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Effects of feeding sodium bicarbonate and multi-strain probiotics on milk yield and milk composition of lactating Holstein Frisian crossbred cows

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Abstract

A trial was conducted on Twelve (12) Holstein frisian crossbred lactating cows to compare the effects of sodium bicarbonate (bicarb) multi-strain probiotics (probiotics) and their interaction on milk yield and milk composition. The cows were grouped in to four (4) with three (3) cows in each treatment group. They were fed according to treatment group viz: T0 compounded feed (control), T1 compounded feed + 120g sodium bicarbonate, T2 compounded feed + 10g probiotics and T3 compounded feed + 100g sodium bicarbonate + 5g probiotics. The experiment lasted for a period of 21 days including 10 days adaptation period. Data were statistically analyzed, mean fat percent was significantly ($p > 0.05$) on T1 than T0 followed by T3 and T2. Milk yield and lactose were also significantly increased ($p > 0.05$) by inclusion of probiotics, interaction of probiotics + bicarb than control group. However, milk acidity, protein percent, SNF and CLR was not significantly influenced by test ingredient. The results indicate interaction of bicarb + probiotics did not have any unique influence on milk yield or its composition as compared to individual test ingredients in different treatment.

Keywords: sodium bicarbonate, multi-strain probiotics, holstein frisian

Introduction

It is well known that the amount of milk produced is highly influenced by the amount and quality of the feed given to the cow. It is also possible to influence milk yield and its composition through feeding. An unbalanced diet increases the risk of metabolic disturbances and weight loss, which have a negative effect on milk yield and its composition. In order to achieved the desired goals, nutrient density must be elevated through increased grain proportions providing necessary energy. High yielding dairy cows received substantial amount of concentrate containing a high proportion of starch in their diets. As the proportion of grain in the diet increases, rumen pH, rumen acetate:propionate ratio and milk fat percentage decreases. If rumen pH is not optimal, dry matter intake decrease, acidosis can cause health problems, and microbial yield of protein and energy decreases (Waje *et al.*, 2010). According to Mertz *et al.* (2009) the use of feed additives such as (sodium bicarbonate and probiotics) will be helpful in maintaining optimum rumen environment, improve growth and performance of microbes which have beneficial effects on health, growth, production and performance to the host animal. Sodium bicarbonate is used to treat acid ingestion and use to treat metabolic acidosis also used as a buffering agent for the rumen. Sodium bicarbonate is added to the diet to replace endogenous deficiencies in saliva production, which can occur when cows consume a high grain diet. Mertz, *et al.* (2009) reported that rumen pH decreases when cows in high producing herds are fed highly fermentable carbohydrates, in transition dairy cows, in cows in peak lactation with high dry matter intake, and in cows at peak milk production. Acid neutralizing capacity can vary significantly with different physical and chemical characteristics of dietary buffers and alkalizing agents. Ondarza, B (2006) ^[15] found that sodium bicarbonate supplementation maintained stable rumen pH over longer period of time; as well she found improved milk production and milk fat. However, the benefits from sodium bicarbonate and other buffers/alkalis were most beneficial in high grain diets and early lactating cows. Probiotics is whole food based supplement of live microorganisms, which benefits the host animal by improving its intestinal microbial balance. Typically, they consist mostly of a combination of fungi (e.g. Yeast) and or rumen and intestinal bacteria and aims to promote a balance of the microbial flora, providing a more efficient digestion of nutrients and then improving the processing of food transformation in milk and meat without these microorganisms are adsorbed and retained in the tissue (Vieira *et al.*, 2014). Probiotics are non-pathogenic microbes that occur in nature and function in the gastrointestinal tract of ruminants

(Dunne *et al.*, 1999) [6]. Currently, the use of probiotics additives have been developed as alternatives to antibiotics to improve animal health and productivity (Allen *et al.*, 2013) [1].

Literature Review

Ondarza, B (2006) [15] found that sodium bicarbonate supplementation maintained stable rumen pH over longer period of time; as well she found improved milk production and milk fat. However, the benefits from sodium bicarbonate and other buffers/alkalis were most beneficial in high grain diets and early lactating cows. Eight Holstein cows were distributed in two 4x4 Latin square, the diets were based on corn silage and concentrate the treatment are (0, 3, 6 or 9 grams of probiotics/animal/day). It was evaluated the dry matter intake of nutrients, milk yield and composition. ($p>0.05$) neither the daily milk production or corrected to 4% fat were improved. However, it observed that there was a significant fall in milk composition with higher levels of probiotics supplementation (Raeth-Knight, *et al.*, 2007). Der Bedrosian (2009) [13] use twenty-eight lactating Holstein cows to compare the effects of feeding live yeasts and sodium bicarbonate, on metabolic indices, digestibility of the total mixed ration (TMR), milk production and composition for a period of 28 days taken last 7 days for data collection and analysis. He revealed that cows fed sodium bicarbonate but not yeasts consumed more dry matter than those fed the un-supplemented diet. There was no difference in milk production, 3.5% fat corrected milk, energy corrected milk, or milk components among treatments but the concentration of milk urea nitrogen was greatest for cows fed sodium bicarbonate. Stephanie (2011) fed seventy-two early to mid-lactation Holstein and Jersey cows in a six-month long study to compare the effects of two rumen buffer (Sodium Bicarbonate and Sodium Sesquicarbonate) and their effects on milk components and production. Buffer treatments were added to the total mixed ration and fed at a rate of 181.6 grams per head per day. Both treatment groups were similar in milk production, milk components, DMI, and fecal pH. He also observed sodium bicarbonate and sodium sesquicarbonate are equally effective buffers relative to milk production and components in both Holstein and Jersey dairy cows during the warm summer months in the Central Valley.

Materials and Methods

The trial was conduct in 2017 on Holstein frisian crossbred cows at department of animal husbandry & dairying farm, SHUATS, Allahabad. Twelve healthy cows were select for the trial and randomly divided into 4 groups with 3 cows in each group. They were kept under same management condition. Ration offered are:

Treatment	Test Ration
T0	Concentrate (control)
T1	Concentrate + 120g sodium bicarbonate
T2	Concentrate + 10g probiotics

T3 Concentrate + 100 sodium bicarbonate + 5g probiotics

Experimental Period; The trial lasted for 21days, taking 10days for standardization and acceptance of the test ration according to treatment combination of experimental animals; Thereafter, 11days milk yield, milk composition analysis where recorded.

Feeding of Animals; All cows where maintained under same management condition to checkmate error due environmental variation. Test ration and control where fed according to treatment groups.

Roughage; Cows were fed green sudan grass @ 21kg + dry wheat straw @ 5kg per animal per day as per recommendation.

Concentrates; Concentrates were given for maintenance purpose @ 1kg per day per cow and 1kg for every 3kg milk produce.

Composition of Concentrate; Concentrate consist of 15.5% maize, 25.9% de-oiled rice bran, 20.7% de-oiled mustard cake, 15.5% wheat bran, 10.3% arhar chuni, 10.3 broken rice, 0.21% trace minerals, 1% common salt, 0.52% soda. Cows under T₀ fed normal compounded ration, T₁ fed compounded ration + 120g sodium bicarbonate to each cow per day, T₂ fed compounded ration + 20g probiotics to each cow per day, T₃ fed compounded ration + 100g sodium bicarbonate + 10g probiotics per day.

Parameters Observed; After 10days for adaptation, milk sample were collected at morning milking 3:00 to 4:30am and 1:00 to 2:30pm for the period of 11days to determine.

1. Milk yield (kg)
2. Milk fat percentage
3. Solid not fat percentage of the milk
4. Correct lactometer reading
5. Lactose
6. Protein
7. Acidity

Milk Sample Collection; 200ml milk samples were collected each from the 12 cows selected in conical flasks and immediately plugged aseptically with cotton plugs. The samples were taken to laboratory for analysis of the above mention parameters.

Milk Yield (kg); Milking were carried out in the morning at 3:00–4:00am and afternoon at 1:00–2:00pm and recorded daily.

Results and Discussion

Table 1 indicate data recorded on mean values of the experimental parameters

Table 1: Mean parameters of milk yield and milk composition

Treatment	Mean Parameters						
	Milk yield	CLR	Acidity	Fat	Protein	Lactose	SNF
T0	3.127	1.0380	0.163	3.255	3.673	4.027	9.673
T1	3.173	1.0370	0.162	5.009	3.655	4.064	9.664
T2	3.773	1.0370	0.161	3.564	3.682	4.518	9.655
T3 Remark	3.555 S	1.0370 NS	0.163 NS	4.691 S	3.664 NS	4.445 S	9.682 NS

CLR= correct lactometer reading, SNF= solid not fat, S=significant, NS= non-significant

The treatment mean of milk yield values recorded range between 3.127 to 3.773 as observed on this trial were significantly difference ($p>0.05$) among the treated and control groups with T₀ (control) having 3.127, T₁ (120g bicarb) 3.173, T₂ (10g probiotics) 3.773 and T₃ (100g bicarb + 5g probiotics) 3.555. Highest value was observed in T₂ followed by T₃ with least values in T₀ and T₁, the overall result shows that feeding probiotics influenced milk yield as compared to bicarb group which had slightly increased and is negligible over control group. This indicate feeding probiotics up to 10g yield more milk and remain effective. The result of this experiment is supported by many authors among are Wohlt *et al.* (1991); Robinson and Garret (1999); Wang *et al.* (2001) on cows fed with *Saccharomyces cerevisiae*. Nocek *et al.* (2003) observed an increased dry matter intake (2.6 kg/day) and increased milk yield (2.3 kg/day) with the same combination of probiotics offered from 3 weeks pre-partum to 10 weeks post-partum. In a very similar trial using 44 Holstein cows Desnoyers *et al.* (2009) [4] reported increased in milk yield, by (+1.2 g/kg of BW) but no changes in milk protein content. However, some other researchers (Erdman and Sharma, 1989; Arambel and Kent, 1990; Kung *et al.*, 1997; Boga and Gorgulu, 2007; Weiss, and McKelvey 2008.) [3] have not found probiotics administration to increase the milk production in cows.

The mean values of milk acidity recorded in present experiment were 0.163, 0.162, 0.161 and 0.163 for T₀ (control), T₁ (120g bicarb), T₂ (10g probiotics) and T₃ (100g bicarb +5g probiotics) respectively. The results did not differ significantly among the treatment groups and is within the normal range. This indicate bicarb and probiotics or their combination did not increased lactic acid content but rather support the growth and development of lactic acid utilizing microbes in the rumen. The result in-line with the report of Krishnamoorthy and Krishnappa (1996) [12] who found no differences in DM intake, body weight gain, milk yield and milk composition when yeast was added in a diet based on finger millet (*Eleusine coracana*) straw for lactating crossbred cattle. Hossain *et al.* (2014) [9] also conducted an experiment on Ten multiparous cows fed *Saccharomyces cerevisiae* and did not observed any effects on acidity of milk.

Data obtained on milk fat percent were significantly influenced ($p>0.05$) by test ingredient over control group. The mean values were 3.255, 5.009, 3.564 and 4.691 for T₀ (Control), T₁ (120g bicarb), T₂ (10g probiotics) and T₃ (100g bicarb + 5g probiotics) this revealed the significance of the test ingredient on milk fat percent. However, T₁ tend to be higher followed by T₃ T₂, with least value in T₀. Although, probiotics increased milk fat percent but bicarb tend to be higher. This indicates the effectiveness of bicarb over probiotics on milk fat percent. The results in agreement with the report of Wang *et al.* (2001) who also observed a significant increased in milk fat content in cows in early lactation during supplementation of yeast culture. Ramanathan and Venkata (2013) [2] conducted a feeding trial on eight cows to compare the effect of supplementing commercial yeast species *Saccharomyces cerevisiae* and *Saccharomyces siccum* on milk yield and its composition. The results revealed significant increase ($p<0.05$) in milk yield, mean milk fat, protein and total solids content was observed in both the treatment groups during supplementation of yeast when compared to the pre supplementation value.

The average mean values of protein in this present experiment ranged between 3.655 to 3.682 across the treatments groups falls within the normal range of 3.3 to 3.9%, no significance

difference ($p>0.05$) was observed. Neither bicarb nor probiotics or their combination influenced protein content in the milk. Similar results were noticed by (Giger-Reverdin *et al.*, 1996; Marius 2007; Stella *et al.*, 2007) [8]. Desnoyers *et al.* (2009) [4] found that yeast supplementation increased milk yield (+1.2 g/kg of BW) but had no influence on milk protein content. Clayton *et al.* (1999) [7] fed virginiamycin and sodium bicarbonate (NaHCO₃) to study their effects on ruminal and fecal pH, rumen volatile fatty acid proportions, blood metabolites, milk production and composition were assessed. Revealed that milk fat and milk protein percentage did not differ significantly as a result of dietary treatment.

The average mean value of lactose obtained in this experiment was 4.027, 4.064, 4.518 and 4.445 for T₀, T₁, T₂ and T₃ viz. The results of T₂ and T₃ show significant increased ($p<0.05$) lactose content in cows milk fed probiotics and interaction of probiotics + bicarb. The results indicate increased in lactose content in cows fed probiotics and interaction of probiotics + bicarb compared to those supplemented with bicarb which remained almost equal with control group. The result agrees with the report of (Triantos 1991) used eighteen multiparous Friesian cows to study effects of sodium carbonate on milk yield, milk composition, blood metabolites plus Na, and K in early lactation. Concentrate diet containing either 0 or 1.2% sodium carbonate (as fed) for ad libitum intake plus 7.0 kg of wet brewer grains and 5.5 kg of long-stemmed alfalfa hay per cow daily. Observed that the dry matter intake, milk yield, milk protein percentage, percentages of milk lactose and milk SNF was not significantly affected. Compared with the control diet, the sodium carbonate treatment increased milk fat percentage (3.98 vs. 3.53%) and yield (1.23 vs. 1.07 kg/d), 4% FCM yield (30.9 vs. 28.2 kg/d) and milk total solids (12.47 vs. 12.04%). Iwanska *et al.* (2000) [10] studied the effect of fungal probiotics and their beneficial effects of biologically active compounds on milk yield and composition. Data obtained on thirty multiparous Polish Black and White cows indicate that fat corrected milk yield, milk fat yield, milk protein yield, casein yield, lactose percentage, total solid, solid-not-fat and somatic cell count were significantly higher than the control group. However, some researchers contradict the results among are. Marius (2007) did not observe response on milk protein levels as well as milk lactose percentage when dosage of probiotics was fed.

The treatment mean of correct lactometer reading (CLR) was 1.0380, 1.0370, 1.0370 and 1.0370 for T₀, T₁, T₂ and T₃ viz. The result were almost similar with little variation in T₁ which is control group but not significant. The result is supported by report of Jayant Kashyap, 2014 [11]. Treatment mean of solid not fat (SNF) observe in this present experiment was 9.673, 9.664, 9.655 and 9.682 for T₀, T₁, T₂, and T₃. The result did not differ significantly. The result revealed neither bicarb nor probiotics or their interaction had influenced SNF content of the milk. Some authors had advocated similar report Krishnamoorthy and Krishnappa (1996) [12] found no differences in DM intake, body weight gain, milk yield and milk composition when yeast was added in a diet based on finger millet (*Eleusine coracana*) straw for lactating crossbred cattle. Ramanathan and Venkata (2003) [2] fed Commercial yeast species *Saccharomyces cerevisiae* and *Saccharomyces siccum* no significant change was observed in solids not fat content of the milk samples obtained before, during and after supplementation of *Saccharomyces cerevisiae* as well as *Saccharomyces siccum*. In contrast, Vibhute *et al.* (2011) selected sixteen multifarious cows on the basis of average daily milk yield and stage of lactation.

The multi-strain probiotics used were containing four strains consist of bacteria and fungi namely *Lactobacillus acidophilus*, *Saccharomyces cerevisiae*, *Saccharomyces boulardii* and *Propionibacterium freudenreichii*. It was found that, the use of probiotics proved to be effective in increasing milk production of lactating cows. Milk fat, milk protein and SNF content tended to be higher in cows supplemented with probiotics preparations. Hossain *et al.* (2014) [9] selected ten multiparous cows to determine the effect of probiotics (*Saccharomyces cerevisiae*) on milk yield and composition. It was observed that there was no significant improvement in butter fat percentage of milk ($P>0.05$) and acidity (%) between treatment group and control group, but significant improvement ($P<0.05$) was found in protein content and solids-not-fat content of milk.

Conclusion

Although there are inconsistency report from different authors concerning feeding of bicarb and probiotics, but the overall results of this experiment revealed that milk yield, milk fat and milk lactose was significant significantly influenced by the individual test ingredients and their interaction among the treatment groups. But the interaction of bicarb + probiotics did not yielded any special result when compared to individual test ingredient. Signifying interactions of bicarb + probiotics did not have any correlational influence on milk yield or its composition.

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