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Comparative performance on late lactating crossbred cows supplemented with sodium bicarbonate and probiotics on milk yield, milk composition and dung score

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Abstract
A trial was conducted on twelve (12) crossbred lactating cows to compare the effects of sodium bicarbonate (bicarb), probiotics and their combination on milk yield, milk composition and dung score. 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. The data were statistically analyzed, mean fat percent was significantly ($p>0.05$) on T1 than T0 (control) followed by T3 and T2 with least on T0. Milk yield and lactose were also significantly increased ($p>0.05$) by inclusion of probiotics, interaction of probiotics + bicarb. However, milk acidity, protein percent, SNF and CLR was not significantly influenced by test ingredient. The results revealed effectiveness of bicarb to increased fat percent while probiotics increased milk yield and lactose content. Cows dung was also observed under consistency method; Score 2 was observed on T2 while score 3 on T0, T1 and T3. By hand feeling method, score 1 was observed on T2 while score 3 on T0, T1and T3 being equal. The results indicated the effectiveness of probiotics up 10g support higher digestion and microbial performance in the rumen environ compared to other treatment groups.

Keywords: dung score, probiotics, sodium bicarbonate, milk yield, milk composition

Introduction
The genetic potential of today's dairy cows is very high and still increasing. That is why feed and feeding strategies are becoming more and more important. It is very 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. Milk production per cow continues to increase 2 to 3 percent annually, genetic improvement accounts for 33 to 40 percent of this increase while feeding and management contributes the remaining 60 to 67 percent (Chase, 1999). High yielding dairy cows received substantial amount of concentrate containing a high proportion of starch in their diets. Starch ferments quickly in the rumen resulting in a drop in pH and if not controlled, result to sub-acute acidosis. 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 the performance of microbes which have beneficial effects on health, growth, and production performance to the host animal. 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.

Literature Review
Ondarza (2006) [16] 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). Currently, the use of probiotics additives has been developed as alternative to antibiotics to improve animal health and productivity (Allen *et al.*, 2013) [1]. Eight Holstein cows were distributed in two 4x4 Latin square, the diets were based on corn silage, concentrate and the treatment are (0, 3, 6 or 9 grams of probiotics/animal/day). It evaluated that 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 (Knight *et al.,* 2007). Der Bedrosian (2009) [14] 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 crossbred cows at department of animal husbandry & dairying farm, SHUATS. ALLAHABAD. Twelve healthy cows for the trial were selected and randomly divide 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 bicsarbonate
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 experimental animals. Thereafter, 11days milk yield, milk composition analysis and dung score were recorded.

Feeding of Animals

All cows are maintained under same management condition to checkmate error due environmental variation. Test ration and control were 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 T_0 fed normal compounded ration, T_1 fed compounded ration + 120g sodium bicarbonate to each cow per day, T_2 fed compounded ration + 20g probiotics to each cow per day, T_3 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

Manure Scoring: After 10days adaptation period, manure scoring was also observed during morning milking throughout the experimental period.

Scoring of manure by consistency

Score One

This manure is very liquid with the consistency of pra soup. The manure may actually “arc” from the rump of the cow. Excess protein or starch, too much mineral, or lack of fibre, can lead to this score. Excess urea in the hind-gut can create an osmotic gradient drawing water into the manure. Cow with diarrhoea will be in this category.

Score Two

Manure appears runny and does not form a distinct pile. It will measure less than 2.5 cm in height and splatters when it hits the ground or concrete. Cows on lush pasture will commonly have this type of manure. Low fibre or a lack of functional fibre can also lead to this manure score.

Score Three

This is the optical score! The manure had a porriage-like appearance, will stack up 4 to 5cm, have a several concentric rings, a small depression or dimple in the middle, make a plopping sound when it hits concrete floors, and it will stick to the toe of your shoe.

Score Four

The manure is thicker, will stick to your shoe, and stacks up over 5 cm. Dry cows and older heifers may have this type of manure (this may reflect feeding with low quality forages and/or a shortage of protein). Adding more grain or protein can lower this manure score.

Score Five

This manure appears as firm faecal balls. Feeding a straw based diet or dehydration would contribute to this score. Cows with a digestive blockage may exhibit this score**.**

Scoring of digestion (feeling by hand)

Score One

Manure feels as a creamy emulsion and is homogeneous. There are no visible undigested food particles.

Score Two

Manure feels like a creamy emulsion and is homogeneous. A few undigested food particles are visible.

Score Three

Manure doesn't feel homogeneous. Some undigested particles are visible. After squeezing in the hand, some undigested fibres will stick to your fingers.

Score Four

Bigger undigested food particles are clearly visible. A ball of undigested food will remain after squeezing the dung in your hand.

Score Five

Bigger food particles are tangible in manure. Undigested components of the feed ration are clearly recognizable.

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 was done 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

Mean Parameters							
Treatment	**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	3.555	1.0370	0.163	4.691	3.664	4.445	9.682
Remark	S	NS	NS	S	NS	S	NS

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

The treatment mean of milk yield values range between 3.127 to 3.773 as observed in 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 on 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 indicates 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 [3]; Weiss, and McKelvey 2008) 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 result did not differ significantly among the treatment groups and are within the normal range. This indicates 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 results in-line with the report of Krishnamoorthy and Krishnappa (1996) [13] 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 on T0. Though 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. Reported a 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. Same result was also noticed by some previous authors (Giger *et al*., 1996; Marius 2007; Stella *et al*., 2007). 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 (Trios 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. Diets were concentrates 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, and observed that the dry matter intake, milk yield, milk protein percentage and yield, and percentages of milk lactose and milk SNF were 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) 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 reading 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 on T1 which is control group but not significant. The results is supported by report Ondarza, B (2006) [16] found that sodium bicarbonate supplementation maintained stable rumen pH over longer period of time, as well she found improved milk production and milk fat and not CLR.

Treatment means of solid not fat (SNF) in the present experiment was 9.673, 9.664, 9.655 and 9.682 for T0, T1, T2, and T3. The results 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) [13] 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 Narasimham (2003) 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 frendenreichii. 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 milk 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 groups, but significant improvement (P<0.05) was found in protein content and solids-not-fat content of milk.

Manure Scoring

Manure scoring is a tool help to evaluate how well cow feed is being digested, whether the ration has a correct balance of nutrients (protein, fibre and carbohydrates) and if water intake is appropriate (Hall, 1999) [10].

Scoring of manure by consistency

Under this category of dung scoring, the present experiment had observed Score Two on T2 (10g probiotics), the manure appears runny and does not form a distinct pile. It measure less than 2.5 cm in height and splatters when it hits the ground or concrete. Score Three was observed on T0 (control), T1 (bicarb) and T3 (bicarb + probiotics). The manure had a porriage-like appearance, stack up 4 to 5cm, have a several concentric rings, a small depression or dimple in the middle, make a plopping sound when it hits concrete floors, and it will stick to the toe of your shoe.

Scoring of digestion (feeling by hand)

Under this category of dung scoring, the present experiment had observed Score One on T2. The manure feels a creamy emulsion and is homogeneous. There are no visible undigested food particles. While Score Two was observed on T0, T1 and T3. Manure feels like a creamy emulsion and is homogeneous. A few undigested food particles are visible.

Conclusion

The overall results were variable but milk yield, milk fat and milk lactose was significantly influenced by the individual test ingredients among the treatment groups, but their interaction bicarb+ probiotics did not yielded any special result signifying interactions of bicarb + probiotics did not have positive effects on milk yield or its composition. The results also revealed higher impact of probiotics on milk yield and lactose than bicarb, fat percent tend to be higher in bicarb treated groups than probiotics indicating effectiveness of bicarb on fat percent than probiotics.

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