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Abstract: The aim of the present study was to establish the influence of organic selenium and a yeast, Saccharomyces cerevisiae, in combination on animal performance, physiological status, milk production and blood metabolites in indigenous and crossbred dairy cows during hot-humid climatic conditions in tropics. A total of 18 indigenous dairy cows and 18 crossbred dairy cows were divided into two groups (control and treatment) containing 9 cows each based on parity and milk yield for a period of 45 days. The control group were fed on a basal diet comprising a concentrate mix, wheat straw, and multi-cut sorghum greens, while the treatment group were offered basal rations supplemented with organic selenium (4 g/d) along with Saccharomyces cerevisiae \((10^{10}\) CFU/g; 4 g/d). There were no significant changes found in feed intake, body weight and animal physiology; however, better feed efficiency was recorded in both of the treatment groups, irrespective of breed variation. There was a non-significant increase in milk yield recorded in both treatment groups in comparison with the control. Similarly, no significant effects were observed on the haemato-biochemical profile in both animal types. Hence, it can be concluded that the supplementation of organic selenium and probiotics in combination to indigenous and crossbred dairy cattle moderately improved feed efficiency and overall performance without affecting metabolic status under heat stress conditions in the tropics.

Keywords: organic mineral; yeast; feed efficiency; dairy cattle; heat stress

1. Introduction

Currently, sudden climatic changes are a reality, with more noticeable effects on agriculture and livestock production systems. It is well known that changes in the environment have variable degrees of impact on all animal physiological processes and productive qualities. Given that the lower Gangetic region in India is being impacted by heat stress, the most harmful constraint to cattle productivity in the area. Heat stress has a considerable negative influence on the productivity and lifespan of dairy cows [1]. Modern management techniques, such as cooling systems [2] and dietary approaches [3], may lessen the negative effects of heat stress, but the financial loss due to decreased milk production, reproductive efficiency, and animal health during hot and humid seasons is a significant problem for the dairy industry globally [4]. The decrease in dry matter intake (DMI) of heat-stressed
cows has been linked to decreased lactation performance throughout the duration of the condition [5]. However, decreased DMI appears to only be responsible for 35 to 50% of the drop in milk production when cows are exposed to heat stress; the remaining percentage may be brought on by changes in the endocrine profile and energy metabolism of heat-stressed cows [6,7]. Heat-stressed cows may be in an energy deficit [8] and have higher maintenance energy needs [9], which can reduce feed efficiency [10].

Selenium (Se) is a vital trace element for human and animal nutrition, and it plays important roles in antioxidant systems, reproduction, immune function, and overall health and productivity [11–13]. Probiotics, on the other hand, increase the rumen fermentation of the forage component in cattle, enhancing the utilization of fibrous feed. It promotes fiber-degrading microorganisms in the rumen and stabilizes and enhances rumen function. It is particularly effective in reducing the detrimental effects that heat stress has on rumen function as a whole and milk production [14]. Selenium is a key component of two amino acids found in animals, selenocysteine (SeCys) and selenomethionine (SeMet). Selenium’s effects on the body are carried out by selenoproteins, which have a Se in their active site in the form of SeCys [15–17]. Selenomethionine, on the other hand, is a Se-containing protein which is non-specifically incorporated into body proteins by randomly replacing (sulphur) methionine [18]. Due to this property, SeMet is considered a safe form of stored Se in the tissues [11]. In order to avoid Se deficiency and to fulfill the Se requirements of livestock animals, feeds are always supplemented with Se, either in inorganic form (sodium selenite [SS]; blends of SS and soya protein hydrolysates), organic form, such as Se-enriched yeast, or pure chemically synthesized SeMet form, such as L-SeMet or OH-SeMet.

Emphasis has been placed on the change in supplementation from inorganic forms of selenium to organic forms, containing SeMet/OH-SeMet, as it leads to the creation of a storage of Se in the body tissues, which can be released later to sustain and maintain the Se status and selenoprotein requirements of animals over time, specially under challenge conditions, such as heat stress [19]. A study found that giving OH-SeMet at 0.3 ppm of Se as a supplement to dairy cows experiencing heat stress led to an increase in milk production and total antioxidant capacity (TAC), as well as a decrease in malondialdehyde (MDA), hydrogen peroxide (H₂O₂), and nitric oxide (NO) levels, indicating a reduction in oxidative stress compared to sodium selenite at the same levels of Se [20]. The antioxidant state and immunological responses after calving are improved when selenium-rich cows are fed a supra-nutritional selenium yeast supplement during late gestation, according to Hall et al. [21].

Live yeast supplementation could enhance the digestion of nutrients [14,22] and control ruminal pH [23]. It has been observed that supplementing heat-stressed cows with yeast led to improvements in DMI, lactation performance, and feed efficiency [24]. A combination of exogenous enzymes and yeast culture supplementation was found to lower the rectal temperature of heat-stressed dairy cows, according to Shwartz et al. [25], indicating a possible effect on thermoregulatory processes. Under heat stress, feeding tactics that can boost digestion, such as adding live yeast, may improve dairy cow performance and nutrient flow to the small intestine.

Given these circumstances, a feeding experiment was carried out on both indigenous and crossbred dairy cows, using organic selenium and probiotic supplements. The experiment’s goal was to observe the effects of heat stress and the protective effects of the combined supplementation of organic selenium and probiotics.

2. Materials and Methods
2.1. Location and Environmental Conditions

The experiment was conducted from 15 July to 30 August 2021 in an open-wall, floor-mat-bedded, tie-stall barn at the livestock research farm of Bihar Animal Sciences University, Patna, India. The barn was located at an altitude of 25°36′45.6372″N and 85°9′31.9500″E. Environmental temperature and humidity at the center of the barn were measured at 30min intervals with the help of a digital recorder, 2.5 m from the floor. The temperature-humidity
index (THI) was calculated according to Yousef [26]: THI = T + 0.36 × DP + 41.2, where T = temperature (℃) and DP = dew point (℃). The effect of THI on animals was based on their ranges, for example: 75–78 (alert), 79–83 (danger) and above 84 (emergency).

2.2. Animals and Diets

Standard practices were followed for animals’ housing, management, handling, and care. The protocol was approved by the Institutional Ethics Committee in Utilization of Animals (protocol no. IAEC/BVC/21/14). Eighteen indigenous (340.78 ± 13.2 kg BW) and eighteen crossbred cows (379.22 ± 16.49 kg BW) were fed a standard diet for 10 d (adaptation period). At the end of the adaptation period, indigenous and crossbred cows were divided into two groups (control and treatment) based on parity and milk yield for a period of 45 days. All the cows were of second parity and the milk yield of indigenous and crossbred cows was 4.53–5.18 kg/d and 6.77–7.19 kg/d, respectively. The control group were fed a basal diet comprising a concentrate mix, wheat straw, and multi-cut sorghum green, while the treatment group were offered basal rations supplemented with organic selenium in combination with the live yeast *Saccharomyces cerevisiae* (10^{10} CFU/g)). The organic selenium (dose rate of 4 g/d) and yeast product (dose rate of 4 g/d) was added to the top of the feed of each cow under treatment once per day in the morning. All diets were formulated to be isonitrogenous and isocaloric. Rations were prepared according to the NRC [27] recommendations, and a roughage to concentrate ratio of 60:40 was maintained throughout the trial (Table 1). Daily feed intake by each animal was recorded. The biweekly weighing of the animals was performed to determine the growth performance of the animals. The BCS (scale of 1 to 5, with 1 being thin and 5 being obese; Wildman et al. [28]) was measured by 3 trained evaluators every fortnight and the average was used to describe the experimental units.

| Table 1. Composition and nutritive value of the experimental diets (% on dry matter basis). |
|-----------------------------------------------|-----------------------------------------------|
| Items                                         | Indigenous Dairy Cattle | Crossbred Dairy Cattle |
| Wheat straw                                   | 2.07                         | 1.98                         | 2.16                         | 2.18                         |
| Multi-cut sorghum green                       | 3.11                         | 2.96                         | 3.24                         | 3.27                         |
| Concentrate mixture                           | 3.19                         | 3.39                         | 3.74                         | 3.74                         |
| Organic Se (g/h/d)                            | 0.00                         | 4.00                         | 0.00                         | 4.00                         |
| Yeast (g/h/d)                                 | 0.00                         | 4.00                         | 0.00                         | 4.00                         |
| Nutrient composition (% on dry matter basis)  |                               |                               |                               |                               |
| Crude protein                                 | 14.3                         | 14.4                         |
| Neutral detergent fiber                       | 34.6                         | 34.4                         |
| Acid detergent fiber                          | 18.2                         | 17.9                         |
| Total ash                                     | 6.3                          | 6.5                          |
| Ether extract                                 | 3.1                          | 3.3                          |
| Total digestible nutrient                     | 68.8                         | 68.9                         |

2.3. Feed Samples Analyses

Samples of the wheat straw, sorghum greens, and concentrate were analyzed for dry matter (DM) (ID number 930.15), ash (ID number 942.05), crude protein (CP) (N × 6.25, ID number 954.01), and ether extract (EE) (ID number 920.39) via the AOAC method [29]. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were estimated as per the method of Van Soest et al. [30] (Table 1).
2.4. Milk Sample Collection

Two times every day, at 04:30 and 16:00 h, the cows were milked using a milking machine equipped with a digital milk meter, and milk yield was recorded daily. Milk samples were collected from each cow biweekly (at 0, 15, 30, and 45 days) during the experimental period in a sampling bottle of 200 mL appropriately for the milking parlor, in order to obtain a representative sample of the milk quantity.

2.5. Milk Chemical Composition

The milk samples were analyzed for fat, protein, lactose, solid no-fat and total solids by IR spectrometry (Milk Analyser, Master Classic LM2; Chadha Sales Pvt. Ltd., New Delhi, India) after proper calibration according to the methods of Gerber and Kjeldahl.

2.6. Blood Sampling and Analysis

At the end of the experiment, blood samples were collected from the jugular vein from individual cow to perform analysis of the haemato-biochemical, antioxidant and hormonal profiles. Blood collected in EDTA vials was used for the hematological investigation, while serum separated from blood without anticoagulants was stored at 20 °C until further use. Hemoglobin (Hb) was estimated via the cyanmethemoglobin Drabkin [31] method. Packed cell volume (PCV) was estimated using the micro hematocrit method [32]. The total leukocyte count (TLC) was determined using the Natt and Herrick [33] method. Mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) were calculated from Hb and PCV. The differential leukocyte count (DLC) was calculated manually by putting a drop of blood from sample on a clear glass slide and smearing it to spread the blood around. Then, the blood smear was stained with a dye that helped to differentiate the types of white blood cells in the sample. After staining, the DLC was calculated under oil immersion microscopy.

Serum metabolites such as total protein, albumin, globulin, urea, creatinine, serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), alkaline phosphatase (ALP), cholesterol, triglycerides, and inorganic phosphate were estimated spectrophotometrically using a commercial kit (Coral Clinical System, Goa, India) as per the manufacturer’s protocol. The activities of markers of oxidative stress such as catalase and super oxide dismutase (SOD) were estimated in serum as described by Cohen et al. [34] and Madesh and Balasubramanian [35], respectively. Malondialdehyde (MDA) and reduced glutathione (GSH) concentration in serum was analyzed using the methods described by Suleiman et al. [36] and Lin et al. [37], respectively. Cortisol concentration was measured in serum as per Hawley et al. [38].

2.7. Statistical Analyses

Data for whole blood, plasma, and milk were analyzed using a general linear model with repeated measures in IBM SPSS Statistics software (IBM Corporation, Armonk, NY, USA), and the results are presented as mean ± standard error [39]. Student’s t-tests were used for data analysis using the same software.

3. Results

3.1. Environmental Temperature, Humidity and THI Status

The biweekly recorded data of the environmental temperature and humidity status of the experimental shed are depicted in Table 2. During the feeding trial, the temperature ranged between 31.0 and 33.0 °C, and the average temperature recorded between days 0 and 45 was 31.9 °C. The temperature difference was observed to be 2.0 °C between trials, and was almost 6.20% higher at the end of trial in comparison with the initial period. The experimental shed’s humidity level varied between 80.9% and 85.1% and the average humidity recorded between days 0 and 45 was 83.7%. It was observed that a 4.1% higher humidity was recorded at the end of trial in comparison with the initial period. The temperature humidity index (THI) of the experimental shed ranged between 84.55 and
88.70, and the average THI recorded during the trial was 86.58, while a 4.68% increase in THI was recorded at the end of trial in comparison with the initial period.

Table 2. Average environmental temperature, humidity and THI status of the experimental shed.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Temperature (°C)</th>
<th>Humidity (%)</th>
<th>THI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–15 days</td>
<td>31.00</td>
<td>80.93</td>
<td>84.55</td>
</tr>
<tr>
<td>16–30 days</td>
<td>31.69</td>
<td>85.13</td>
<td>86.50</td>
</tr>
<tr>
<td>31–45 days</td>
<td>33.05</td>
<td>85.00</td>
<td>88.70</td>
</tr>
<tr>
<td>0–45 days</td>
<td>31.91</td>
<td>83.69</td>
<td>86.58</td>
</tr>
</tbody>
</table>

3.2. Performance and Physiological Status

There were no significant (p > 0.05) changes observed in feed intake between the control and treatment groups of both animal types (Table 3). The initial body weight was found to be similar between the groups. However, final body weight was significantly influenced (p < 0.05) by the treatment in indigenous dairy cattle, and an 8.07% enhancement in body weight was observed in the treatment group. Meanwhile, non-significant (p > 0.05) changes were found in crossbreed dairy cattle, and only a 3.34% body weight enhancement was observed in the treatment group in comparison with those fed the control diet. The body condition score recorded at the end of trial in indigenous dairy cattle was significantly improved (p < 0.01) in the treatment group, by 10.64%, in comparison with the control group. A similar trend was observed in crossbred dairy cattle, where a 11.97% improvement in BCS was recorded (p < 0.01) in treatment group in comparison to the cattle fed the control diet. The feed efficiency was improved by 2.82% in the treatment group of indigenous dairy cattle compared to the cows fed the control diet, whereas a remarkable improvement in feed efficiency by 12.0% was observed in the treatment group of crossbred dairy cattle. The respiration rate and rectal temperature were similar in the treatment groups for both types of cattle; however, the respiration rate was found to be lower in the indigenous dairy cattle in comparison with the crossbred dairy cattle, while no major changes were observed in rectal temperature between the types of animals. Moreover, a slight reduction (varies between 0.56% and 1.09%) in rectal temperature was recorded in both types of animals in the treatment group.

3.3. Milk Production and Its Composition

There were no significant (p > 0.05) changes observed in average milk yield between the control and treatment groups of both animal types (Table 4). However, milk production was significantly (p = 0.056) higher in the treatment group between days 31 and 45 of the trial in comparison with the control group. The average milk yield was influenced by the supplements used in the treatment group, increasing by 2.54% and 10.53% in indigenous and crossbred dairy cattle, respectively. The milk fat percentage in indigenous cows was unchanged among the groups; however, a significantly higher value (p < 0.05) by 15.66% was recorded in the crossbred dairy cattle treatment group. Protein and lactose percentage were not significantly influenced in both types of animals, but moderate enhancements in protein percentages by 7.14%, 13.20%, 5.84%, and 13.13% were observed in indigenous and crossbred dairy cows, respectively. The SNF and total solid constituents were unaffected by treatment in both types of animals; however, a moderate increase in total solid constituents by 5.35% was recorded in the treatment group of crossbred dairy cattle in comparison with the control.
### Table 3. Effect of supplementing organic selenium and yeast on the performance and physiological status of indigenous and crossbred dairy cattle.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Indigenous Dairy Cattle</th>
<th>Crossbred Dairy Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treatment</td>
</tr>
<tr>
<td>Number of animals</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Feed Intake (kg DM/d)</td>
<td>8.36 ± 0.34</td>
<td>8.32 ± 0.19</td>
</tr>
<tr>
<td>Conc. Mixt. (kg DM/d)</td>
<td>3.19 ± 0.37</td>
<td>3.39 ± 0.15</td>
</tr>
<tr>
<td>Roughage (kg DM/d)</td>
<td>5.18 ± 0.36</td>
<td>4.93 ± 0.14</td>
</tr>
<tr>
<td>R:C ratio</td>
<td>60.13:39.87</td>
<td>59.38:40.62</td>
</tr>
<tr>
<td>% DMI</td>
<td>2.45 ± 0.02</td>
<td>2.40 ± 0.04</td>
</tr>
<tr>
<td>Initial BW (kg)</td>
<td>340.78 ± 14.08</td>
<td>346.78 ± 9.86</td>
</tr>
<tr>
<td>Final BW (kg)</td>
<td>343.22 ± 11.04</td>
<td>373.33 ± 12.50</td>
</tr>
<tr>
<td>Initial BCS</td>
<td>3.98 ± 0.09</td>
<td>4.13 ± 0.04</td>
</tr>
<tr>
<td>Final BCS</td>
<td>3.62 ± 0.13</td>
<td>4.05 ± 0.07</td>
</tr>
<tr>
<td>Feed: Milk</td>
<td>1.82</td>
<td>1.77</td>
</tr>
<tr>
<td>Respiration rate (bpm)</td>
<td>36.44</td>
<td>35.56</td>
</tr>
<tr>
<td>Rectal temperature (°F)</td>
<td>102.03</td>
<td>101.46</td>
</tr>
</tbody>
</table>

Mean values within a row with different superscript letters differ significantly (p < 0.05; p < 0.01); BW, body weight; DM, dry matter; DMI, dry matter intake; BCS, body condition score; bpm, breaths per minute.

### Table 4. Effect of supplementing organic selenium and yeast on the average milk production and composition of indigenous and crossbred dairy cattle.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Indigenous Dairy Cattle</th>
<th>Crossbred Dairy Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treatment</td>
</tr>
<tr>
<td>Number of animals</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Average milk yield (kg/d)</td>
<td>4.53 ± 0.65</td>
<td>4.74 ± 0.48</td>
</tr>
<tr>
<td>Day 16–30</td>
<td>4.58 ± 0.59</td>
<td>4.73 ± 0.49</td>
</tr>
<tr>
<td>Day 31–45</td>
<td>4.84 ± 0.70</td>
<td>4.85 ± 0.41</td>
</tr>
<tr>
<td>Day 0–45</td>
<td>4.60 ± 0.68</td>
<td>4.70 ± 0.41</td>
</tr>
<tr>
<td>Milk composition (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>4.49 ± 0.45</td>
<td>3.77 ± 0.29</td>
</tr>
<tr>
<td>Protein</td>
<td>3.90 ± 0.16</td>
<td>4.20 ± 0.09</td>
</tr>
<tr>
<td>Lactose</td>
<td>5.97 ± 0.19</td>
<td>6.34 ± 0.13</td>
</tr>
<tr>
<td>SNF</td>
<td>10.97 ± 0.29</td>
<td>11.28 ± 0.37</td>
</tr>
<tr>
<td>Total solid</td>
<td>15.47 ± 0.55</td>
<td>15.05 ± 0.56</td>
</tr>
</tbody>
</table>

Mean values within a row with different superscript letters differ significantly (p < 0.05; p < 0.01); SNF, solid not fat.
3.4. Hematobiochemical Indices and Antioxidant Profile

The hemoglobin and packed cell volume concentrations were significantly increased \((p < 0.05)\) in the treatment group of indigenous dairy cow by 13.79 and 13.53%, respectively, whereas no such changes were observed in crossbred dairy cows (Table 5). Meanwhile, the rest of the hematological parameters were not influenced \((p > 0.05)\) by the addition of supplements in the diet of both types of animals. There were no significant changes \((p > 0.05)\) recorded in various serum biochemical indices among the groups in both types of animals (Table 6). However, serum creatinine level declined by 5.30% and 5.19% in the treatment groups of both indigenous and crossbred dairy cattle, respectively. Liver and kidney function enzymes were also unaffected by the treatment in both categories. Serum cholesterol and triglyceride were found to be unchanged \((p > 0.05)\) in both animal types. However, the inorganic phosphate concentration was significantly lower \((p = 0.053)\) in the treatment group of indigenous cattle in comparison to the control, whereas its concentration remained unchanged in crossbred dairy cattle.

The effects of supplements on various serum antioxidant parameters such glutathione peroxidase (GSH-Px), catalase, superoxide dismutase (SOD) and total antioxidant capacity (TAC) were significant \((p > 0.05)\) among the groups in both types of animals (Table 6). However, the serum lipid peroxidase (LPO) concentration was significantly increased \((p < 0.05)\) in the treatment group of crossbred dairy cattle, whereas its activity remained unchanged in indigenous dairy animals. Moreover, the concentrations of GSH-Px, SOD and TAC were improved by 19.67%, 13.88%, and 3.77% and 25.59%, 3.67%, and 6.02% in the treatment groups of both indigenous and crossbred dairy cows, respectively. The serum cortisol level was significantly increased \((p < 0.05)\) in the treatment group of indigenous dairy cattle by 24.54% in comparison with the control group, whereas it was found to be moderately increased \((p = 0.08)\) in the treatment group of crossbred dairy cattle by 16.07%, respectively (Table 6).

### Table 5. Effect of supplementing organic selenium and yeast on the hematological indices of indigenous and crossbred dairy cattle.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Indigenous Dairy Cattle</th>
<th>Crossbred Dairy Cattle</th>
<th>(p)-Value</th>
<th>Indigenous Dairy Cattle</th>
<th>Crossbred Dairy Cattle</th>
<th>(p)-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of animals</td>
<td>9</td>
<td>9</td>
<td></td>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Hb (g/dL)</td>
<td>11.19 ± 0.45</td>
<td>12.98 ± 0.88</td>
<td>0.046</td>
<td>8.48 ± 0.60</td>
<td>8.77 ± 0.78</td>
<td>0.387</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>33.67 ± 1.32</td>
<td>38.94 ± 2.67</td>
<td>0.048</td>
<td>25.43 ± 1.81</td>
<td>26.19 ± 2.53</td>
<td>0.400</td>
</tr>
<tr>
<td>MCV (µm³)</td>
<td>97.63 ± 1.35</td>
<td>98.82 ± 1.00</td>
<td>0.246</td>
<td>97.36 ± 1.49</td>
<td>97.23 ± 1.30</td>
<td>0.476</td>
</tr>
<tr>
<td>MCH (pg/cell)</td>
<td>32.97 ± 0.48</td>
<td>33.28 ± 0.27</td>
<td>0.289</td>
<td>32.96 ± 0.50</td>
<td>33.11 ± 0.35</td>
<td>0.400</td>
</tr>
<tr>
<td>TLC (mm³)</td>
<td>11,813.33 ± 687.81</td>
<td>10,788.89 ± 663.83</td>
<td>0.145</td>
<td>11,161.11 ± 459.82</td>
<td>10,538.89 ± 624.09</td>
<td>0.217</td>
</tr>
<tr>
<td>Neutrophil (%)</td>
<td>70.56 ± 1.86</td>
<td>66.78 ± 1.62</td>
<td>0.073</td>
<td>64.67 ± 1.74</td>
<td>65.89 ± 0.99</td>
<td>0.275</td>
</tr>
<tr>
<td>Lymphocyte (%)</td>
<td>24.78 ± 1.42</td>
<td>26.22 ± 1.06</td>
<td>0.214</td>
<td>27.00 ± 1.22</td>
<td>27.56 ± 0.80</td>
<td>0.355</td>
</tr>
<tr>
<td>Monocyte (%)</td>
<td>3.56 ± 0.55</td>
<td>3.44 ± 0.44</td>
<td>0.339</td>
<td>2.89 ± 0.61</td>
<td>3.44 ± 0.62</td>
<td>0.267</td>
</tr>
<tr>
<td>Eosinophil (%)</td>
<td>2.33 ± 0.33</td>
<td>2.78 ± 0.32</td>
<td>0.177</td>
<td>2.56 ± 0.41</td>
<td>2.33 ± 0.29</td>
<td>0.332</td>
</tr>
<tr>
<td>Basophil (%)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

\(a, b\) Mean values within a row with different superscript letters differ significantly \((p < 0.05; p < 0.01)\); Hb, hemoglobin; PCV, packed cell volume; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; TLC, total leucocyte count.
4. Discussion

The temperature and humidity index has become very crucial for lactating dairy cattle, in particular under summer conditions in the tropics. In an experiment that Hisham et al. [40] conducted on Holstein dairy cows supplemented with selenium and vitamin E throughout the Egyptian summer, they discovered that the average THI values for the months of July and August were 79 and 80, respectively. THI values between 74 and 78 are deemed harmful for animals, according to Marai and Habeeb [41], while THI values between 68 and 78 are thought to be the upper limit of dairy cattle comfort zones [42]. According to Davis et al. [43], the present data demonstrated that animals were experiencing heat stress; nonetheless, over the experimental period, performance was not significantly affected in either category of dairy cows, demonstrating the animals’ ability to adapt to their environment and survive.

The physiological status of dairy cattle could be altered during changing environmental temperature and humidity, influencing the feed intake and overall production performance. The current outcome was consistent with the findings of the researchers mentioned below. Hisham et al. [40] found that supplementing Se with vitamin E or organic forms had no discernible impact on the rectal temperature and respiration rate of dairy cows.
Holstein dairy cows throughout the summer in Egypt. El-Shahat and Abdel-Monem [44] made a similar observation, demonstrating that there was no significant difference in the experimental animals’ rectal temperature or respiration rate. Sun et al. [20] observed that the supplementation of hydroxy-selenomethionine in dairy cows had no significant effect on rectal temperature, respiratory rate, and dry matter intake. The dry matter intake of cattle that were fed live yeast (S. cerevisiae) on malt extract agar in their feed was also not significantly improved, according to Kung et al. [45]. Similarly, adding live yeast to cattle feed had no appreciable impact on their consumption of dry matter, body weight gain, milk production, or milk composition [46]. Similar findings to those reported by the various studies were found in the current data.

According to Kamada [47], supplementing Holstein cows with yeast-based Se at a level of 0.3 mg/kg DMI from the beginning of the ninth month of pregnancy until 100 days after parturition had a non-significant influence on milk production. Dairy cows fed OH-SeMet instead of sodium selenite, on the other hand, produced more milk during heat stress [20]. Wang et al. [48] reported that feeding dairy cows a selenium–yeast mix boosted milk output. Selenium insufficiency weakens the immune system, raising the risk of illness—particularly udder illness, which reduces milk production—and weakening the body’s ability to fight off infection [49]. The reason for the increased milk production in response to Se supplementation may be a better immune system [50]. The overall health of the animal, the health of the mammary gland, and other environmental factors have a direct impact on milk production, including inadequate food intake, a high production system, and poor physical condition [51]. Organic Se increases milk production by improving feed digestibility and managing the antioxidant system in dairy cows [48]. When S. cerevisiae was added to the diet of ruminants, Putman et al. [52] found that the milk production of dairy cattle increased only when the diet was lacking in protein. The results of the experiments where S. cerevisiae was included were quite variable. There are a number of factors that could affect this situation, including the experiment’s use of various doses, the animals’ age and lactation stage, the feed’s composition, and the feeding method. According to some reports, S. cerevisiae is more effective in diets with an insufficient nutritional content or high-energy diets [53]. Numerous investigations have demonstrated that adding S.cerevisiae to cattle feed enhances milk production [54]. According to Bruno et al. [55], cattle fed with supplemental live yeast (S.cerevisiae) produced 1.2 kg/d more milk than controls. Additionally, dairy cows given live yeast during the summer showed a +1.5 kg/d increase in milk production, according to Moallem et al. [24]. When live yeast (S. cerevisiae) was added into cattle feed in several tests, researchers did not observe a noticeably improved milk output in dairy cattle [56,57]. Other research trials revealed that adding S.cerevisiae to dairy cattle diets had no discernible impact on milk production or milk composition [56,57]. The current conclusion is consistent with the earlier findings, and it appears that supplements have no discernible impact on milk output in indigenous dairy cows but have a considerable impact by the second week in crossbred dairy cows.

According to Liu et al. [58], vitamin E and selenium supplementation enhanced milk fat concentration and production in comparison to the control diet. Since the rumen is where the majority of the precursors to milk fat are produced, rumen fermentation may have had an impact on the increased milk fat content. The effect of Se supplementation in the form of yeast on rumen fermentation was investigated by Faixova et al. [59], who discovered considerably greater activity of alkaline phosphatase and glutamate dehydrogenase in ruminal fluid in the Se-supplemented group. They attributed this to the supporting effect of Se on the rumen microbial community, which increased this community’s resistance and activity. In comparison to other therapies, selenium and vitamin E dramatically improved milk protein and lactose, according to Firestani et al. [60]. This was consistent with the findings of Wang et al. [48] and Eulogio et al. [61], who discovered that the treatment had no impact on the total solids. According to Oltramari et al. [62], the experimental diets had no impact on the milk’s solids-to-fat ratio. When calves were fed live yeast (S.cerevisiae)-supplemented diet, Maamouri et al. [63] observed a considerable rise in milk fat and
protein percentage. In a meta-analysis of published studies on \textit{S. cerevisiae} supplementation to ruminants, Desnoyers et al. [64] found that the milk fat content of cows receiving yeast supplementation increased in the last few weeks of the study. The current study’s findings corroborate the general perception of the observations made above, according to which organic selenium and yeast in dairy cows’ diets can alter milk production or the concentrations of fat, protein, and lactose, as well as the total solid content. These changes may be caused by modifications to the ruminal fermentation pattern and changes in the cellular availability of nutrients.

Hematobiochemical indices and antioxidant profiles could be indicators for measuring the cellular stress conditions and metabolic activities of dairy cattle during the summer months. According to Hisham et al. [40], supplementing Holstein dairy cows with selenium and vitamin E in an organic form or with vitamin E under summertime conditions in Egypt had no appreciable impact on the amounts of plasma total protein, albumin, or globulin. This outcome was in line with the findings from [65,66], indicating that plasma proteins were not impacted by Se supplementation. Kumar et al. [67] concluded that the addition of Se had no appreciable impact on serum globulin levels. According to Tahmasbi et al. [68], combined selenium and vitamin E injections given to dairy cows did not significantly affect their plasma urea levels; however, the blood urea nitrogen level may be influenced by the protein source consumed. Both Das et al. [69] and Antunovi et al. [70] found that selenium supplementation had no discernible effect on the enzyme activity (ALT and AST) in lamb blood. According to Tahmasbi et al. [68], supplementing with Se (0.5 mg/kg) had no impact on dairy cows’ triglyceride and cholesterol levels. According to Antunovic et al. [70], there was no discernible difference between control- and Se (0.3 mg/kg)-fed lambs in terms of blood total cholesterol and triglycerides. Furthermore, the findings from studies performed on farm animals supported the non-significant effect of Se supplementation on triglycerides [47,71]. The blood cholesterol and triglyceride levels in the study’s control and treated cows were not significantly affected by organic Se supplementation.

In dairy calves [72] and goats, Se and vitamin E increased glutathione peroxidase (GSH-Px) activity in the blood and increased the plasma concentrations of total antioxidant capacity and Se. The selenoenzyme activity and blood Se content are positively correlated, according to the findings. According to Illek et al. [73], the activity of the selenoenzyme glutathione peroxidase is frequently thought to represent the selenium level in whole blood. The review of 11 studies cited by Weiss [74], of which 9 reported no significant difference in GSH-Px activity when comparing Se and yeast with inorganic Se, even though the values were generally numerically higher, is supported by the lack of a significant effect of the source of dietary selenium on GSH-Px activity. Sun et al. [20,75] reported that supplementation of hydroxy-selenomethionine to lactating dairy cow increased the total antioxidant capacity and decreased malondialdehyde, hydrogen peroxide, and nitric oxide serum concentrations compared with the inorganic Se-fed control group. In our study, organic selenium and yeast supplementation in combination significantly raised serum cortisol levels in comparison to the control group. This might have been caused by environmental stress at the time, which also affected lipid peroxidation and antioxidant activity, leading to problems [76]. Reis et al. [77] discovered that Se supplementation at the rate of 3.6, 5.4, and 6.4 mg per animal per day has no effect on the level of blood cortisol in cows, which is in direct contrast to our finding. When under stress, the hypothalamic–pituitary–adrenal axis is activated, telling the adrenal gland to create cortisol. According to Roche et al. [78], early lactation’s negative energy balance is a significant contributor to oxidative stress, which triggers the release of cortisol and the production of inflammatory cytokines [79,80]. Selenium antioxidant activity is mostly dependent on the redox power of seleno-proteins such as the glutathione peroxidase and thioredoxin reductase families [81]. Thus, Se supplementation lowers plasma cortisol levels and oxidative stress [82]. In the current investigation, organic selenium, yeast, and equivalent antioxidant activity did not reduce serum cortisol levels or display comparable antioxidant activity. We can infer from this that the dose rate was insufficient to reduce lipid peroxidase activity and cortisol levels.
in the hot, humid environment. The findings of the performance parameters, however, showed that both supplements were successful in partially reducing the stress.

5. Conclusions

Based on these findings, it is concluded that supplementing indigenous and crossbred dairy cows with organic selenium and probiotics in combination moderately improved feed efficiency, improved milk production, enhanced milk compositions, and improved overall performance without affecting lactating dairy cattle’s physiological status. Additionally, neither indigenous nor crossbred lactating dairy cattle in the tropics experienced much of an impact on the hematobiochemical indices or antioxidant status under heat stress conditions.


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