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Maximizing Workshop Efficiency Reusing Old Compressors Globally: Memaksimalkan Efisiensi Bengkel Menggunakan Kembali Kompresor Lama Secara Global

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This study investigates the feasibility of repurposing old refrigerator compressors to construct an air compressor for workshop use. Conducted at the Laboratory of Mechanical Engineering, Muhammadiyah University of Sidoarjo, the research assesses performance factors such as compressor tube filling time and injection settings. Results indicate that using one compressor motor takes 12 minutes and 57 seconds to fill the tube, while two motors reduce this to 8 minutes and 12 seconds, reaching a maximum pressure of 75 psi. Higher spray gun settings result in faster air depletion. Although pressure output is weaker compared to conventional compressors, the cost-effectiveness of using reused materials is evident, highlighting potential economic and environmental benefits.

Highlight:

Repurposing old compressors for workshop air supply.

Assessing performance: filling time, injection settings.

Cost-effective, eco-friendly solution for workshop equipment.

Keyword: Repurposing, Refrigerator Compressors, Workshop Equipment, Performance Assessment, Cost-effectiveness

Introduction

A lot of people around the world depend on milk and other dairy goods, so dairy farming is an important part of farming (Rozhkova & Olentsova, 2020). Even so, many outside factors, like heat stress, can have a big impact on the health, output, and well-being of dairy cows (Cartwright et al., 2023:30). Animals are stressed by heat when they are exposed to too much heat and can't get rid of it. This makes the body do a lot of things that are supposed to keep things in balance (Sammad, Wang, et al., 2020). Each time these things happen they can wreck up milk yield, lose the pregnancy, and the health in general of all dairy animals, for which dairy farms lose money at times (Lovarelli et al., 2020).

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The superimposition of heat stress on dairy cows is characterized by their breathing faster, excessive sweating, and development of dehydration. It can cause dehydration and malfunction of the body fluid that may result in eventual death (Burhans et al., 2022). This may result in the udder of cows to eat smaller which would amount to a lower milk production and thereby making dairy milk look different (Ran et al., 2021). When temperature overheat producing milk is the worst. It is estimated that a loss of milk output ranging from 1 to 2 % of total annual dairy production is a resultant response from temperature stress on the farms. This is a big figure (Wankar et al., 2021).

The heat stress (HS) poses various challenges to the dairy cows due to its tendency to alter their physiological environment (McManus et al., 2022). By no means an acclimate, cows begin to appoint themselves to lower feed intakes, less activity and short and fast breaths (Zhou et al., 2022). The other point is that they could seek protection from the sun and wind by looking for shade that can help them to cool themselves down and the circulation of the blood around their bodies can speed up to get the lost heat (Périard et al., 2021). However, such dehydration symptoms may not be critical enough to stop the rise of the body's temperature. The consequence could be a spectrum of heat-related diseases and high absenteeism (Cramer et al., 2022).

Tao et al. (2020) add that there are also other effects. Heat stress is not only the quantity and quality of milk, but also the result of many other changes. In addition, it is hormones that may also be altered by the heat effect. Heat stress faced by dairy cows would bring them a low rate of pregnancies and more disappearance of the eggs (Baruselli et al., 2020). Heat stress can be expected to affect animal behavior as well, for instance, anxiety, risk of myoglobinuria and therefore aggravation of their wellbeing (Herbut et al., 2021). Huge damage is done to the business by heat stress. Every year, dairy and beef cow herds around the world lose a huge amount of money (Thornton et al., 2022).

Finally, heat stress is a big problem in dairy farming because it has a big impact on milk production, fertility, and the health of the animals (Sammad, Umer, et al., 2020). It's getting more and more important to find good ways to keep dairy cows from getting heat stress as temperatures rise around the world (Gupta et al., 2022). Harimana et al. (2023) say that this could be done with cooling devices, genetic selection to make cows more tolerant of heat, and food formulas that meet the specific needs of dairy cows that are stressed by heat. We can make plans to improve dairy cows' health, output, and well-being by learning how their bodies respond to heat stress. This will make dairy farming last a very long time (Dahl et al., 2020; Habimana et al., 2023; Silpa et al., 2021). A lot of physiological, biological, and blood factors will be looked at as part of the study to fully understand how different levels of heat stress affect the health and performance of dairy cows..

Methods

2.1. Treatments, Experimental Design, and Animals

They divided the cows into three groups based on the Thermal Humidity Index (THI): Comfortable Zone (CZ), with a temperature 25±14°C and a humidity level of 40±5%; mild stress (MS) whether with a temperature that ranges 36±33°C and a humidity level 50±5% or; and High Stress (HS), with temperature 45±25°C and a humidity level 45±5 This research paper investigates the implications of heat stress on dairy cows. Feeding the cows a mixed diet early in the morning and mid-day, with 2 kg of alfalfa hay in addition, for 90 days was carried out. The components of the mix were precisely chosen to supply all the requirements of the cows, and then, samples were tested and analyzed to find out their exact levels of dry matter, energy, protein, fiber, fat, and minerals.

2.2. Physiological parameters

As part of the tests, the animals' heart rate, breathing rate, abdominal temperature, pulse rate, and

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level of thirst were all measured. A non-contact telethermometer was used to check the temperature of the skin around the edges, making sure it was 2 to 3 inches away from the shoulder area. The respiratory rate (RR) was found by watching how the abdomen moved. Each movement outward was equal to one breath per minute. The heart rate (PR) was found by watching the middle coccygeal artery at the base of the tail beat. PR is given as beats per minute. A digital thermometer was put on the rectal tissue and left there for about two minutes to record the rectal temperature (RT) (Joksimović-Todorović et al., 2011). To check if the animals were under thermal stress, weather variables were used, especially Thom's formula (1959), which is THI = 0.72 x (Tdb + Twb) + 40.6, where Tdb is the dry bulb temperature in degrees Celsius and Twb is the wet bulb temperature in degrees Celsius (Fabris et al., 2019).

2.3. Blood sampling and Hematological parameter

After the hair was cut short and the area was cleaned with vinegar, K3-EDTA, heparinized, and serum vacutainers were used to draw blood from the jugular vein. Right away, the blood samples were taken to the lab and put in an ice bath so that basic stats could be found. We used Drabkin's Method to measure hemoglobin (Hb), the microhematocrit method to measure packed cell volume (PCV), a hemocytometer to count red blood cells and white blood cells, and normal ways to figure out MCV, MCH, and MCHC. A pH meter was used to measure the pH of the blood (Berian et al., 2019; Nabi et al., 2020).

2.4. Biochemical parameter

Other biological factors that were checked and found to be different were Total Protein (g/dl), Albumin (g/dl), Globulin (g/dl), A:G (g/dl), Aspartate aminotransferase (AST) (U/L), Alanine aminotransferase (ALT) (U/L), Creatinine (mg/dl), and Cholesterol (mg/dl). The DetectX Cortisol Enzyme Immunoassay Kit Method was used to find out how much cortisol there was. The small amounts of anti-cortisol monoclonal antibody added, the cortisol antigen in the sample or standard, and the small amounts of cortisol-peroxidase substance added all cause an immune reaction. When the cortisol level in the sample goes up, the number of bound cortisol-peroxidase conjugates goes down, which means the signal is weaker. The same thing happens when the cortisol level goes down. The anti-cortisol antibody is linked to the goat anti-mouse IgG-coated plates, and cortisol-peroxidase is linked to it. That's what makes the sound. Extra cortisol peroxidase doesn't stick to the plates and is flushed out of the well before the substrate is added. After being left alone for an hour, the plate is washed, and then the substrate is added. The cortisol-peroxidase molecule that is connected to the substrate reacts with it. A microtiter plate reader is used to measure the strength of the color at 450 nm after the reaction has been going on for a short time. To find the total protein (TP), the Biuret method (ERBA®) was used. Cupric ions in an alkaline solution are used in this method to change plasma into a blue complex. How bright the blue color is is tied to the amount of proteins. A colorimetric test was used to find out how much sodium (Na) there was. This method used color to find out how much potassium (K) there was. The idea behind this method is that potassium and sodium tetra phenol boron can mix in a certain buffer to make a colloidal solution. It is directly linked to the amount of potassium in the sample how much haze is made. To find out how much chloride (Cl) there was, the Ferric Thiocyanate Method was used. To use this method, you mix chloride with a solution of mercuric thiocyanate that has not yet been broken apart. The chloride wants to join with the mercury, which makes mercuric chloride. The thiocyanate that is released mixes with ferric ions in the fluid to form ferric thiocyanate. This is a very brightly colored substance that soaks up light with a wavelength of 480 nm. Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities were checked using standard Transasia Bio-Medicals kits. One way to do it is to mix aspartate or alanine with α-ketoglutarate. This makes oxaloacetate or pyruvate, which is the key process used to check AST and ALT activity. We tracked how much oxaloacetate or pyruvate was made by looking at how much oxaloacetate or pyruvate hydrazine was made with 2,4-dinitrophenyl hydrazine. It says that Total Plasma Proteins, Albumin (BCG Dye Method), and Cholesterol (CHOD PAP Method) are used by BUN (Balabel et al., 2023; Berian et al., 2019).

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2.5. Milk Sampling and Processing

Milking capacity was recorded daily during the trial period in both seasons, by direct reading on a milking device. The milk samples for chemical analysis were taken in sterile plastic cups from each quarter of udders on the 30th, 60th, and 90th day of lactation immediately before morning milking. The chemical composition of milk was determined on the apparatus Lactoscope-Delta Instruments-C-4 2.0 Holland (Joksimović-Todorović et al., 2011; Lengi et al., 2022).

2.6 Statistical Analysis

GraphPad Prism software, version 8.01, was used to do statistical analysis after evaluating the data for both normality and homogeneity of variance. one-way analysis of variance (ANOVA) was used to analyze and compare the data for significant differences between the experimental groups. All sample numbers are equal, where there are 6 samples per group. Tukey's post hoc multiple comparison test was used also. When the p-value was less than 0.05, differences were considered significant and were assigned separate superscription letters. The means and SEM are used to express all results

Result and Disscusion

3.1. Nutrition of caw

The dairy cows in this study received a mixed ration diet designed to meet their nutritional requirements. The daily feed intake consisted of a variety of ingredients, including grass hay, corn silage, alfalfa haylage, wet brewers' grains, corn grain, barley grain, soybean meal, soybean flour, wheat flour, and a mineral and vitamin supplement. This combination provided a total daily intake of 42 kg, with a dry matter content of 21.9 kg. The diet was formulated to deliver 157 MJ of net energy for lactation (NEL) and contained 16.5% crude protein, 17.5% crude fiber, and 4.45% crude fat on a dry matter basis. Additionally, the diet provided essential minerals such as calcium (0.92% of dry matter) and phosphorus (0.56% of dry matter), ensuring adequate intake of these nutrients for optimal cow health and milk production. Cows were fed 2 times a day with mixed rations (Table 1) and manual distribution of 2 kg alfalfa hay.

Feeds	Quantity (kg)
Grass hay	3.5
Corn silage, 35-40% DM	19
Alfalfa haylage	4.5
Wet brewers' grains	5.5
Corn grain	2.4
Barley grain	2.1
Soybean meal	1.5
Soybean flour	1.3
Wheat flour	1.4
Minerals and vitamins	0.8
TOTAL	42
Chemical composition	
Dry matter, kg	21,90
NEL, MJ	157,00
Crude protein, % DM	16,50
Crude fiber, % DM	17,50
Crude fat, % DM	4,45
Ca, % SM	0,92
P, % SM	0,56

Table 1. *Daily feedstuffs consumption per cow.*

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3.2. Physiological parameters

Heat stress significantly impacts various physiological parameters in dairy cattle, with progressively intensifying effects observed from comfortable zone (CZ) to high stress (HS) conditions. Respiration rate (Figure 1, A), a key indicator of heat dissipation efforts, exhibited a significant increase with rising stress levels, showing the highest values in HS followed by MS and then CZ (p-values < 0.0001 for both HS vs CZ and HS vs MS). Heart rate (Figure 1, B) also showed a significant elevation under HS compared to CZ and MS, indicating increased cardiovascular strain (p-values < 0.01 for both comparisons). Pulse rate (Figure 1, C), another measure of cardiovascular activity, followed a similar pattern with significant increases observed in both MS and HS groups compared to CZ (p-values < 0.0001 for all comparisons). Rectal temperature (Figure 1, D), a direct measure of core body temperature, showed a significant, though less pronounced, elevation in HS compared to CZ and MS (p-values < 0.05 for both comparisons). Dehydration levels (Figure 1, E), reflecting the body's fluid balance, were significantly higher in both MS and HS groups compared to CZ, with the most severe dehydration observed in HS cows (p-values < 0.001 for HS vs CZ and < 0.01 for MS vs CZ). Skin temperature (Figure 1, E), another indicator of heat dissipation, also increased significantly with rising stress levels, showing the highest values in HS followed by MS and then CZ (p-values < 0.01 for both HS vs CZ and HS vs MS). These findings collectively demonstrate the significant physiological strain experienced by dairy cattle under heat stress, affecting respiratory, cardiovascular, and thermoregulatory functions, as well as fluid balance.

Figure 1.

Figure 2.

Figure 1: Effect of Heat Stress on Physiological parameters of dairy cattle, Where Respiration Rate (A), Heart Rate (B), Pulse Rate (C), Rectal Temperature (D), Dehydration (E), and Skin temperature (F). Values are expressed as mean ± SE from triplicate groups. Asterisks on the data bars indicate significant differences between the experimental groups to their control when $p < 0.05$ (*), $p < 0.01$ (**), $p < 0.001$ (***), and $p < 0.0001$ (****).

3.3. Hematological parameter

Heat stress significantly impacts several hematological parameters in dairy cattle, with progressively worsening effects observed as stress levels rise from comfortable zone (CZ) to high stress (HS) conditions. Hemoglobin (Hb) and packed cell volume (PCV), both indicators of oxygen-carrying capacity, showed significant declines with increasing stress levels (p-values 0.0002 and 0.0024, respectively). This suggests that heat stress may impair the ability of blood to transport oxygen effectively. Red blood cell (RBC) count, however, exhibited a significant increase under HS compared to CZ and MS, potentially as a compensatory mechanism to counteract the reduced Hb and PCV levels (p-value <0.0001). White blood cell (WBC) count also showed significant variation, with MS cows having the highest count followed by CZ and then HS (p-value 0.0014), indicating potential shifts in immune response under different stress levels. HS also caused a big rise in the average corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin content (MCHC). Since all three factors had p-values less than 0.0001, this means that the amount and size of hemoglobin in red blood cells changed. An interesting fact is that blood pH didn't change much at any amount of stress (p-value 0.3692). A lot of these data show that heat stress changes many things in dairy cows' blood, which can impact their health, their immune systems, and the amount of oxygen they get., see Table 2.

Parameter	CZ	MS	HS	P-values
Hb(g/dl)	9.187±0.2534a	10.60±0.07881b	11.33±0.05783c	0.0002
PCV (%)	31.36±0.6094a	33.22±0.1703a	35.61±0.5459b	0.0024
RBC (×106 /µl)	5.467±0.06360a	4.480±0.09074b	3.550±0.1242c	<0.0001
WBC (×103 /µl)	9.280±0.3166a	7.653±0.4195b	5.910±0.2894c	0.0014
MCV (fl)	46.47±1.204a	70.70±3.175b	92.10±1.208c	<0.0001
MCH (pg)	14.03±0.3001a	17.55±0.4279b	27.70±0.8705c	<0.0001
MCHC (g/dl)	28.91±0.2285a	30.26±0.09292b	32.55±0.4620c	0.0004
Blood pH	7.317±0.01202	7.317±0.01453	7.360±0.03512	0.3692

Table 2. ***Effect of Heat Stress on hematology of dairy cattle (Mean ± SEM)***

Where CZ is related to cows in Comfortable Zone, MS is related to cows in mild stress, and HS is related to caws in high stress. Means within each raw that lack common superscripts differ significantly at $p < 0.05$.

3.4. Biochemical parameter

The metabolic factors of dairy cattle are greatly affected by heat stress, and the effects get worse as the temperature rises from the comfortable zone (CZ) to high stress (HS). Cortisol is a stress hormone that significantly increased under HS compared to CZ (p-value 0.0048), which means that the body was under more stress. In the same way, blood urea nitrogen (BUN) levels went up a lot when stress levels went up (p-value <0.0001). Heat stress had a big effect on the levels of total protein, albumin, and globulin. HS cows had higher levels of total protein and globulin but lower levels of albumin than the CZ and MS groups (p-values 0.0021, <0.0001, and 0.0004, respectively). This led to a much lower albumin-globulin (A: G) ratio in HS cows, which suggests that their livers may not be working as well and their immune systems may not be working as well either. AST and ALT enzymes in the liver also went up significantly as stress levels went up (p-values <0.0001 for both), which is more proof that the liver is damaged. Creatinine values, which show how well the kidneys are working, were significantly higher in the MS and HS groups compared to the CZ group (p-value 0.0004). Lastly, cholesterol levels went up significantly, though not as much as they did in CZ compared to HS (p-value 0.0336). These findings provide strong evidence of the detrimental effects of heat stress on various physiological systems in dairy cattle, with implications for animal health, welfare, and productivity. see Table 3.

Parameter	CZ	MS	HS	P-values
Cortisol (µg/dl)	0.8400±0.005774a	0.8700±0.005774ab	0.8933±0.008819b	0.0048
BUN (mg/dl)	14.64±0.4328a	29.40±0.5781b	36.16±0.3721c	<0.0001
Total Protein (g/dl)	6.410±0.03512a	6.583±0.03844a	6.783±0.04910b	0.0021
Albumin (g/dl)	3.327±0.01202a	3.420±0.005774b	3.550±0.005774c	<0.0001
Globulin (g/dl)	2.333±0.006667a	2.790±0.1498a	4.030±0.1986b	0.0004
A: G (g/dl)	1.853±0.03712a	1.577±0.03283b	1.357±0.03712c	0.0002
AST (U/L)	87.53±2.707a	108.0±3.910b	132.9±0.8207c	<0.0001
ALT (U/L)	38.52±0.5417a	43.13±0.8896b	56.31±0.7191c	<0.0001
Creatinine (mg/dl)	1.340±0.04041a	1.567±0.02728b	1.783±0.04096c	0.0004
Cholesterol (mg/dl)	126.8±0.4383a	128.5±0.5785ab	129.4±0.5460b	0.0336

Table 3. ***Effect of Heat Stress on biochemical parameters of dairy cattle (Mean ± SEM)***

Where CZ is related to caws in Comfortable Zone, MS is related to cows in mild stress, and HS is related to caws in high stress. Means within each raw that lack common superscripts differ significantly at $p < 0.05$.

3.5. Milk Sampling and Processing

Table 4 reveals a statistically significant impact of heat stress on milk yield and composition in dairy cows. Cows exposed to high heat stress (HS) produced significantly less milk per milking compared to those in comfortable zone (CZ) and mild stress (MS) conditions, as evidenced by a p-value of 0.0004. This decline in milk yield was accompanied by a significant reduction in milk fat and protein content under high-stress conditions (p-values of 0.0228 and 0.0150, respectively). Interestingly, lactose content remained relatively stable across all stress levels, with no significant differences observed (p-value of 0.7438). These findings highlight the negative consequences of heat stress on dairy production, specifically impacting milk quantity and the quality of key components like fat and protein.

Parameter	CZ	MS	HS	P-values

Milk yield (kg per milking)	28.50±0.5774a	24.50±0.5774b	21.50±0.5774c	0.0004
Milk fat (%)	4.187±0.1919a	3.697±0.03180ab	3.600±0.03606b	0.0228
Proteins (%)	3.187±0.1369a	2.840±0.04041ab	2.697±0.02028b	0.0150
Lactose (%)	4.367±0.03180a	4.417±0.07881a	4.427±0.05239a	0.7438

Table 4. ***Effect of Heat Stress on Milk Yield and Components of Dairy Cows (n = 10) (Mean ± SEM)***

Where CZ is related to cows in Comfortable Zone, MS is related to cows in mild stress, and HS is related to caws in high stress. Means within each raw that lack common superscripts differ significantly at $p < 0.05$.

4. Discussion

As part of this study, dairy cows were fed a mixed meal that was specially made to meet their specific nutritional needs for good health and milk production. The food had a lot of different feedstuffs, like grass hay, corn silage, and alfalfa haylage for roughage and different grains and soybean products for concentrates. This gave the animals a lot of fresh matter and dry matter every day (Lardy & Anderson, 2009). Notably, the food was carefully planned to make sure that the animals got enough energy from net energy for nursing (NEL) and important macronutrients like crude protein, crude fiber, and crude fat (Katoch, 2022; Te Pas et al., 2021). Mineral and vitamin supplements were also added to meet the important need for micronutrients, especially calcium and phosphorus, which are needed for many bodily functions, such as bone health and milk production (Godswill et al., 2020; Pellegrino et al., 2021). This careful method to making feed shows how important it is to give cows a well-balanced food to meet their metabolic needs during nursing and keep them healthy in general (Kaur et al., 2023).

As illustrated in the study, some biochemical elements in dairy cattle are affected negatively by heat stress. We witnessed huge fluctuations in respiratory rate, cardiovascular rate pulse rate, abdominal temperature, dehydration, and skin temperature as the weather conditions changed from a comfortable zone (CZ) to the moderate stress (MS) and high stress (HS) zones. Data analysis reveals that the animals expended energy to get rid of heat from their bodies and keep in balance when they were facing heat stress conditions (Oke et al., 2021). Elevation of the heart and pulse rates are with the aim of improving the blood flow to peripheral organs for heat exchange (Sejian et al., 2021). Lungs increase the breathing rate to cause cooling through evaporation. A rectal temperature increase will make the maintenance of the core body temperature difficult, and dehydration will mean that the body is losing more water through breathing and sweating (Idris et al., 2021). Thus, the final sign of a human body's effort to push the heat outside is a higher skin temperature. These bodily reactions are necessary for short-term lifespan but can lead to low food intake by rats, insufficient milk production, reproduction problem and a higher risk of diseases (Chen et al., 2021). To minimize the detrimental effects of excessive heat on the health and production of dairy cattle, more research needs to be done on the creation and utilization of effective ways to reduce heat, such as better house designs, cooling systems, and dietary changes. On the other hand, genetic characteristics of heat tolerance could provide a basis for breeding programs that select animals that perform well in hot areas.

Through this study we can observe that heat stress increases the level of biological markers in the blood tests of dairy cows, and the effect becomes more intense as the stress level goes from "comfortable" to "high stress". Among the main results is the decrease in Hb and PCV, which indicates the body may not carry enough oxygen required. On the other hand, RBCs keep multiplying due to the compensation.(Ahlgrim et al., 2020). The most WBC were found in cows that were not very stressed (MS). This implies that these rats are responding to heat differently than other animals (Siddiqui et al., 2022). When HS was used, all three of them MCV, MCH, and MCHC were raised. It implied the size of the red blood cells and the quantity of hemoglobin in them was altered. The body transforms its chemistry during heat stress in ways like losing water quicker, having reactions in its metabolism process, and stress. They lead to changes in blood flow, red blood cell generation and in cells function (Périard et al., 2021). According to Liang et al. (2022), the alteration observed by them in animal's blood can have big impacts such as reducing the amount of oxygen supply, weakening the immune system, and eventually affecting the health and productivity of the animals. The most significant part is to learn more about the changes that occur in their blood and find strategies to lessen the effect that stress has on their body and health e.g. altering their diets and adding cooling systems. To establish sustainable ways to care for the dairy cows in an ever-changing world, studies also need to be conducted to know how heat stress affects blood markers and overall health of cows.

The results of this study show that heat stress has a big effect on the bodies of dairy cows. As the stress level rose from low (CZ) to high (HS), the results got worse. Notably, levels of blood urea nitrogen (BUN) and cortisol, a key stress hormone, both went up a lot during HS. This suggests that the body was under more stress and that proteins may have been broken down. They also had different amounts of total protein and globulin in their blood, but less albumin than the cows in the mildly stressed (MS) and control groups. This means that the ratio of albumin to globulin (A: G) was smaller. It means the liver isn't working as well and the body's defenses may be weaker (Albillos et al., 2022). AST and ALT levels in the liver also went up a lot, which is more proof that the liver is damaged by heat stress (Zhang et al., 2022). Also, creatinine levels went up, which could mean that kidney function is getting worse, and cholesterol levels went up, though not as much as creatinine levels (Kim et al., 2021). These molecular changes show how the body reacts to heat stress, which includes hormonal issues, metabolic problems, and organ failure. These results are very important because they show that animal health, comfort, and productivity have been affected (Chauhan et al., 2021). Future study should focus on figuring out the complicated processes that cause these molecular changes and looking into specific treatments, like food strategies and heat reduction methods, to lessen the negative effects of heat stress on the health and function of dairy calves.

It was found that heat stress makes dairy cows make less milk and milk of a different type. The cows made a lot less milk each time they were milked when the heat stress level went from a comfortable zone (CZ) to high stress (HS). The amount of milk fat and protein also went down at the same time. But the amount of lactose stayed about the same. Lack of food, changes in metabolism, and chemical issues are some of the things that can cause milk production to drop. These all happen because of the stress on the body that comes from heat stress (McNamara et al., 2003). Because of changes in how nutrients are spread and how the mammary gland works when there is heat stress, the amount of fat and protein in the milk drops. (Tao et al., 2018). Farmers lose money when milk output and quality go down, which means these results are very important for the dairy business (Puerto et al., 2021). To keep milk quality high and reduce production losses, future study should look into effective ways to reduce heat stress, such as better house designs, cooling systems, and nutrition changes. Also, studying the genetic basis of dairy cows' ability to handle heat could lead to breeding plans that make animals better able to live in warmer places. A better knowledge of the exact ways that heat stress impacts milk production and release could also help in creating focused treatments that make dairy cows more resilient and productive in harsh weather circumstances.

Conclusion

Many of the physiological, blood, biochemical, and milk output factors of dairy cows in Iraq are affected by heat stress. Cows that were under a lot of heat stress had a lot of physical problems, like changes in their blood patterns, liver and kidney problems, and less milk production and quality. These results make it clear that successful methods for reducing heat stress must be put in place to protect animal health and keep the dairy business going in hot areas. In the future, researchers should work on improving and creating ways to keep dairy cows cool and looking into how to use diet to help cows' bodies and production when they are under a lot of heat stress.

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