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Digestibility, ingestive behavior, and nitrogen balance in goat kids fed a diet containing dehydrated passion fruit residue

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ABSTRACT - The objective was to determine the optimal dehydrated passion fruit pulp replacing ground corn in diets for goat kids. We used 24 crossbred castrated goat kids with initial body weight of 26.6±0.3 kg. The experimental period was 23 days, with 15 days of adjustment and acclimatization (mostly to the installation and diet). Kids were distributed in a randomized experimental design with four treatments of 0, 80, 160, or 240 g/kg of dehydrated passion fruit residue as a supplementary inclusion in the dry matter (DM) content of the diet. The statistical model considered the fixed effect of the included amount of residue from dehydrated passion fruit. Analysis of variance was conducted using the PROC GLM of SAS. Intakes of DM and total digestible nutrients (TDN) were not affected by residue inclusion. However, neutral detergent fiber (NDF) intake increased linearly. The inclusion linearly decreased intake of ether extract (EE) and non-fibrous carbohydrates (NFC). Crude protein (CP) intake was quadratically affected, with a greater value under treatment of 160 g/kg passion fruit. Dry matter and NFC digestibility decreased linearly with the amount of passion fruit included in diet. Fecal N and total N excretion values (in g/d and %N intake) increased linearly. Nitrogen balance and N retained values showed a quadratic increase, with greater values under the 160 g/kg inclusion. Time spent ruminating, DM and NDF eating efficiency, and g DM/bolus chewed were affected quadratically by inclusion of passion fruit residue. The replacement of ground corn with dehydrated passion fruit residue at a level of 160 g/kg is recommended for diets of goat kids to improve their NDF and CP intake and their N balance without affecting DM and TDN intakes.

Keywords: alternative feed, feedlot, fruticulture, small ruminant

1. Introduction

Residues from the processing of tropical fruits can be used for the enrichment of silages, as well as directly in animals' troughs (Lousada Júnior et al., 2006; Fachinello et al., 2016). Among the available options is passion fruit (*Passiflora edulis* f. flavicarpa) residue, which is obtained from the passion fruit pulp and seeds discarded during juice production.

The genus *Passiflora,* which belongs to the Passifloraceae family, contains more than 500 tropical species, and Brazil is the place of origin of most of them. The yellow passion fruit (*Passiflora edulis*), which is the main cultivated variety, is responsible for the supply of raw material for the processing industry and commercialization of fresh fruits (Lousada Junior et al., 2005).

As an industrial byproduct of fruit production, passion fruit seeds can be obtained in large amounts at a low cost (Sena et al., 2015). However, the product with the greatest potential for use in goat and sheep diets is the residue from the processing of passion fruit, which corresponds to approximately 65 to 70% of the total fruit. Passion fruit residue has an approximate chemical composition of dry matter (DM) ranging from 112 to 175 g/kg (as feed basis), after-drying processing DM content of 800 to 870 g/kg (as feed basis), crude protein (CP) content ranging from 75.3 to 122 g/kg DM, and neutral detergent fiber (NDF) content between 375 and 444 g/kg DM (Neiva Júnior et al., 2007; López-Vargas et al., 2013).

Thus, adding value to this residue product would be both economically and environmentally relevant, but further scientific and technological studies are needed to enable the efficient, economical, and safe use of this product (Schieber et al., 2001). Therefore, due to the variations in the chemical composition of this residue and the effects of its use in diets provided to young goats, the effects of including increasing amounts of this residue on the production performance and ingestive behavior of goat kids need to be assessed.

Based on this scenario, this experiment aimed to test the hypothesis that the inclusion of up to 240 g/kg DM from dehydrated passion fruit residue in diets of goat kids will promote positive effects on intake and digestibility of diets and will not change the standard ingestive behavior of animals. The objective of this study was to determine the optimum dehydrated passion fruit residue amount that should be added to diets of goat kids based on an evaluation of nutrient intake, digestibility, ingestive behavior, and nitrogen (N) balance.

2. Material and Methods

2.1. Ethical considerations, animal management, and treatments

The trial was performed in São Gonçalo dos Campos, Bahia, Brazil (latitude 12°23'58" S and longitude 38°52'44" W). Research on animals was conducted according to the institutional committee on animal use (case no. 18/2016).

Twenty-four castrated Boer goat kids at five months of age (on average) with an average body weight (BW) of 26.6±0.3 kg were distributed in a randomized experimental design with four treatments (inclusion of 0, 80, 160, or 240 g/kg DM of dehydrated passion fruit residue in the concentrated supplement). The animals were kept in individual cages (1×1 m), where they had *ad libitum* access to feed, minerals, and water. The experiment lasted 23 days, with 15 days used for adjustment and acclimatization (mostly to the installation and diet). An early adjustment was included to identify the animals, and they were treated for external and internal parasites.

We followed the recommendations of the National Research Council (NRC, 2007) to formulate diets to meet the requirements for an average daily gain (ADG) of 200 g. The forage (400 g/kg) was Tifton-85 grass hay chopped into 5-cm pieces. The concentrated (600 g/kg) feedstuffs were soybean meal, corn bran, a mineral mixture, and dehydrated passion fruit residue (Table 1). Upon arrival at the experimental farm, passion fruit residues were spread on top of a black plastic, forming a 5 cm-thick layer. They were dried under the sun (average atmospheric temperature = 30.5 °C) for approximately 92 h until they reached 85-88% DM and then ground to a 1-cm particle size.

The diets (Table 2) were provided in a total mixed ration (TMR). The animals were given two daily meals (at 8:00 and 15:00 h), and the TMR was mixed and weighed daily for inclusion in the two meals offered to each individual. The next day, the leftovers were collected from the trough and weighed, and the offered meals were then adjusted based on leftovers compared with the offered amount, allowing 10-20% leftovers. Additionally, the ingestion of DM and other nutrients by the animals was analyzed and calculated.

To determine ingredients and compositions of diets, samples were obtained from the individual ingredients and the manipulated diets, and based on the concentrations and leftovers, feeds were collected weekly and then frozen (–20 °C) for further analyses.

Table 1 - Chemical composition of ingredients used in the preparation of experimental diets

Chemical composition (g/kg dry matter)	Ground corn	Soybean meal	Dehydrated passion fruit residue	Tifton-85 hay
Dry matter (g/kg as fed)	867	867	875	857
Ash	13.0	70.5	26.5	59.8
Crude protein (CP)	75.0	459	78.3	64.5
Ether extract	28.5	15.9	7.70	26.0
NDF_{ap}	132	140	401	780
Acid detergent fiber	38.5	66.3	303	391
NDIP (g/kg CP)	228	115	80.7	395
ADIP (g/kg CP)	116	60.6	27.6	75.4
Hemicellulose	93.6	73.7	97.0	389
Cellulose	27.0	56.7	224	334
Acid detergent lignin	11.5	9.60	79.8	57.4
Non-fibrous carbohydrates	751	315	487	69.7
Acid detergent lignin	12.1	11.2	110	61.5
Condensed tannin	-	-	4.70	-

NDF_{ap} - neutral detergent fiber corrected for ash and protein; NDIP - neutral detergent insoluble protein; ADIP - acid detergent insoluble protein.

Table 2 - Proportions of ingredients and chemical composition of experimental diets in dry matter (DM) basis

Variable	Dehydrated passion fruit residue (g/kg DM total)			
	0	80	160	240
Ingredient proportion (g/kg DM)				
Ground corn	332	251	169	87.0
Soybean meal	253	254	256	258
Passion fruit residue	0.00	80.0	160	240
Mineral mixture[1]	15.0	15.0	15.0	15.0
Tifton-85 hay	400	400	400	400
Chemical composition (g/kg DM)				
Dry matter (g/kg as fed)	865	866	866	867
Ash	61.1	62.2	63.4	64.6
Crude protein (CP)	167	167	169	170
Ether extract	23.9	22.2	20.5	18.8
NDF_{ap}	391	413	434	456
Acid detergent fiber	186	207	228	250
NDIP (g/kg CP)	263	251	239	227
ADIP (g/kg CP)	84.0	76.9	69.7	62.5
Hemicellulose	205	206	206	206
Cellulose	157	173	189	204
Acid detergent lignin	29.2	34.7	40.1	45.6
Non-fibrous carbohydrates	357	335	313	291
Condensed tannin	31.5	39.3	47.1	54.9

NDF_{ap} - neutral detergent fiber corrected for ash and protein; NDIP - neutral detergent insoluble protein; ADIP - acid detergent insoluble protein.
[1] Assurance levels (per kg in active elements): 120.00 g calcium, 87.00 g phosphorus, 147.00 g sodium, 18.00 g sulfur, 590.00 mg copper, 40.00 mg cobalt, 20.00 mg chromium, 1800.00 mg iron, 80.00 mg iodine, 1,300.00 mg manganese, 15.00 mg selenium, 3,800.00 mg zinc, 300.00 mg molybdenum, and maximum 870.00 mg fluoride.

2.2. Nutrient intake and digestibility

To determine the nutrient intake, the quantity of each nutrient present in the leftover feed was subtracted from the total amount of each nutrient in the offered feed.

The digestibility trial lasted from days 17 to 23 of the experiment. For each animal (total sampling), leftovers and feces were collected and quantified using appropriate canvas bags. Goats first used the canvas bags for four days to adapt to them. During the next seven days, feces was collected twice a day (at 8:00 and 15:00), and 30% of the total feces was sampled each day and stored in plastic cases in a refrigerator. For each animal, samples of feedstuffs, leftovers, and feces were collected from the totals accumulated during the assay for further processing and analysis. Samples were dried at 55 °C for 72 h and ground using a Willey cutting mill (1-mm mesh sieve).

Urine was sampled using a container installed at the cage, and 0.036 *N* H_2SO_4 was proportionately equivalent to 10% of the volume of urine from the prior day.

The equation DC = [(kg of fraction ingested – kg of fraction excreted)/(kg of ingested fraction)] × 100 was used to determine the digestibility coefficients of DM, CP, ether extract (EE), NDF, and non-fibrous carbohydrates (NFC). The content of total digestible nutrients (TDN) was calculated using the following equation: TDN = (TDN intake/DM intake) × 100.

Nitrogen contents (obtained in triplicate) in diet, feces, and urine were analyzed according to the AOAC (2012). The nitrogen balance (g/d) was calculated with the following equation: N-balance (g/g) = N intake (g/d) – [fecal N excreted (g/d) + urinary N excreted in (g/d)]. Notal N excretion was calculated from the sum of the fecal N + urinary N excreted. Nitrogen excretion was also considered as the %N intake. Nitrogen retention was obtained as the difference between N balance and basal endogenous nitrogen (BEN), considering the endogenous tissue and dermal N losses to be 0.35 and 0.018 in metabolic weight, respectively (AFRC, 1993). The BEN was obtained using the equation: BEN (g/day) = (0.018 + 0.35) × $BW^{0.75}$.

2.3. Ingestive behavior

Each animal's behavioral activities (Martin and Bateson, 1993) were scored by two trained observers at 5-min intervals for 24 h, and during this process, the observers took care to have minimal impacts on the animals' activities. During nighttime, artificial lighting was used.

Both observers considered the total ruminating chews and boluses ruminated throughout the day. Rumination efficiency, eating efficiency, and total chewing time (h/day) were determined according to Bürger et al. (2000).

2.4. Chemical analyses

The samples obtained from the ingredients, remaining feedstuffs, and feces were dried for 72 h at 55 °C and ground in a 1-mm sieve for further laboratory analysis. Triplicate samples were used for the analyses of DM (967.03 method), ash (942.05 method), CP (981.10 method), and EE (920.29 method) according to the AOAC (2012).

The NDF was determined following recommendations of Van Soest et al. (1991) after extracting ash and protein (NDF_{ap}) based on the Ankom manual of procedures ($Ankom^{200}$ Technology Corporation, New York, US) with some modifications. The method developed by Robertson and Van Soest (1981) and the method 973.18 of the AOAC (2012) were used for the determination of ADF and acid detergent lignin (ADL). The NFC was determined as described by Mertens (1997) based on NDF_{ap} values. The acid and neutral detergent-insoluble protein were determined using the method recommended by Licitra et al. (1996).

Spectrophotometric analysis (Folin-Ciocalteu method; Singleton and Rossi, 1965; Georgé et al., 2005), which was performed in triplicate with gallic acid as the standard, was used to determine the total phenolic content in the feedstuffs. The results are stated as equivalents of gallic acid (mg/g) and were determined based on a calibration curve assembled using several dilutions of gallic acid. The total flavonoid content was determined through a spectrophotometric analysis after reaction with aluminum chloride, as recommended by Fu et al. (2010). Total flavonoid contents were expressed as equivalents of quercetin (mg/g) based on a calibration curve elaborated using different quercetin levels. The concentration of condensed tannin (g/kg DM) was measured based on the mean difference between total phenolic and total flavonoid contents and tannin content.

2.5. Statistical analyses

The statistical model considered the fixed effect of the included amount of dehydrated passion fruit residue (0, 80, 160, and 240 g/kg DM), and initial body weight was used as a covariate once it reached significance. The statistical model was as follows:

$$Y_{ij} = \mu + T_i + \beta(W_{ij} - W) + e_{ij},$$

in which Y_{ij} = observed value of the dependent variable in animal *j* receiving treatment *i*; μ = general mean; T_i = fixed effect of treatment *i* (*i* = effect of dehydrated passion fruit residue); β = linear regression coefficient relative to covariate W_{ij}; W_{ij} = covariate effect (initial BW of animal *j* receiving treatment *i*); and e_{ij} = random effect of experimental error. Analysis of variance was conducted using the PROC GLM SAS (Statistical Analysis System, version 9.1), and means were subjected to regression analysis using the PROC REG command of SAS statistical package. P-values less than 0.05 were assumed to indicate significance, and 0.05<P<0.10 was considered to indicate a trend. Results of the cubic effect analysis that were not significant are not presented in the tables.

3. Results

Linear decreases in EE (P = 0.001) and NFC (P = 0.003) intake and a linear increase in NDF_{ap} intake (P = 0.005) were observed with increasing amounts of dehydrated passion fruit residue in diets (Table 3). The inclusion of increasing amounts of dehydrated passion fruit residue in the goat diet also

Table 3 - Feed intake, digestibility, and nitrogen balance of goat kids fed passion fruit residue, on dry matter (DM) basis

Item	Dehydrated passion fruit residue (g/kg DM total)				SEM	P-value[1]	
	0	80	160	240		Linear	Quadratic
Intake (g/day)							
Dry matter	1067	1113	1146	1027	57.0	0.720	0.143
Crude protein	186	197	205	164	11.6	0.235	0.028
Ether extract	28.6	27.6	26.0	21.5	1.31	0.001	0.185
NDF_{ap}	366	411	441	458	23.8	0.005	0.529
NFC	425	415	406	332	20.3	0.003	0.117
TDN	808	839	818	746	49.0	0.332	0.286
Digestibility (g/kg DMI)							
Dry matter	759	746	707	718	1.69	0.035	0.447
Crude protein	747	755	756	651	1.71	0.691	0.500
Ether extract	801	861	772	818	3.09	0.778	0.826
NDF_{ap}	657	661	606	660	2.17	0.633	0.238
NFC	899	876	872	853	1.17	0.007	0.868
TDN	757	752	711	727	1.58	0.056	0.483
Nitrogen (N) balance (g/day)							
N intake	29.8	31.5	32.8	26.2	1.84	0.235	0.028
Fecal N excretion	7.54	7.70	7.99	9.13	0.52	0.025	0.552
Urinary N excretion	2.13	2.01	2.18	1.94	0.18	0.582	0.725
Total N excretion	9.67	9.71	10.2	11.1	0.74	0.041	0.674
N balance	20.1	21.8	22.6	15.1	1.93	0.089	0.029
N retained	8.89	10.3	10.9	3.82	0.19	0.001	0.032
BEN	11.2	11.5	11.7	11.3	0.95	0.883	0.953
N balance (as %N intake)							
Fecal N excretion	25.3	24.4	24.4	34.8	1.78	0.043	0.665
Urinary N excretion	7.15	6.38	6.65	7.40	0.69	0.314	0.275
Total N excretion	32.5	30.8	31.1	42.4	1.83	0.012	0.538
N balance	67.5	69.2	68.9	57.6	2.87	0.033	0.101

NDF_{ap} - neutral detergent fiber corrected for ash and protein; NFC - non-fibrous carbohydrates; TDN - total digestible nutrients; DMI - dry matter intake; BEN - basal endogenous nitrogen; SEM - standard error of the mean.
[1] Significance at 0.05 and trend at 0.10.

had a positive quadratic effect on CP intake (P = 0.028) and resulted in linear decreases in digestibility of DM (P = 0.035), NFC (P = 0.007), and TDN (P = 0.056). Moreover, the inclusion of this dehydrated residue quadratically increased N intake (P = 0.028), N balance (P = 0.029), and N retained (P = 0.032), with greater values for the 160 g/kg DM inclusion treatment. Additionally, the inclusion resulted in a linear increase in fecal N excretion (P = 0.025) and total N excretion (P = 0.041). The intake of DM (P = 0.143) and TDN (P = 0.286), digestibility of EE (P = 0.778) and NDF_{ap} (P = 0.238), urinary N excretion (P = 0.582), and BEN (P = 0.883) were not affected by the inclusion of dehydrated passion fruit residue in goat kid diets. Significant effects were presented in the %N intake, fecal N (P = 0.043), and total N (P = 0.012) excretions and reduced N balance (P = 0.033) due to dehydrated passion fruit residue inclusion.

The inclusion of dehydrated passion fruit residue in goat diets did not change time spent eating (P = 0.751), number of times/day that goat kids went to the feeder (P = 0.400), ruminated (P = 0.131), or idled (P = 0.413), or ruminating efficiency of DM (P = 0.228) (Table 4). However, the addition of at least 80 g/kg passion fruit residue to goat kid diets had a positive quadratic effect on eating efficiency of DM (P<0.01) and NDF (P = 0.003) and the amount of DM/bolus chewed (g) (P = 0.026). A linear increase in time that goat kids spent ruminating (P<0.01) and a linear decrease in time spent idling (P = 0.062) in the feedlot were also observed. In addition, the inclusion of dehydrated passion fruit residue in goat kid diets tended to be associated with a negative quadratic effect on the number of boluses/day chewed (P = 0.092) and showed linear increases in ruminating efficiency of NDF (P = 0.064) and number of chews per bolus/day (P = 0.092).

Table 4 - Ingestive behavior of goat kids fed passion fruit residue

Variable	Dehydrated passion fruit residue (g/kg DM total)				SEM	P-value[1]	
	0	80	160	240		Linear	Quadratic
Time spent (min/d)							
Eating	368	358	357	366	30.5	0.953	0.751
Ruminating	202	176	217	283	11.7	<0.01	0.003
Idling	870	907	867	791	30.0	0.062	0.089
Eating efficiency (g/h)							
Dry matter	321	382	318	222	19.0	<0.01	<0.01
NDF_{ap}	111	141	122	99.1	7.64	0.159	0.003
Ruminating efficiency (g/h)							
Dry matter	177	193	202	174	17.2	0.968	0.228
NDF_{ap}	60.2	70.9	77.8	78.1	6.58	0.064	0.459
Chewing							
g DM/bolus	2.30	3.00	2.74	2.14	0.25	0.550	0.026
No. bolus/day	474	391	433	499	40.7	0.541	0.092

DM - dry matter; NDF_{ap} - neutral detergent fiber corrected for ash and protein; SEM - standard error of the mean.
[1] Significance at 0.05 and trend at 0.10.

4. Discussion

The range of DM intake (from 1.02 to 1.14 kg/day; 4.52 to 6.03% BW) of goat kids was greater than that reported by other authors (Sultana et al., 2015; Garcez et al., 2019), and the DM intake met the nutritional requirements established by the NRC (2007) that was consistent with the prediction of voluntary DM intake in stall-fed growing goats. Almeida et al. (2019b) suggested that, on average, animals weighing 25 kg would eat 1.0 to 1.2 kg of DM per day (5.5 to 6.0% BW).

The inclusion of dehydrated passion fruit residue (240 g/kg DM) increased the NDF_{ap} content by 143% and reduced NFC by 21.2% due to the higher NDF_{ap} (401 g/kg DM) and lower NFC (487 g/kg DM) contents in the residue than in ground corn (132 g/kg NDF_{ap} and 751 g/kg NDF_{ap} as DM) and, consequently, increased NDF_{ap} intake. In general, fruit residues show high variation in their NDF_{ap} contents because of differences in the cell wall composition (Azevêdo et al., 2011; Almeida et al., 2019a). The proportion of each cell wall component influences the fiber intake, mainly because the components influence the cell wall digestibility, which in turn affects the nutrient intake (Van Soest et al., 1991; Almeida et al., 2019b). Dehydrated passion fruit residue in goat kid diets reduced the digestibility of DM, TDN, and NFC. The lower digestibility of NFC from the dehydrated passion fruit diet compared with the control diet could be explained by the high lignin content of this residue, as also observed by Sena et al. (2015) and Almeida et al. (2019a). The presence of lignin tends to increase the indigestible fraction of the fiber, reducing the potentially digestible fraction (Wilson 1994; Fox et al., 2003).

Although the inclusion of dehydrated passion fruit residue did not influence the time spent eating, the increase of dietary fiber concentration and intake increased the time spent ruminating and reduced the time spent idling in goat kids. The consequence of this effect was an increase in chewing (g DM/bolus) and a decrease in eating efficiencies of DM and NDF_{ap} among the kids.

In addition, dehydrated passion fruit residue can increase the free tannins, which can negatively affect fibrolytic bacteria by changing their membranes (Makkar, 2003). Some researchers have reported that the presence of a high tannin concentration (>50 g/kg DM) in fruit residues results in the inhibition of voluntary intake and increases the number of chews and bolus chewing time due to astringents resulting from the formation of complexes by salivary proteins and tannins (Muir, 2011; Bezerra et al., 2015; Gxasheka et al., 2015).

The N balance increased due to the addition of dehydrated passion fruit residue at the level 160 g/kg DM in goat kid diets, which indicated that the animals retained protein from the diets (N retained increases), achieving the main objective of the nutritional planning.

However, when the inclusion of dehydrated passion fruit residue to replace ground corn was at the level of 240 g/kg DM, the protein degradation rate exceeded the rate of carbohydrate fermentation, and more N compounds were eliminated (Van Soest 1994; Parente et al., 2009). The total N excretion increased from 32 to 42% of the N intake. Therefore, our results indicated that the experimental diets provided a balanced supply of protein and energy, which in turn may have improved the use of dietary protein. Lousada Junior et al. (2005) evaluated the feeding of sheep using byproducts of juice extraction and passion fruit, observing an increase in CP intake. Sena et al. (2015) added dehydrated passion fruit in amounts of up to 600 g/kg DM in diets of Santa Inês × Dorper sheep and observed similar CP digestibility with increasing N intake values, but no effect was observed on fecal N and urinary N excretion or N balance.

Replacing ground corn with dehydrated passion fruit residue guarantees an adequate protein supply and allows the concentration of N-NH_3 in the rumen to supply most of the nitrogen requirement for microbial growth, which is the first priority in improving the fermentative digestibility of the fiber. According to Silva and Ørskov (1988), when there is a sufficient protein supply to assist microorganisms in digestion, there is no effect of supplementation on the digestibility of DM and NDF, since all supplements provide ruminal N-NH_3 concentrations greater than 5 mg/dL of ruminal fluid, which was suggested by Satter and Slyter (1974) to support cellulolytic activity.

According to Azevêdo et al. (2011), passion fruit byproduct has a cell wall containing 7.79% acid detergent lignin as DM, which can make it difficult for microorganisms to access, decreasing the availability of this component and reducing CP digestibility. This can promote greater intestinal flux of N in the intestine, which would explain the greater excretion of fecal N and, consequently, total N. However, a positive N balance was observed with all the diets, which demonstrated that all of them provided an adequate N supply to the animals.

In addition, passion fruit byproduct has the potential to partially replace roughage in diets for ruminants, as long as the EE levels are respected (Azevêdo et al., 2011). In our study, our hypothesis included challenging the animals by replacing corn grain in the concentrated supplement, which increased the NDF of the animals' diet and probably produced a rumen-filling effect, which, depending on its level, may restrict DM intake.

5. Conclusions

The replacement of ground corn with dehydrated passion fruit residue at the 160 g/kg level is recommended for goat kid diets to improve their intake of neutral detergent fiber and crude protein and their N balance and N retained, without affecting intakes of dry matter and total digestible nutrients. The substitution of ground corn with dehydrated passion fruit residue at the level of 240 g/kg negatively affects the N balance and retention. It is important to note that the use of this feedstuff is recommended when it is easily available and cost-effective.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization: R.L. Oliveira. Data curation: J.M. Galvão, T.M. Silva, A.G.V.O. Lima and L.R. Bezerra. Formal analysis: J.M. Galvão, W.P. Silva, P.R.S. Pimentel and D.P.V. Castro. Funding acquisition: R.L. Oliveira. Investigation: J.M. Galvão, W.P. Silva, P.R.S. Pimentel and D.P.V. Castro. Methodology: T.M. Silva, A.G.V.O. Lima, T.V.C. Nascimento, R.D.X. Ribeiro and R.L. Oliveira. Project administration: A.G.V.O. Lima, T.V.C. Nascimento, R.D.X. Ribeiro and J.M. Silva Júnior. Supervision: A.G.V.O. Lima, T.V.C. Nascimento, R.D.X. Ribeiro and J.M. Silva Júnior. Writing-original draft: J.M. Galvão, J.M. Silva Júnior and R.L. Oliveira. Writing-review & editing: J.M. Silva Júnior and L.R. Bezerra.

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