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Advance prediction of metabolic diseases in dairy animals using metabolic profiling

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Abstract
The transition period from last 21 days of parturition to first 21 days after parturition is the most critical period in the productive life of dairy cycle. During this period a lot of metabolic changes occurs in the body of animal resulting in clinical and sub clinical form of various diseases. So in this study, for predicting the metabolic diseases, equations were created and ranges were established to predict various important productive/metabolic diseases in the life of dairy animals, so that by using these equations, future disease conditions of the animals can be predicted and farmer can be saved from the losses.

Keywords: Prediction, cattle, buffalo, metabolic diseases, sub clinical

Introduction
Metabolic errors in dairy farming in todays dairy scenario are emerging as the major cause of economic losses to the dairy farmers. Most of the metabolic health problems such as Milk fever, ketosis, hypomagnesemia, mastitis, and metritis are commonly related to metabolic errors during the late gestation period. (Luke *et al.*, 2018) [1]. Subclinical conditions of these metabolic diseases are more important than the clinical conditions because the animal continue to produce at a reduced rate without showing any clinical sign of the disease resulting in economic losses to the dairy farmers. (Singh *et al.*, 2016) [2].
In order to monitor the metabolic health of dairy cows, metabolic profiling is an important tool for the management of clinical and subclinical forms of metabolic diseases (Payne *et al.*, 1970) [3]. In this metabolic profiling, blood concentration of various important metabolic parameters such as Beta Hydroxy Butyric Acid (BHBA), Non esterifiied fatty acid (NEFA), and various other important hemato biochemical (Hb, PCV, TEC, TLC, total protein, albumin, BUN, Creatinine, glucose) and various minerals (calcium, magnesium, phosphorus, sodium, potassium, copper, iron, zinc, etc. are evaluated during various stages of periparturient periods and their levels helps in evaluating the metabolic health of dairy animal during this period. Along with the metabolic profiling, body condition scoring and back fat thickness are emerging as important parameters for evaluating the metabolic health of dairy animals (Singh *et al.*, 2017; Singh *et al.*, 2018) [4, 5] So based on the results of these parameters, a study was planned to establish various equations using the data from the metabolic profiling so that by using these equations, metabolic health or the clinical or subclinical form of these diseases can be predicted so that by adopting preventive measures, we can prevent the losses to the farmers.

Materials and Methods
A total of 101 crossbred dairy cows and 167 buffaloes in their last trimester of pregnancy were sampled during the study period. From each animal blood samples were collected thrice during different stages of periparturient period, *viz*:

Far off dry- > 10 days following dry off and not < 30 days prior to calving.
Close up dry- Between 3 and 21 days prior to calving.
Fresh- 3 to 30 days in milk.

Body condition score (BCS) was estimated by the same individual using the five point visual BCS technique with 0.5 increment (Wildman *et al*., 1982) [6]. Back fat thickness was measured using the technique of Nanda and Herdt, (2009) [7].
Based on the results of metabolic profiling, from various farms, using linear regression, statistically significant (p<0.05) regression equations were created by using the combinations

of various parameters from both healthy and diseased animals, and a range was established for the different parameters during various periods for the advance prediction of diseases.

Results and Discussion

During the periparturient period, blood Glucose, BHBA, NEFA are the most important parameters because during this period a lot of metabolic, hormonal, physiological, endocrinological changes are occurring in the body of the animal (Singh *et al.,* 2020) [8] and if during this period, proper care and management of animal *viz*. feeding, management, nutrition is not taken care of, will result in losses during the post parturient period, so in order to monitor the metabolic health of the animals, metabolic profiling is carried out and to predict these diseases in future, various equations are created for different periods, so that by using these equations metabolic diseases can be easily predicted.

Prediction Equations were created for different periods (FOD, CUD and fresh) in both cattle and buffalo, so that by using these equations prediction of clinical and subclinical form of metabolic diseases can be done.

In Cows

Far off Dry period

Equation 1

By using the results of Glucose, BHBA, NEFA, BCS AND BFT obtained during metabolic profiling of the animals, prediction equations were created and the range was established for the normal, diseased and sub clinical stage of the disease. Similar to our study, (Ho *et al.,* 2021) [9] also tried to predict metabolic status of dairy cows in his study.

X=1.775-0.011a- 0.208b+0.1070c+0.182d-0.438e
a= Glucose, b= BHBA, c= NEFA, d=BCS, e=BFT

Status	Healthy	Subclinical	Diseased
Range	≤0.80	1.19-3.14	>3.14

Close up dry period

Similarly using results for the below mentioned parameters from the metabolic profiling, range was established for predicting the healthy, clinical and diseased animal during the cud period for the prediction of ketosis in cows. Body condition score (BCS) along with BHBA and NEFA values play an important role in predicting metabolic diseases in dairy animals (Bernabucci *et al.,* 2005) [10].

Equation 1
X= 1.900-0.204a+1.670b-0.016c-0.136d
a= BHBA, b=NEFA, c= Glucose, d= BCS

Status	Healthy	Subclinical	Diseased
Range	≤0.91	1.33-1.75	>1.75

Fresh period

The postparturient period is the most crucial period in the life of dairy animal as during this period animal is under extreme stress due to the recent parturition and onset of lactation due to which animal is always susceptible various diseases (Duffield *et al.,* 2009) [11]. So for this period, using regression equations range was created by using data from the cows from various districts using various parameters under study for the healthy and ketotic cows.

Equation 1
X=0.923+1.209a-0.024b-0.003c
a=NEFA, b=BHBA, c= Glucose

Status	Healthy	Subclinical	Diseased
Range	≤1.50	1.50-2.26	>2.26

Equation 2
X= 1.063+1.171a-0.020b-0.002c-0.068d
A= NEFA, b=BHBA, c=Glucose, d= Calcium

Based on the equation a range was created for the healthy, subclinical and diseased animals

Status	Healthy	Subclinical	Diseased
Range	≤1.33	1.33-2.26	>2.26

For buffaloes

A lot of work has been done worldwide, on the metabolic profiling of dairy cows during periparturient period, but very less work has been done on the metabolic profiling in buffaloes. Buffaloes are also equally susceptible to various metabolic diseases, so establishing the normal values of metabolic parameters during different phases of periparturient period will equally help in predicting the diseases for buffaloes in future. Belay *et al.,* (2017) [12] also tried to establish equationsa for the prediction of metabolic health of dairy animals.

Far off dry period

Equation 1
X= 2.907-0.019a+0.200b+0.774c-0.147d
a= Glucose, b= BHBA, c= NEFA, d=BCS

By using the data from the healthy and diseased buffaloes from the FOD period, an equation was created and a range was established for future prediction of diseases.

Status	Healthy	Subclinical	Diseased
Range	≤1.65	1.75-2.22	>2.22

Close Up Dry Period

Equation 1
X= 1.734-0.084a+0.536b-0.705c-0.010d
a= BCS, b= BHBA, c= NEFA, d= Glucose

Similarly for the close up dry period, using the data from the buffaloes a range was established for the healthy and diseased animals to serve as a base in the future for the prediction of ketosis in cows. Similarly, Xu *et al.,* (2020) [13] also predicted metabolic diseases in dairy animals in his study.

Status	Healthy	Subclinical	Diseased
Range	≤0.98	0.98-1.32	>1.32

Fresh period

As explained previously, first 21 days after parturition is very important period in the productive life of animal because any disease or any metabolic error occurring during this period will result in lower production in terms of decrease milk yield, repeat breeding, anestrous and various other conditions resulting in economic losses to the farmers so inorder to get maximum benefit from the animal first 21 days after parturition should be properly taken care of. So in order to achieve higher production from the animals metabolic health

of the animal should be monitored. For that regression equations were created for the fresh period using data from the buffaloes from various districts using various parameters under study.

Equation 1
X= 1.218+0.321a+0.576b=0.006c
a= BHBA, b= NEFA, c= Glucose

Based on the equation and using the data from buffaloes in the present study during the fresh period, range was established for the healthy and ketotic buffaloes.

Status	Healthy	Subclinical	Diseased
Range	≤1.10	1.10-1.94	>1.94

Equation 2
X= 2.292+0.110a+0.511b-0.005c-0.156d-0.234e
a= BHBA, b= NEFA, c= glucose, d= BCS, e= Calcium

Based on the equation a range was created for the healthy, subclinical and diseased animals

Status	Healthy	Subclinical	Diseased
Range	≤1.20	1.20-2.10	>2.10

Similar to the present investigation, number of other researchers (Larsen *et al.*, 2001, McArt *et al.*, 2013 and Suthar *et al.*, 2013) [14, 15, 16] also used their equations and created the values for the prediction of various metabolic diseases.

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