada 3 dias. O manejo de cocho para sobras entre 5-10% levou ao maior consumo de partículas menores que 4mm (50,73% e 49,37%, P=0,0022), menor desperdício de alimento (0,220 e 0,246 kg MS/dia, P<0,0001) e maior consumo de matéria seca (CMS), com 3,775 kg/dia (P=0,0440). O ajuste de fornecimento, quando realizado a cada 3 dias, apresentou maior oferta de alimento (3,966 kg e 3,863 kg MS/dia, P=0,0005) e maior consumo de matéria seca (CMS) pelos animais, tanto em kg/dia (3,775 kg/dia, P=0,0004), como em relação ao peso corporal (3,334% e 3,233% do PV, P=0,0150). O manejo com sobras de 5-10% e ajuste a cada 3 dias teve a maior receita (R$ 688,15) e o menor custo por quilo (R$ 2,57). Portanto, o manejo de cocho para sobra entre 5-10% e o ajuste no fornecimento a cada 3 dias foi a estratégia mais viável.

Palavras-chave: comportamento alimentar; confinamento; manejo alimentar; *Ovis aries*.

1. Introduction

Sheep farming has a global reach, being highly technological in some countries and one of the few sources of income and animal protein for feeding the local population in several countries with vast arid and semiarid regions [(1)]. In Brazil, sheep farming has received increasing attention from livestock farmers, a fact that was evident in the 2018 census, which showed that the national herd had approximately 19 million heads, meaning an increase of 12.86% in the last six years [(2)]. However, sheep meat production in Brazil does not meet the consumer market's demand in terms of quantity and quality, as consumers, especially in large urban centers, increasingly demand meat from young animals and top-quality cuts [(3)].

The finishing of lambs in feedlots can help increase productivity, reduce slaughter age, and produce quality carcasses, which are highly sought after by commercial slaughterhouses [(4)]. Therefore, the implementation of adequate feeding management and knowledge of its impacts on animal feeding behavior, feed selectivity, and nutrient intake are essential to improve animal performance [(5)]. The costs involved in the activity consist of other factors directly related to the success of finishing lambs in feedlots, and the analysis and interpretation of these data can be used as an important administrative tool [(6)].

In this context, the study and understanding of feeding behavior and analysis of economic variables can help increase production and profitability in sheep farming. Therefore, this study aimed to evaluate the effects of different bunk management and feeding adjustment intervals on selectivity, performance, and economic return in the finishing of feedlot lambs.

2. Material and methods

All procedures used in this experiment were approved by the Ethics Committee for the Use of Animals of the School of Veterinary Medicine and Animal Science–UNESP (CEUA 0210/2018). The experiment was conducted from September to December 2020 in the Forage Cultivation Sector on the Lageado Experimental Farm of the School of Veterinary Medicine and Animal Science (FMVZ/UNESP), located in the municipality of Botucatu, state of São Paulo, Brazil (22°51'01" S and 48°25'28" W, with an altitude of 777 meters).

Sixty intact crossbred White Dorper x Ile de France lambs with a mean weight of 22.64 ± 3.71 kg and approximately 90 (± X days) days of age were used. All lambs were individually identified with numbered ear tags before the start of the experimental period to facilitate monitoring and data recording. After identification and sanitary management, three animals were housed per pen measuring 2.00 × 1.50 m (3 m^2) with drinking and feeding troughs according to the body weight, totaling 15 animals per treatment. The experimental design consisted of randomized blocks in a 2 x 2 factorial scheme, with treatments consisting of two bunk management systems based on feed refusals (5–10% and 10–15%) and two feeding adjustment intervals (every 2 or 3 days). The diet was increased by 5% for feed refusals below the stipulated intervals, the diet was maintained for feed refusals within the intervals, and the diet was reduced by 5% for feed refusals above the intervals.

The experimental period lasted 70 days, of which 14 were for adaptation. Diet intake was 2.3% of live weight in the first week and 2.7% of live weight in the second week. Dry matter intake (DMI) was set at 3% of live weight after the adaptation period. The experimental diet consisted of whole corn plant silage and concentrate. The corn used for silage production was harvested when the plants had a dry matter (DM) content of 35% and ensiled in a bag-type silo. The concentrate-to-roughage ratio and concentrate composition (Table 1) were defined based on the proximate analyses of the corn silage and for daily live weight gain (DWG) estimated at 300.0 g [(7)].

The lamb diet was formulated using the Small Ruminant Nutrition System (SRNS) computer program based on the Cornell Net Carbohydrate and Protein System [(8)] for sheep and considering the effects of using ionophore (sodium monensin).

Table 1. Formulation and nutritional composition of the experimental diet.

Ingredient	% DM
Corn silage	33.62
Ground corn	48.72
Soybean meal	14.01
Calcitic limestone	1.20
[1]Mineral	1.70
[2]Sodium monensin	0.30
Urea	0.75
[3]Nutritional composition	**%**
Dry matter, %	54.69
Crude protein, %	16.73
Rumen-degradable protein, %CP	65.60
Metabolizable protein, %	10.50
Metabolizable energy, kcal/kg	2.908
Physically effective NDF, %	11.34
Ether extract, %	2.76
Calcium, %	0.81
Phosphorus, %	0.46

[1]Mineral composition (kg of product): 120 g Ca, 0 g P, 110 g Mg, 210 g S, 380 mg Se, 83,500 mg Zn, 26,300 mg Mn, 2,500 mg I, 2,500 mg Co (Maximicrominer, Maxi Nutrição Animal). [2]Rumensin, Elanco Animal Health, Greenfield, IN (30 mg kg^{-1} dry matter). [3]Values calculated by the CNCPS program – Sheep.

The diet was provided thrice daily, at 8:00, 12:00, and 16:00, and feed refusals were collected and weighed daily. Diet and feed refusal samples were collected weekly to evaluate particle size distribution using the Penn State Particle Separator (PSPS), determine physically effective neutral detergent fiber (NDFfe) and the contents of dry matter (DM), crude protein (CP), mineral matter (MM), ether extract (EE), acid detergent fiber (ADF), hemicellulose (HEM), cellulose (CEL), and lignin (LIG) according to techniques described by AOAC [9], and the contents of neutral detergent fiber (NDF) and corrections for ash and CP as recommended by Mertens [10].

The lambs were weighed on a digital scale with a restraining cage at the end of the adaptation period and again every 14 days, aiming to monitor weight gain and adjust the diet. Daily intake (concentrate + silage) was calculated by the difference between the offered feed and feed refusals. Dry mass intake (DMI) during the experimental period was estimated by the difference between the offered feed and feed refusals multiplied by the diet dry matter content. Dry mass intake relative to body weight (DMI, % of BW) was estimated by dividing DMI by the weight gain during the experimental period multiplied by 100. The average daily gain (ADG) of lambs was calculated by the difference between the lamb weight on the day of slaughter and the weight on the 1st day of the experiment divided by 70 days.

The animals were weighed on the last day of the experimental period and sent to a commercial slaughterhouse and slaughtered according to the methods described by the Ministry of Agriculture, Livestock, and Food Supply [11]. The carcasses were identified with numbered seals on the tendon of the gastrocnemius muscle. After evisceration, the carcasses were weighed (hot carcass weight, HCW) and remained in a cold chamber at 4 °C for 24 hours to establish rigor mortis and determine the cold carcass weight (CCW). Calculations of hot (%HCY) and cold (%CCY) carcass yields and chilling losses (%CL) were also performed.

The economic analysis was conducted based on the fixed costs of medicines and necessary labor (based on the minimum wage for 2019 – R$ 954.00) and the variable costs, that is, treatment with anthelmintics, supplementation with concentrate (based on dry matter intake and the cost per kilogram of supplement) and silage (based on dry matter intake and the cost per kilogram of silage). Thus, the following were presented in the economic analysis: the operating cost (sum of fixed and variable costs) and the final cost (operating cost + financial charges). The contribution margin (gain in reais per head), the cost per kilogram of produced live weight, and the break-even point (how much is needed to be produced to cover the costs) were calculated based on the weight gain and the price per kilogram of live weight of the lamb. All costs used in the simulation were budgeted according to the prices found in the market of the state of São Paulo.

The data were analyzed for normal distribution using the Shapiro-Wilk test of PROC UNIVARIATE of SAS [12], being considered normal when $W \geq 0.90$. Each pen was considered an experimental unit for feed refusals, dry matter intake, feed conversion, feed efficiency, and economic analysis of data from feedlot lambs. The animal was considered the experimental unit for the variables of initial and final weights, weight gain, average daily gain, and hot and cold carcass yields. PROC MIXED of SAS and the Satterthwaite command were used to determine the degrees of freedom of the denominator for fixed effect tests. All data were analyzed using the random coefficients model, bunk management was based on feed refusals (5–10% and 10–15%), the two feeding adjustment intervals (two or three days) and their interactions were considered as fixed effects, and the experimental unit (pens and animals) were considered as random effects. The effects were considered significant when $P \leq 0.05$.

3. Results

Bunk management for feed refusals of 5–10% resulted (P = 0.0123) in a lower intake of particles of 19–8 mm (28.27% and 33.52%) (Table 2). Animals that had the bunk managed for feed refusals of 10–15% and feeding adjustment interval every three days (P = 0.0192) consumed fewer particles of 8–4 mm (9.32%). Particles with a length lower than 4 mm were consumed more (P = 0.0022) by animals that had the bunk managed for feed refusals of 5–10% (50.73% and 49.37%). The NDFfe content was higher (P = 0.0093) for the bunk management with feed refusals of 5–10% (7.84% and 9.35%) and lower for bunk management with feed refusals of 10–15% (6.90% and 6.47%).

Table 2. Particle size distribution and NDFfe content of feed refusals from feedlot lambs subjected to two bunk management systems and two feeding adjustment intervals.

Item[2]	5–10%		10–15%		*P*-value[1]		
	2	3	2	3	S	D	S x D
> 19 mm, %	2.91	2.37	2.07	2.82	0.6500	0.8046	–
19–8 mm, %	28.27	33.52	25.84	23.81	0.0123	0.4922	–
8–4 mm, %	13.56a	12.80a	12.81a	9.32b	0.0005	0.0004	0.0192
< 4 mm, %	50.73	49.37	57.56	61.94	0.0022	0.6160	–
NDFfe, %	7.84	9.35	6.90	6.47	0.0093	0.4481	–

[1]There was an effect of isolated factors by the F-test (P ≤ 0.05) and an interaction of factors by the Tukey test (P ≤ 0.05). [2]NDF = physically effective neutral detergent fiber of the samples.

The highest NDF (P = 0.0345) and ADF (P = 0.0297) contents of feed refusals were observed when the bunks were managed for feed refusals of 5–10%, being 33.17% and 33.30% for NDF and 17.51% and 18.23% for ADF (Table 3). The CEL content was lower (P = 0.0013) for bunk management with feed refusals of 10–15% and feeding adjustment intervals every three days (10.18%).

Table 3. Proximate analysis of feed refusals from feedlot lambs subjected to two bunk management systems and two feeding adjustment intervals.

Item[2]	5–10%		10–15%		*P*-value1		
	2	3	2	3	S	D	S x D
% DM	57.16	52.34	54.23	56.42	0.6765	0.3400	–
MM, %DM	5.91	6.38	6.24	6.92	0.2147	0.1000	–
CP, %DM	16.61	16.83	17.09	17.25	0.0933	0.4658	–
NDF, %DM	33.17	33.30	30.83	30.65	0.0345	0.9812	–
ADF, %DM	17.51	18.23	16.07	15.89	0.0297	0.7482	–
CEL, %DM	12.23a	12.61a	13.86a	10.18b	0.4999	0.0077	0.0013
LIG, %DM	2.47	2.74	2.43	2.24	0.2158	0.8613	–

[1]There was an effect of isolated factors by the F-test (P ≤ 0.05) and an interaction of factors by the Tukey test (P ≤ 0.05). [2]DM = dry matter; MM = mineral matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; CEL = cellulose; LIG = lignin.

No differences were observed between the bunk management systems and feeding adjustment intervals for initial weight (IW), final weight (FW), weight gain (WG), average daily weight gain (ADG), feed conversion (FC), and feed efficiency (FE) (Table 4). The DM supply was higher when the feeding adjustment interval was every three days (P = 0.0005), regardless of the bunk management (3.96 kg and 3.86 kg DM/day) (Table 4). Feed refusals were lower (P < 0.0001) when the adopted bunk management consisted of feed refusals of 5–10% (0.22 and 0.24 kg DM/day).

Daily DMI was higher for the bunk management with feed refusals of 5–10% (P = 0.0440) and feeding adjustment interval every three days (P = 0.0004), reaching 3.77 kg, 3.45 kg, and 3.31 kg, 3.77 kg DM/day, respectively (Table 4). DMI as a percentage of live weight (DMI, %LW) was different between feeding adjustment intervals (P = 0.0150), in which the correction every three days presented the highest values (3.33 and 3.23% of LW).

Table 4. Dry matter offer and intake and performance of feedlot lambs subjected to two bunk management systems and two feeding adjustment intervals.

Item[2]	5–10%		10–15%		*P*-value[1]		
	2	3	2	3	S	D	S x D
IW, kg	27,57	28.85	27.16	27.98	0.5920	0.3806	–
FW, kg	45,59	51.22	47.07	47.14	0.4105	0.1182	–
WG, kg	18,02	22.37	19.91	19.16	0.7182	0.3336	–
ADG, kg/day	0,26	0.32	0.29	0.28	0.7182	0.3336	–
FC	3,61	3.77	3.63	3.60	0.6484	0.7231	–
FE	0,27	0.27	0.27	0.27	0.9440	0.9670	–
Item[4]	**5–10%**		**10–15%**		***P*-value[3]**		
	2	**3**	**2**	**3**	**S**	**D**	**S x D**
Offer, kg DM/day	3.54	3.96	3.58	3.86	0.7418	0.0005	–
Refusals, kg DM/day	0.22	0.24	0.35	0.34	<0.0001	0.6387	–
DMI, kg DM/day	3.31	3.77	3.24	3.45	0.0440	0.0004	–
DMI, % LW	3.15	3.33	3.11	3.23	0.2581	0.0150	–

[1]There was an effect of isolated factors by the F-test (P ≤ 0.05) and an interaction of factors by the Tukey test (P ≤ 0.05). [2]IW = initial weight (kg); FW = final weight (kg); WG = weight gain (kg); ADG = average daily gain (kg/day); FC = feed conversion; FE = feed efficiency. [3]There was an effect of isolated factors by the F-test (P ≤ 0.05) and an interaction of factors by the Tukey test (P ≤ 0.05). [4]DM offer kg/day = dry matter offer in kilograms per day; DMI, kg/day = dry matter intake of diet in kilograms per day; DMI, %BW = dry matter intake of diet as a percentage of body weight.

Daily DMI was higher for the bunk management with feed refusals of 5–10% (P = 0.0440) and feeding adjustment interval every three days (P = 0.0004), reaching 3.77 kg, 3.45 kg, 3.31 kg, and 3.77 kg DM/day, respectively (Table 4). DMI as a percentage of live weight (DMI, %LW) was different between feeding adjustment intervals (P = 0.0150), with the correction every three days showing the highest values (3.33 and 3.23% of LW). No differences were observed between bunk management systems and feeding adjustment intervals for initial weight (IW), final weight (FW), weight gain (WG), average daily weight gain (ADG), feed conversion (FC), and feed efficiency (FE) (Table 5). Also, no differences were observed between bunk management systems and feeding adjustment intervals for cold carcass weight (CCW), hot carcass yield (HCY), and cold carcass yield (CCY) (Table 5).

Table 5. Carcass characteristics of feedlot lambs subjected to two bunk management systems and two feeding adjustment intervals.

Item[2]	5–10%		10–15%		*P*-value[1]		
	2	3	2	3	S	D	S x D
CCW, kg	19.73	23.86	21.48	21.05	0.6901	0.1719	–
HCY, %	46.47	47.52	47.45	47.67	0.4886	0.4342	–
CCY, %	45.49	47.15	47.06	47.05	0.3935	0.3414	–

[1]There was a significant effect of isolated factors by the F-test (P ≤ 0.05) and an interaction of factors by the Tukey test (P ≤ 0.05). [2]CCW = cold carcass weight (kg); HCY = hot carcass yield (%); CCY = cold carcass yield (%).

Bunk management for feed refusals of 5–10% and feeding adjustment interval every three days presented the highest revenue (R$ 688.15), the highest contribution margin during the experimental (R$ 503.40) and monthly period (R$ 221.76), and the lowest cost per produced kilogram (R$ 2.57) (Table 6).

Table 6. Analysis of the economic variables of confinement of lambs subjected to two bunk management systems and two feeding adjustment intervals.

Item[2]	5–10%		10–15%		*P*-value[1]		
	2	3	2	3	S	D	S x D
OC (R$)	165.32	181.54	165.35	170.85	0.6026	0.2952	–
Fin. (0.5%/month)	1.88	2.06	1.88	1.94	0.6026	0.2952	–
TOC (R$)	167.19	183.60	167.22	172.79	0.6026	0.2952	–
Revenue (R$)	519.85b	688.15a	574.67ab	561.38b	0.3689	0.0643	0.0335
CMP (R$)	352.40b	503.40a	407.41b	388.16b	0.3551	0.0542	0.0164
MCM (R$)	155.24b	221.76a	179.47b	171.00b	0.3551	0.0542	0.0164
CQW (R$)	3.09a	2.57b	2.80ab	2.99a	0.6018	0.2127	0.0125
BP (kg)	17.326	19.026	17.329	17.906	0.6026	0.2952	–

[1]There was an effect of isolated factors by the F-test (P ≤ 0.05) and an interaction of factors by the Tukey test (P ≤ 0.05). [2]OC = operating cost; Fin. = financial; TOC = total operating cost; CMP = contribution margin during the experimental period; MCM = monthly contribution margin; CQW = cost per kilogram of produced live weight; BP = breakeven point.

4. Discussion

Animals that received bunk management for feed refusals of 5–10% consumed more particles with a length lower than 4 mm (Table 2), demonstrating their predilection for smaller particles. It is due to the feeding habits of sheep, which can selectively consume feed and change their feeding behavior according to the feed supply and availability (13; 14). According to Miller-Cushon and DeVries (5), the amount provided and the time that the feed is available to the animals can influence the way they select their diet. Another fact that shows the higher intake of particles by animals that had the bunk managed for feed refusals of 5–10% (Table 2) is the higher values of NDFfe, as only larger particles with a higher fiber content remained in the bunk, as this attribute is correlated with the physical characteristics and fiber content of the feed (15). In general, animals tend to selectively consume fine particles, which are more palatable and have better nutritional value, but selective intake tends to reduce the nutritional value of the diet remaining in the bunk as the hours pass after the diet is provided (16; 17).

Animals subjected to bunk management for feed refusals of 10–15% and feeding adjustment interval every three days consumed a higher proportion of particles measuring 4–8 mm in length (Table 2). There are some problems associated with the selection of diet components by animals, as the selection of feed or some diet components can result in unbalanced nutrient intake, interfering with feed efficiency by reducing dry matter intake and, consequently, animal performance, negatively impacting financial return (5).

The highest values for NDF and ADF contents (Table 3) were also found in the bunk management for feed refusals of 5–10%, which is also related to the preference of these animals for small particles, resulting in feed refusals with longer particles that normally have a higher NDF content [17]. According to Miller-Cushon and DeVries [5], the behavior of animals in selecting the components that make up the diet influences individual nutrient intake and reduces the nutritional value of the feed that remains in the bunk. On the other hand, the bunk management for feed refusals of 10–15% and feeding adjustment interval every three days presented the lowest CEL content in the feed refusals (Table 3) due to the higher intake of long particles by these animals, leaving smaller particles with better nutritional value.

The amount of feed refusals was lower and dry matter intake (DMI) was higher for the bunk management with feed refusals of 5–10% (Table 4), as the animals consumed smaller particles with higher digestibility and passage rate. According to Della Rosa *et al*. [18], feed management can affect the behavior and feeding pattern of animals, and the amount of provided feed affects the animal selectivity. Haselmann *et al*. [19] evaluated the effect of diets with two particle sizes (52 mm and 7 mm) and observed an increase in DMI, NDF intake, and apparent nutrient digestibility for cows that consumed the diet with smaller particle sizes. The intake of feed with reduced particle size increases DMI due to an increase in the passage rate and a reduction in the time for ruminal emptying [20].

Dry matter supply (kg/day) and dry matter intake (kg/day and %BW) were higher when the feeding adjustment interval was every three days (Table 4), as the animals apparently have a longer period to adapt and mitigate the impacts caused in the rumen by the increased feed supply. Feed intake by ruminants has a high influence on the acid-base balance of the ruminal fluid and a drop in ruminal pH leads to a reduction in feed intake to decrease short-chain fatty acids (SCFA) production [21]. Thus, the management of adjustment in diet supply should promote synchronization between SCFA production, absorption capacity, and neutralization to maintain a stable ruminal environment [22].

Bunk management for feed refusals of 5–10% and feeding adjustment every three days resulted in higher values for revenue, contribution margin during the experimental period, monthly contribution margin, and lower cost per kilogram of produced live weight (Table 6). This is mainly due to the lower feed waste by these animals (Table 4), resulting in a higher financial return. Pacheco *et al*. [23] worked with increasing levels of concentrate in the diet of steers finished in a feedlot and found that concentrates can represent up to 91.3% of the feed costs in diets containing 80% concentrate.

5. Conclusion

The combination of bunk management for feed refusals of 5–10% and feeding adjustment interval every three days was the most viable feeding strategy for feedlot finishing lambs.

Conflicts of interest statement

The authors declare no conflict of interest.

Data availability statements

The data will be provided upon request.

Author contributions

Conceptualization: D. M. de Souza, C. Costa and P. R. de L. Meirelles. Data curation: D. M. de Souza. Formal analysis: D. M. de Souza and P. R. de L. Meirelles. Funding acquisition: A. M. de Castilhos, C. M. Pariz and C. Costa. Investigation: D. M. de Souza and J. da S. Barros. Methodology: D. M. de Souza, C. Costa and P. R. de L. Meirelles. Project administration: D. M. de Souza, C. Costa and P. R. de L. Meirelles. Resources: D. M. de Souza and P. R. de L. Meirelles. Supervision: C. Costa and P. R. de L. Meirelles. Validation: C. Costa and P. R. de L. Meirelles. Visualization: L. B. Furlan and C. Costa. Writing (original draft): D. M. de Souza, C. Costa and P. R. de L. Meirelles. Writing (review and editing): L. B. Furlan and C. Costa.

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