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Short communication

Dry sugarcane yeast and urea could replace soybean meal in the diet of buffalo heifers

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Abstract

The aim of this study was to examine the effects of replacing soybean meal (SBM) with increasing levels (0%, 33%, 67%, and 100%) of sugarcane yeast and urea on the intake, performance, and feeding behaviour of buffalo heifers. Twenty Murrah female buffalos with an initial average weight of 157 ± 1.9 kg at 7 months old were distributed in a completely randomized design. The experimental period was 84 days, and was preceded with 30 days of adaptation. Data were subjected to analysis of variance and regression, using the GLM and REG procedures of SAS software at 5% probability level. The replacement of SBM with sugarcane yeast did not have a significant effect on the intake of dry matter (DM), organic matter and crude protein (CP). Non-fibrous carbohydrate intake increased linearly, whereas the intake of neutral detergent fibre (NDF), and ether extract (EE) decreased linearly. There was no treatment effect on average daily gain or feed conversion (FCR). Rumination efficiency on nondetergent fibre (NDF) decreased linearly. The times spent ruminating, remaining idle, and feeding were not influenced by the treatments, and neither were the parameters of feeding efficiency as a function of DM and NDF intakes and rumination efficiency as a function of DM intake. Dry sugarcane yeast and urea could replace SBM fully in the diet of buffalo heifers with a roughage to concentrate ratio of 50 : 50, because animal performance would not be affected.

Keywords: *Bubalus bubalis*, buffalo performance, dietary protein, *Saccharomyces cerevisiae*
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Buffalo farming is increasing, especially in tropical areas of Asia and the Mediterranean, with milk production being its most prominent purpose (FAO, 2019). The success of a dairy production system is associated partly with the replacement of lactating dams to achieve continuous production and to allow the genetic improvement of the species. In this context, age at puberty and age at first conception are important factors in the efficiency of buffalo milk production systems. In an extensive review of buffalo reproduction, Warriach *et al.* (2015) stated that a major cause of delayed puberty may be poor feeding and management under field conditions. Nutritional management and growth from weaning and during the pre-pubertal period influence age and live weight at first conception (Campanile *et al.*, 2001). Improvements in feed and nutrient intake can improve reproductive performance (Hussein & Abdel-Raheem, 2013). In this context, age of maturity in growing buffalo heifers was reduced significantly by concentrate supplementation compared with fodder alone (Rafiq *et al.*, 2008; Sabia *et al.*, 2014). However, feed accounts for about 70% of production costs, and concentrate feedstuffs such as SBM are expensive (Manceron *et al.*, 2014; Pacheco *et al.*, 2006).

Among agro-industrial by-products, waste from the sugar-alcohol sector such as sugarcane yeast may be a good candidate for use in animal feeds (Makkar *et al.*, 2018). Produced in significant amounts in Brazil (694 000 ton/year) (MAPA, 2018), this by-product is readily available for use in animal feeds (Erickson *et al.*,

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2020; Lucey *et al.*, 2021). Indeed, it could replace SBM fully in the diet of goats (Lima *et al.*, 2011) and cattle heifers (Franco *et al.*, 2016). However, there is a dearth of published data on the use and effect of sugarcane yeast on the performance of buffaloes, especially heifers. Therefore, this study was conducted to investigate the effect of replacing SBM with sugarcane yeast on the nutrient intake, performance and feeding behaviour of buffalo heifers.

All experimental procedures complied with the Ethics Committee on Animal Use (Licence 075/2015, CEUA/UFRPE/Brazil). The experiment was carried out in the Buffalo Farming section of the Department of Animal Science at the Federal Rural University of Pernambuco, Recife, Pernambuco, Brazil.

Twenty seven-month-old Murrah heifers with an average initial bodyweight of 157 ± 1.9 kg were fed individually in covered stalls with concrete floors and equipped with a feeder. Water was available ad libitum. The animals were treated against ecto- and endo-parasites and supplemented with vitamins A, D, E and K. The experimental period consisted of 84 days of data collection, preceded by a 30-day adaptation period.

Feed consisted of sugarcane forage *(Saccharum officinarum)* and concentrate (50 : 50), formulated to produce a weight gain of 700 g/day (Paul & Patil, 2007). Sugarcane forage (RB92579 cultivar) was harvested just before being offered to the animals. The experiment was a completely randomized design with four treatments with increasing levels (0%, 33%, 67% and 100% DM) of replacement of SBM with dry sugarcane yeast and urea (Table 1) and five replicates.

Table 1 Ingredients and chemical composition of diets used to establish effects of replacing soybean meal with urea and sugarcane yeast.

Ingredients, g/kg DM	Replacement levels, %			
	0	33	66	100
Sugarcane forage	500	500	500	500
Corn ground	130	130	130	130
Soybean meal	225	150	75	0
Wheat bran	130	130	130	130
Sugarcane yeast	0	66	132	198
Mineral salt	15	15	15	15
Urea/ammonium sulfate (9 : 1)	0	9	18	27
Chemical composition				
Dry matter, g/kg of fresh matter	617	614	612	609
Organic matter, g/kg of dry matter	942	942	941	941
Crude protein, g/kg of dry matter	160	160	161	161
Ether extract, g/kg of dry matter	20	20	19	19
Neutral detergent fibre, g/kg of dry matter	382	371	361	351
Indigestible neutral detergent fibre, g/kg of dry matter	119	118	116	115
Non-fibre carbohydrates, g/kg of dry matter	380	390	400	410
Total digestible nutrients, g/kg of dry matter	684	675	665	656

The diets were provided ad libitum, twice a day, at 08h00 and 16h00, allowing approximately 10% orts. The amounts of feed supplied and orts were calculated daily to measure intake. Samples of roughage, concentrates and orts were collected, packed and frozen. The samples were composited weekly for chemical analysis.

The DM (method 967.03), mineral matter (method 942.05), CP (method 981.10), and EE (method 920.29) contents were determined according to the Association of Official Analytical Chemists (2012). Acid detergent fibre (ADF) and NDF levels were determined according to Van Soest *et al.* (1991). The remaining material from NDF analysis was subjected to nitrogen and ash analysis (Mertens *et al.*, 2002), the results of which were used in calculating neutral detergent insoluble nitrogen and neutral detergent insoluble ash (NDIN and NDIA) (Licitra *et al.,* 1996). The NDF content was corrected for ash and protein as follows:

NDF = NDF – NDIP – NDIA

where the neutral detergent insoluble protein content (NDIP = NDIN × 6.25). Non-fibrous carbohydrate (NFC) levels were calculated using the equation proposed by Detmann & Valadares Filho (2010):

NFC = OM – (CP – (CPu + Ur)) + EE + NDF

where CPu = CP from urea (% DM); and Ur = urea content of the diets (% DM).

At the start and end of the experiment, after a 16-hour solid fast, the animals were weighed to determine average daily weight gain (ADG). Feed conversion was calculated as DM intake/ADG and expressed in kg/day.

Measurements of behavioral patterns were taken by applying the 'scan sampling' method proposed by Martin and Bateson (2007) at 5-minute intervals, over 48 hours. These behaviours were determined, namely idle time, rumination time and feeding time. Feeding efficiencies were calculated as a function of the intakes of DM and NDF as ratios to FT. Likewise, rumination efficiencies based on DM and NDF were calculated as the ratio of the intake of each nutrient to rumination time (Bürger *et al.*, 2000).

The data were evaluated according to this statistical model:

$$Y_{ij} = \mu + T_i + b(w_{ij} - \overline{w}) + e_{ij}$$

where: Y_{ij} = response of the jth animal to the ith treatment (T_i),
μ = mean of the response variable,
$b(w_{ij} - \overline{w})$ = linear effect of initial weight (w_{ij}), and
e_{ij} = random error associated with each observation.

The data were subjected to analyses of variance and regression using the GLM and REG procedures of SAS (SAS Institute Inc., Cary, North Carolina, USA). In the regression analysis treatment was continuous, and for analysis of variance it was discrete. The 5% probability level was used for type-I error.

The replacement of SBM with sugarcane yeast did not influence (*P* >0.05) the intakes of DM, OM, and CP. Non-fibrous carbohydrate intake increased linearly with the replacement of SBM, whereas the intakes of NDF (*P* =0.0259) and EE (*P* =0.0341) decreased linearly in response to the treatments. There was no treatment effect (*P* >0.05) on ADG or feed conversion (Table 2).

Table 2 Nutrient intake and performance of buffalo heifers fed with dry sugarcane yeast and urea to replace soybean meal

Response variables	Replacement levels (%)				SE	*P*-values	
	0	33	66	100		Linear	Quadratic
Dry matter, kg/day	5.14	5.31	5.21	5.23	0.142	0.730	0.542
Organic matter, kg/day	4.83	4.99	4.90	4.92	0.134	0.711	0.539
Crude protein, kg/day	0.87	0.89	0.86	0.86	0.024	0.497	0.579
Ether extract, kg/day	0.10	0.10	0.10	0.10	0.003	0.034	0.540
NDF, kg/day	1.90	1.95	1.84	1.75	0.053	0.025	0.207
Non-fibre carbohydrates, kg/day	1.94	2.03	2.09	2.20	0.059	0.000	0.828
Initial weight, kg	160	157	156	156			
Final weight, kg	222	221	220	218	0.152	0.974	0.447
Average daily gain, kg/day	0.74	0.77	0.76	0.73	0.015	0.884	0.462
Feed conversion	7.10	6.89	6.92	7.15	0.240	0.891	0.480

Replacing the dietary SM with sugarcane yeast did not affect DM intake, possibly because of the similar composition of the diets. Franco *et al.* (2016) did not observe an influence of yeast inclusion on the

DM intake of cattle heifers. In the present study, DM intake averaged 5.22 ± 0.07 kg/day, a value similar to that reported by Mondal and Prakash (2005) for buffalo heifers.

The association of urea with sugarcane yeast led to an adjustment in the dietary levels of CP, which resulted in a lack of effects on the intake of this nutrient. The decrease in NDF and EE intakes was because of the reduction of these fractions in the diets caused by the inclusion of sugarcane yeast. The experimental diets had an average NDF content of 366 ± 129.1 g/kg DM, which was higher than the 330 g/kg DM proposed by Ahmad *et al.* (2014) (330 g NDF/kg f DM) that was indicated as the ideal level for maximizing intake in Nili-Ravi buffaloes.

The increase in NFC intake could also be attributed to a higher concentration of it as SBM was replaced with sugarcane yeast and urea in the treatment diets. It was assumed that even with the addition of urea, there was no damage to microbial synthesis, given the NFC profile in yeast (rapidly fermentable) (Franco *et al.,* 2016). Alves *et al.* (2009) observed that diets with a CP to NFC ratio between 0.39 and 0.27 resulted in similar fermentation in the rumen to male buffaloes of the Mediterranean breed, indicating synchronism in the use of nitrogen and energy by ruminal microorganisms. In the present study, the CP to NFC ratio was 0.45, 0.44, 0.41, and 0.39, for the sugarcane yeast replacement levels of 0%, 33%, 66%, and 100%, respectively.

The treatments had no effect (P >0.05) on feeding time, rumination time, idling time, feeding efficiency for either DM or NDF, and rumination efficiency for DM (Table 3). Despite the reduction in NDF intake, there was no effect on feeding time or RT, possibly because of the similar DM intakes of the animals. In the present study, rumination time averaged 6.27 hours, a value close to that reported by Pessoa *et al.* (2019) in buffalo heifers fed diets with 20% sugarcane. The absence of differences in DM intake and feeding time (average of 178 ± 1.89 min/day) possibly resulted in the similar values for dry matter feeding efficiency. The decreasing linear effect observed for NDF rumination efficiency was probably a consequence of the concentration of NDF in the experimental diets and the consumption of NDF, since rumination time was not influenced by the treatments. Buffaloes perform a different chewing movement (slower and more effective) from cattle, because they have more developed muscles for rumination (De la Cruz-Cruz *et al.*, 2014), which makes them more efficient in feed utilization.

Table 3 Ingestive behaviour of buffalo heifers fed with dry sugarcane yeast and urea to replace soybean meal

Response variables	Replacement levels (%)				SE	*P*-values	
	0	33	66	100		Linear	Quadratic
Rumination time, minutes/day	373	388	370	374	4.211	0.715	0.562
Idle time, minutes/day	889	877	891	887	6.879	0.910	0.806
Feeding time, minutes/day	178	175	179	179	3.749	0.857	0.867
Feeding efficiency, kg DM/hour	1.72	1.83	1.79	1.76	0.063	0.838	0.504
Feeding efficiency, kg NDF/hour	0.63	0.67	0.63	0.59	0.023	0.286	0.314
Rumination efficiency, kg DM/hour	0.82	0.81	0.84	0.84	0.022	0.416	0.969
Rumination efficiency, kg NDF/hour	0.30	0.30	0.30	0.28	0.008	0.050	0.447

Inclusion of yeast and urea in the diet as a replacement for SBM did not induce changes in the final bodyweight, ADG, or FCR of the heifers. In fact, on all treatments the heifer grew slightly faster than anticipated. The diets being formulated to be isonitrogenous and isocaloric ensured an adequate supply of fermentable energy and rumen nitrogen necessary for microbial synthesis and adequate animal performance. Similarly, Iqbal *et al.* (2017) reported a nonsignificant effect of various concentrate levels on ADG in Nili-Ravi buffalo heifers. Thus, sugarcane yeast and urea could replace SBM in the diet of buffalo heifers with a roughage to concentrate ratio of 50 to 50, because animal performance would not be affected.

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Authors' Contributions

DOL, MVGS and MLMWN participated in designing the study, laboratory analysis, and manuscript writing. RASP, ALRM, and FFRC were involved in drafting and revising the manuscript for important intellectual content. ALRM and DMLJ carried out data analysis and interpretation. DMLJ, DOL, RASP, MLMWN were involved in the preparation and revision of the manuscript. FFRC, DOL, DMLJ contributed to the acquisition, analysis and interpretation of data.

Conflict of Interest Declaration

The authors declare that they have no conflict of interest.

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