Pure Appl. Biol., 7(3): 998-1006, September, 2018
http://dx.doi.org/10.19045/bspab.2018.700118

Research Article

Nutritional assessment of corn wet feed in Nili Ravi Buffalo (*Bubalus bubalis*)

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Citation
Sana Najeeb, Asif Javaid, Kashif Siddiq, Muhammad Akhtar, Mahr-un-Nisa and Muhammad Shuaib Khan. Nutritional assessment of corn wet feed in Nili Ravi Buffalo (*Bubalus bubalis*). Pure and Applied Biology. Vol. 7, Issue 3, pp998-1006. http://dx.doi.org/10.19045/bspab.2018.700118

Received: 27/04/2018 Revised: 09/07/2018 Accepted: 13/07/2018 Online First: 17/07/2018

Abstract

Four rumen fistulated buffalo bulls were used in Latin Square Design (4×4) to inspect the impact of replacement of corn grains with corn wet feed (CWF) on nutrients digestibility, rumen characteristics (rumen pH and ammonia N) and nitrogen (N) balance. The bulls were fed restricted diets. Diets were formulated isocaloric (ME 2.30 Mcal/kg) and isonitrogenous (12.55% crude protein (CP). The CWF0 (control diet) had no CWF, while CWF10, CWF20 and CWF30 diets contained CWF 10, 20 and 30%, correspondingly. Experimental duration was eighty days. The CP and dry matter (DM) intakes did not differ (P>0.05) across all diets because of restricted diets. High intake (P<0.05) of neutral detergent fiber (NDF) was noted in animals fed CWF30 than animals fed CWF0, it was similar to those fed CWF10 and CWF20 diets. The CP, DM and NDF digestibility was high (p<0.05) in bulls fed CWF10 diet as compared to bulls fed CWF0, CWF20 and CWF30 diets, whereas, these were similar (P>0.05) among bulls fed CWF30, CWF20 and CWF0 diets. The N balance was positive in all bulls. High N balance (P<0.05) was noted in animals fed CWF10 and CWF20 diets compared to those fed other experimental diets. Rumen pH at 0, 3, 6 and 9 hours after feeding was same across all diets. Rumen ammonia N was different (P<0.05) at 3, 6 and 9 hours after feeding, however, it was same at 0 hour. In conclusion, replacing 10% corn grains with CWF showed improved digestibility, rumen characteristics and N retention of bulls.

Keywords: Buffalo bull; Digestibility; N balance; Ruminal ammonia-N; Ruminal pH

Introduction

Recently native and exogenous livestock breeds are being raised with manipulation of feed ingredients to fulfill nutritional requirements of peoples of developing countries. However, Pakistan is still facing scarcity of feed ingredients for potential ruminant production [1]. Animal nutritional needs cannot be met resulting under fed because of this scarcity of feeds. The existing resources of feeds are 24 and 38 % scarce in total digestible nutrient and crude protein (CP), correspondingly [1]. There are various substitutes to fulfill this nutrient deficiency. The agro-industrial byproducts (AIBP) are considered significant feed stuffs that can

meet the feed scarcity in ruminant animals [2] because the concentrates share in total feed resources is approximately 77% total digestible nutrients and 9% CP share of the total concentrate comes from AIBP in Pakistan [3].

The AIBP feed resources (wheat bran, rice polishing, sugarcane pith, molasses, corn cobs, corn gluten meal 60 and 30%, corn bran, oil seed cake, corn steep liquor, hulls and meals etc.) can not only meet the animal nutrients requirement but have also the potential to make the diet economical [1]. However, their nutritional evaluation is essential before inclusion in ruminant's diet [4]. Biological and chemical evaluation of AIBP for ruminant animals may expose a new opportunity to minimize the gap between nutrient demand and their availability [5].

Wet corn gluten feed (WCGF) is a potential feed ingredient for beef and dairy animals [6]. It is fed to animals as a dry or wet form. Procedure of milling of WCGF initiate with the separation of the maize grain and removing of any foreign particle. The corn kernel is soaked in a blend of sulfur dioxide and water which results to swell up the kernel. During the procedure of steeping/soaking, the nutrients moved into the water, which is called the corn steep liquor. The liquor is squeezed, concentrated and the remaining is called corn gluten feed or corn wet feed (CWF) [7].

The CWF is good source of protein, moderately high digestible fiber, less in starch and low in vegetable oil [8]. On the basis of its characteristics, the CWF can be fed in high amount to ruminant animals. It may be considered as energy source in spite of its increased portion of fiber. Fiber is slightly more digestible in wet CWF than its dry condition results in more intake of wet compared to dry form [8]. Many studies have reported improved production with inclusion of CWF in the diet but few have stated rumen effects [9].

The CWF is byproduct of corn processing industry and contains 14% CP, 40% DM, 80% total digestible nutrients, 12% crude fiber and holds high contents of moisture. High moisture content in CWF is major constraints for its higher inclusion level in the diet of ruminants. Higher moisture contents ingredients are more prone to fungal growth and ultimately toxin production in CWF which is injurious to animal production and health [10-12]. Nutritionists are in efforts to preserve CWF by using in total mix ration along with other feeding stuffs containing less contents of moisture which will prevent it from fungal growth. However, the inclusion of CWF in the diet of ruminant animals can only be recommended after its nutritional evaluation by conducting its thorough studies in ruminant animals [13]. The objective of this experiment was to assess the impact of gradually replacement of CWF on nutrients digestibility, N balance and rumen characteristics in fistulated Nili Ravi buffalo bulls.

Materials and methods

Four ruminally fistulated Nili-Ravi buffalo bulls (550 ± 20 kg) were used in Latin Square Design (4x4) to find out the effect of gradual replacement of corn grain with CWF on digestibility of nutrients, N balance and rumen characteristics (rumen pH and ammonia N). Four iso-nitrogenous (12.55%) and iso-caloric (2.30 Mcal/kg) total mixed rations were formulated using different levels of CWF (Table 1). The CWF was secured from Rafhan Maize Products Co. Ltd. The chemical composition of CWF is presented in (Table 2). Faisalabad. Control diet (CWF0) contained 30% of corn grain and 0% CWF on DM basis, whereas rations CWF10, CWF20 and CWF30 contained 20, 10 and 0% corn and 10, 20 and 30% CWF on DM basis, correspondingly. Bulls were fed restricted diets @ 1% of body weight on DM basis. The bulls were kept on concrete floor and in

individual pens. The bulls fed two-time a day. The availability of water was ensured for 24 hours. Experimental duration was 80 days. The bulls fed for 15 days, the first 10 days served as adjustment period whereas the next 5 days as collection period. After 20, 40 and 60 days, re-randomization of diets was done and same procedure was replicated. The total collection method procedure was used to find out nutrient digestibility [14]. Complete urine collection was done by the method defined by Javaid *et al*. [15]. Daily collection of feces and urine of each bull was done, properly weighed, well mixed and 20 % of it was sampled. The feces dried at 55 °C in oven. Dried fecal samples were composited at the termination of each collection phase and 10 % of this was used for chemical analysis. The 10% urine sample was collected after acidifying urine with 50% H_2SO_4. The urine sample was well preserved at -20°C. The urine samples were composited at the end of collection phase and 10% of the composited sample was used for chemical analysis [4]. Rumen sampling was done at 3, 6, 9 and 12 hours of post feeding in morning to determine NH_3-N and rumen pH. Subsequently the sample was pressed through cheesecloth (4 layers). Approximately 50 ml of rumen liquor was preserved after acidifying with 3 ml of 6 N HCI to end the process of fermentation.

Table 1. Ingredients and chemical composition of experimental diets (%)

	Diets[1]			
Ingredients	**CWF 0**	**CWF 10**	**CWF 20**	**CWF 30**
Corn cobs	30.00	30.00	30.00	30.00
Corn	30.00	20.00	10.00	0.00
Corn wet feed	0.00	10.00	20.00	30.00
Maize gluten 30%	9.00	10.00	9.00	8.50
Maize gluten 60%	5.00	5.00	5.00	5.00
Maize oil cake	5.00	4.00	4.00	3.50
Corn steep liquor	5.00	4.00	4.00	4.00
Enzose	14.00	15.00	15.00	15.00
Maize oil	1.00	1.00	2.00	3.00
Dicalcium Phosphate	1.00	1.00	1.00	1.00
Total	**100**	**100**	**100**	**100**
Chemical Composition				
Dry matter %	85.38	80.70	75.80	71.08
Crude protein %	12.57	12.59	12.56	12.59
Neutral detergent fiber	35.66	37.51	39.11	40.65
ME[2] Mcal/Kg	2.40	2.30	2.30	2.33

[1]CWF0 represents the control diets having 30% corn and 0% corn wet feed, while CWF10, CWF20 and CWF30 refer to diets having 10, 20 and 30% corn wet feed replacing with corn, respectively.
[2]Metabolizable Energy

Feed samples and fecal samples were analysed for DM and CP [16]. The samples were dried at 105°C for 24 hours in hot air oven to determine DM [16]. The N was determined by Kjeldahl method and then N was multiply with 6.25 factor to calculate CP [16]. The NDF was determined by using method of Van Soest *et al.* [17]. During each collection period at 17th day ruminal liquor was taken from the rumen of cannulated bulls and pH was determined by Ohaus pH meter (Model, STATER3000). Ruminal NH3-N was determined by direct distillation and titration carried out by Kjeldhal's method [18]. General linear model of SPSS 17.0 was used to analyse the data by the analysis of variance technique in Latin Square Design [19]. Duncan's new multiple range test was used for means separation.

Results and discussion

No difference (P>0.05) in CP and DM intakes among the treatments was only due to method of feeding because all animal were on restricted feed intake. While, higher (P<0.05) intake of NDF was noted in bulls fed CWF30 diet followed by bulls fed CWF20, CWF10 and CWF0 diet, correspondingly (Table 3). The increasing trend in intake of NDF bulls fed diet having varying level of CWF was because of its increased dietary contents of NDF (35.66, 37.51, 39.11 and 40.65%) with increasing inclusion level of CWF.

Table 2. Chemical composition of corn wet feed

Dry matter %	37
Crude protein %	14
Fat %	2.5
ME[1] Kcal/Kg	1518

[1]Metabolizable Energy

Table 3. Effect of replacing different levels of corn grains with corn wet feed on nutrients intake and digestibility in buffalo bulls

	Diets[1]				
Items	**CWF0**	**CWF10**	**CWF20**	**CWF30**	**SE[2]**
Intake (Kg/day)					
Dry matter	5.35	5.35	5.35	5.35	±0.857
Crude protein	0.673	0.672	0.673	0.674	±0.473
Neutral detergent fiber	1.91^{b}	2.01^{ab}	2.09^{ab}	2.17^{a}	±0.01
Digestibility%					
Dry matter	65.07^{b}	70.19^{a}	66.41^{b}	66.86^{b}	±0.668
Crude protein	60.48^{b}	66.05^{a}	62.65^{b}	62.45^{b}	±0.0417
Neutral detergent fiber	59.98^{b}	66.83^{a}	61.08^{b}	58.87^{b}	±0.947

[1]CWF0 represents the control diets having 30% corn and 0% corn wet feed, while CWF10, CWF20 and CWF30 refer to diets having 10, 20 and 30% corn wet feed replacing with corn, respectively.
[2]Standard error
[a,b] Means within row with different superscripts differ (P<0.05)

The DM digestibility was high (P<0.05) in bulls fed CWF10 diet as compared with bulls fed CWF0, CWF20 and CWF30 diets. Same findings were observed for CP and NDF digestibility. The lower CP, NDF and DM digestibility in bulls fed CWF30 and CWF20 diets might be related to increased addition of CWF. Less digestibility of nutrients by bulls fed CWF0 diet might be because of large particle, floating in rumen liquor having low

specific gravity and earlier passing from rumen compared with particles having small size and high gravity [20, 21]. Another possible reason might be increased passage rate of digesta from rumen to rectum [20-22]. The results of this study are supported by scientists [23] who stated low digestibility of CP, NDF and DM with increase in the inclusion WCGF level in the cattle diet. Another possible reason may be related to increasing dietary moisture because of increasing the inclusion CWF level which might had enhanced diet passage rate in digestive tract as reported by [24, 25]. Allen and Grant [21] and Crystal *et al.* [22] reported that CP, DM and NDF digestibility was decreased with increased WCGF level. It might be due to low ruminal NH_3-N concentration because Javaid *et al.* [15] reported low digestibility of DM with low ruminal NH_3-N concentration. The low digestibility in bulls fed higher corn grain level might be related to nutrients uncoupling in rumen restricting microbial fermentation of the nutrients [26].

The total N excreted, urinary N and N intake were same by bulls across all diets (Table 4). While, fecal N was high (P>0.05) in bulls fed CWF0 diet. Retention of N was high (P>0.05) in bulls fed CWF20 and CWF10 diets followed by bulls fed CWF0 and CWF30 diet. As the bulls fed restricted diets thus non-significant difference in N excreted, urinary N and N intake was observed in bulls across all diets. Rich *et al*. [27] noted same findings regarding fecal N that was higher (33.60%) as compared to control. This might be because of greater bypass protein. Findings of this study are in agreement with findings of other researchers [28, 29]. As the CWF supplies a mixture of free amino acids, ammonia and peptides for the growth of microbes and microbial protein synthesis therefore it can be considered valuable for the rumen.

Table 4. Effect of replacing different levels of corn grains with corn wet feed on N balance in buffalo bulls

Diets[1]					
Items (g/day)	**CWF0**	**CWF10**	**CWF20**	**CWF30**	**SE[2]**
Nitrogen Intake	107.68	107.6	107.8	107.8	±1.722
Fecal nitrogen	43.42[a]	36.42	40.2	40.58	±0.881
Urinary nitrogen	52.35	53.13	54.85	51.93	±1.365
Total excreted nitrogen	94.79	88.43	95.05	92.48	±1.917
Nitrogen balance	12.88[b]	16.27[a]	15.57[a]	15.31[b]	±0.466

[1]CWF0 represents the control diets having 30% corn and 0% corn wet feed, while CWF10, CWF20 and CWF30 refer to diets having 10, 20 and 30% corn wet feed replacing with corn, respectively.
[2]Standard error
[a,b] Means within row with different superscripts differ (P<0.05)

The rumen pH was unaltered in bulls fed all diets (Table 5). The increase in CWF level in the diet caused decreased ruminal pH which might be because of sufficient provision of long particle size essential for normal rumen function resulting maintenance of rumen pH. Same results were also reported by [7, 30] with enhancing the concentration of dietary WCGF. Feeds deficient in long particle size are more fermentable [20] resulting more acid production with subsequent drop in rumen pH. The particle size and pH are related, the diets having high WCGF had more part of longer particles (greater than 8 mm). This might had increased chewing activity. Enhanced activity of chewing might had resulted to stimulate the production of salivary buffer resulting no change in rumen pH [31, 32]. It is observed that even adding CWF decreased ruminal pH, it might because

of provision of adequate effective fiber by 30% CWF diet to maintain rumen function. The CWF is fermented rapidly in rumen as compared to corn grain [33, 34]. The cows fed rapidly fermentable feeds have acidic rumen pH because of readily fermentation of CWF as compared to corn grain [35]. It describes the linear increase in acidic rumen pH resulting the feeding of greater quantity of CWF to bulls in this experiment.

Rumen NH_3-N concentration was observed at 0, 3, 6, and 9 hours post feeding in animals fed diets having different CWF level as expressed in (Table 6). Rumen NH_3-N concentration before feeding (0 hour) was same in bulls across all diets. Higher ($p<0.05$) rumen NH_3-N concentration at 3 hours post feeding was noticed in bulls fed CWF10 diet than those fed other diets. Similar trend in NH_3-N concentration was noticed at 6 hours post feedings. Rumen NH_3-N concentration was high ($P<0.05$) in bulls fed CWF10 diet at 9 hours post feeding than bulls fed CWF0 diet but it was similar to those fed CWF20 and CWF30 diet. Higher concentration of rumen NH_3-N concentration in bulls fed CWF10 was related to high digestibility of CP. Schroeder *et al.* [7] also reported similar results with enhancing level of WCGF in the diets of Holstein cows. The NH_3-N concentration in rumen have been explained to increase when urea, molasses and starch was supplemented to non-lactating cow from non-forage fiber like WCGF [36], the dietary portion of nonstructural carbohydrate was increased [37] resulting increased amount of starch digestion in the rumen [38]. However, the concentration of rumen NH_3-N in bulls fed diets having CWF was close to optimum rumen NH_3-N [39, 40] healthier to improve synthesis of microbial protein and feed digestibility.

Table 5. Effect of replacing different levels of corn grains with corn wet feed on Rumen pH in buffalo bulls

Diets[1]					
Items	**CWF0**	**CWF10**	**CWF20**	**CWF30**	**SE[2]**
pH 0h	6.52	6.45	6.35	6.25	±0.235
pH 3h	6.10	6.05	5.95	5.83	±0.253
pH 6h	6.30	6.10	6.03	5.97	±0.314
pH 9h	6.45	6.30	6.30	6.17	±0.293

[1]CWF0 represents the control diets having 30% corn and 0% corn wet feed, while CWF10, CWF20 and CWF30 refer to diets having 10, 20 and 30% corn wet feed replacing with corn, respectively.
[2]Standard error

Table 6. Effect of replacing different levels of corn grains with corn wet feed on rumen ammonia concentration in buffalo bulls

Diets[1]					
Items (mg/dl)	**CWF0**	**CWF10**	**CWF20**	**CWF30**	**SE[2]**
NH_3-N 0 h	25.2	25.2	26.2	26.2	1.7
NH_3-N 3 h	25.5 ^{b}	27.8 ^{a}	26.4 ^{ab}	26.1 ^{ab}	1.4
NH_3-N 6 h	26.1 ^{b}	28.4 ^{a}	27.7 ^{ab}	27.0 ^{ab}	3.6
NH_3-N 9 h	23.2 ^{b}	27.3 ^{a}	26.1 ^{a}	25.5 ^{a}	3.5

[1]CWF0 represents the control diets having 30% corn and 0% corn wet feed, while CWF10, CWF20 and CWF30 refer to diets having 10, 20 and 30% corn wet feed replacing with corn, respectively.
[2]Standard error
[a,b] Means within row with different superscripts differ ($P<0.05$)

Conclusion

From this study, nutrients digestibility, N balance, ruminal pH and ruminal NH_3-N for diets in which the corn grains were replaced gradually with corn wet feed showed best response at inclusion level 10% of corn wet feed in bull diet. But it requires additional lactation trials having more number of buffaloes necessary before giving any recommendation for its inclusion in rations of lactating Nili-Ravi buffaloes.

Authors' contributions

Conceived and designed the experiments: MU Nisa, S Najeeb, M Akhtar & A Javaid, Performed the experiments: S Najeeb & K Siddiq, Analyzed the data: S Najeeb, A Javaid & MS Khan, Contributed materials/ analysis/ tools: MU Nisa, M Akhtar & K Siddiq, Wrote the paper: A Javaid, S Najeeb & MS Khan.

Acknowledgements

We acknowledge the Rafhan Maize Products Company, Faisalabad to provide feed ingredients for the conduction of this study.

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